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MICHIGAN APPLE CIDER: PROCESSING PRACTICES, HAZARD SURVEILLANCE, AND PERCEPTIONS

By

Donna J. Thede

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ABSTRACT

MICHIGAN APPLE CIDER: PROCESSING PRACTICES, HAZARD SURVEILLANCE, AND PERCEPTIONS

By

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Numerous foodborne illness outbreaks linked to consumption of juice containing microbial pathogens occurred in the U.S. in the 1990's and increased public concern about cider safety. Sources of several foodborne illness outbreaks were unpasteurized apple juice and cider, which contained the pathogen *E. coli* O157:H7 because of poor food safety practices in orchards and processing facilities. Therefore, the U.S. Food and Drug Administration (FDA) announced a comprehensive program to eliminate pathogen contaminations of juice and in 2001 issued the juice Hazard Analysis and Critical Control Points (HACCP) regulation, which require juice processors to implement HACCP into their processing facilities. Processors who only sell juice directly to consumers are not required to implement HACCP but they must include a warning statement about the risk of pathogens on their juice containers.

The objectives of this study were to determine a) bacterial counts of cider and manufacturing practices of Michigan cider processors between 1997 and 2002 and b) perceptions of both Michigan cider processors and consumers regarding HACCP and juice safety in 2002.

E. coli O157:H7 was not detected in any of the cider samples tested during 1997-2002 (n=582). A small percentage (5.8%) of cider samples contained generic *E. coli*, indicating potential fecal contamination and the need to improve sanitation practices in some mills. During 1997-2002, more processors took affirmative steps to carefully

inspect and safely store apples and had upgraded processing facilities and equipment. In 2002, 26% of the processors producing over 4,000 gallons of cider per year had installed thermal pasteurization (n=17) or ultraviolet (UV) light irradiation (n=7) equipment to reduce the risk of pathogens, but microbial data also indicated that some processors either did not operate the equipment properly or post-processing contamination occurred. Michigan cider processors were divided regarding the juice HACCP regulation: 31% agreed, 21% were neutral, and 48% opposed HACCP regulations. In contrast to processors that favored HACCP, processors that disagreed with HACCP did not prepare for HACCP. Those processors believed that HACCP was not necessary for cider safety and did not improve consumer confidence because they believed that their customers trusted their cider mill and preferred the taste of untreated cider.

Michigan apple cider and juice consumers were concerned about food safety but not knowledgeable about labeling or HACCP. Only 20% of those surveyed were aware that HACCP is a food safety program. Our respondents based their apple cider or juice purchase decisions first on their perception of its taste and then safety. Consumers would buy juice from grocery stores if they look for safety, whereas consumers would buy juice from local farms or orchards if they look for freshness and 100% juice.

Future research should further evaluate the safety of Michigan cider and how to overcome perceived constraints of processors to HACCP implementation. Additionally, using focus groups and interviews to examine consumers' perceptions and purchase decision about apple cider and juice are warranted.

To my mom and dad who taught me perseverance and to realize great things happen when you least expect them and Danny for his love, patience and understanding.

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LIST OF ABBREVIATIONS

CDC .....U.S. Centers or Disease Control and Prevention

CFU.....Colony Forming Unit

CFR.....U.S. Code of Federal Regulations

CGMPs.....Current Good Manufacturing Practices

CODEX.....Codex Alimentarius Commission

CSA.....Community Supported Agriculture

FDA.....United States Food and Drug Administration

GAPs.....Good Agricultural Practices

HACCP .....Hazard Analysis and Critical Control Points

HTST.....High Temperature Short Time Thermal Pasteurization

HUS.....Hemolytic Uremic Syndrome

MDA .....Michigan Department of Agriculture

NACMCF.....National Advisory Committee on Microbiological Criteria for Foods

PEF.....Pulsed Electrical Field

SEM .....Standard Error of Mean

SSOPs .....Sanitation Standard Operating Procedures

U.S. .....United States

USDA.....United States Department of Agriculture

USGAO.....United States General Accounting Office

UV light .....Ultraviolet light irradiation

CHAPTER I. INTRODUCTION

Juice Food Safety Concerns and HACCP

The United States (U.S.) is considered to have one of the safest food supplies in the world. Research and opinion polls, however, continue to find that consumers are concerned about food safety. To address these concerns, the government agencies responsible for food safety have investigated foodborne outbreaks to identify sources of contamination and other factors that contribute to these illnesses. Additional laws and regulations have been established for foods that the agencies believe present significant risk to consumers. Juice is a food of concern because there have been several well-publicized foodborne illness outbreaks and the U.S. Food and Drug Administration (FDA) estimates there are between 16,000 to 48,000 cases of juice-related illnesses each year in the U.S. (FDA, 2001).

The FDA recently promulgated a regulation requiring Hazard Analysis and Critical Control Point (HACCP) systems be implemented by the juice industry. Investigations into juice outbreaks and operating procedures in juice processing facilities determined that the pathogens, *Salmonella* spp., *E. coli* O157:H7 and *Cryptosporidium parvum*, are the most resistant microorganisms of public health significance found in juice and considered to be the pertinent juice pathogens (FDA, 2001).

In January 2001, the FDA published the final juice HACCP regulation with compliance to occur in phases based on the size of the juice manufacturing business. In January 2002, implementation of the FDA juice HACCP regulation was expected for the largest juice manufacturers – those having more than 500 employees and not being defined as small or very small businesses. Small businesses were to comply no later than

January 2003 and were defined as operations employing fewer than 500 employees and not considered a very small operation. Very small juice manufacturers were required to comply with the regulation in January 2004 and were defined as those operations that have either total annual sales of less than $500,000, or have total annual sales greater than $500,000 but their total food sales are less than $50,000 or are operations that employ fewer than an average of 100 full-time equivalent employees and sell fewer than 100,000 units of juice in the U.S. (FDA, 2001). The juice HACCP regulation states that significant food safety hazards must be addressed at all points in fruit and vegetable growing, harvesting, processing, storage and distribution of juice. The regulation also established a performance standard, such that juice products subject to the regulation must be treated in a manner that will achieve a 5-log reduction of the pertinent pathogens. An exception was made to the juice HACCP regulation for juice processed and sold at the same retail establishment and directly to consumers. These juice manufacturers were exempted from implementing HACCP and a 5-log reduction step to reduce the risk of pertinent pathogens but were required to have a specific warning label on juice packaging informing consumers about the risk of pathogens in the juice (FDA, 2001).

The juice HACCP regulation provides a research opportunity to investigate processors' food safety practices and their perceptions of HACCP. HACCP is a well-established food safety program, in the U.S. and internationally, and required in most sectors of the U.S. food industry (Table 1). HACCP is a systematic approach to the identification, evaluation and control of chemical, physical and biological hazards in the food supply. The objective of HACCP is to make the food safe and to be able to prove that food was produced in a manner that ensures its safety.

In 1995, the FDA issued the first legislation requiring HAACP implementation in the seafood industry. The United States Department of Agriculture (USDA) closely followed with issuance of a HACCP regulation better known as the "Mega-Reg" in 1996 for the meat and poultry industry (FDA, 2001; National Research Council, 1998; Stevenson and Bernard, 1999; USDA, 1999).

A report from the U.S. General Accounting Office (USGAO) into HACCP compliance found that in the seafood industry, two years after implementation of the HACCP regulation, only 44% of processors were using HACCP (USGAO, 2001). This poor compliance was believed to stem from a lack of processor knowledge, disagreement with the seafood legislation, and limited enforcement by FDA inspectors. Successful implementation of HACCP depends upon processors' consensus that it is beneficial to improving food safety of their products and agency inspectors ensuring that HACCP systems are in place and effective (USGAO, 2001).

Another research opportunity provided by the juice HACCP regulation is to investigate consumers' perception of food safety in regards to juice and HACCP. Surveys of consumers' perceptions reveal that concerns over food safety are increasing (Bruhn and Schutz, 1999; Johnson and Griffith, 1996; Unklesbay et al., 1998). At the same time, perceptions and behaviors are not necessarily correlated. For example, Bruhn and Schutz (1999) surveyed over 600 California residents, and found that while many were aware of the cross-contamination risks associated with raw meat and fruits and vegetables, they would often wash cutting boards and utensils with nothing more than water. In addition, many relied on sensory perceptions to judge the safety of the food, instead of safe handling practices. Johnson and Griffith (1996) studied consumers'

perceptions toward seafood and pollution, and concluded that while consumers were concerned with heavy metals in their seafood, there was not enough information for consumers to make informed purchase decisions. Consumers involved in focus groups about food safety of meat were not familiar with HACCP. After an explanation of HACCP consumers were asked if a HACCP approval seal on the meat package would increase their confidence in the product and would they be willing to pay a higher price for the meat if it carried the HACCP seal. Consumers indicated HACCP would increase their confidence in the product but believed this type of food safety program should already be the standard operating procedure for meat processors. Therefore, they were not willing to pay more for a HACCP approval seal (Ford et al., 1998).

This research study investigates Michigan cider processor food safety practices from 1997 through 2002 and the bacterial populations of Michigan apple cider. We also surveyed processors in 2002 on their perceptions of the juice HACCP regulation and cider safety, and Michigan consumers who purchased apple cider and juice during 2002 about their perceptions of juice food safety. Apples, apple cider and juice are important commodities to the state of Michigan. Michigan is one of the top four apple producing states and one of the top three states in cider production with approximately 30 percent of Michigan apples processed into cider each year (Michigan Apple Association, 2004; Michigan Agricultural Statistics, 2003).

In this dissertation, the term cider describes unfiltered apple juice. Cider mills describe processing plants that process apples into unfiltered juice and processors of these plants are referred to as cider processors. In the literature review, the term juice refers to fruit juice and apple juice is used when the research does not specific cider.

Objective, Hypotheses And Specific Aims

The objective of this research was to determine if bacterial hazards and perceptions of cider by Michigan processors and consumers have changed due to foooborne illness outbreaks associated with juice and the implementation of the FDA juice HACCP regulation. My hypothesis is; H_0: Because of the FDA juice regulation it is hypothesized that:

a) From 1997 through 2002, bacterial counts in cider are influenced by cider mill size and implementation of technologies to reduce bacterial load;

b) In 2002, practices and perceptions about HACCP differ among processors;

c) In 2002, consumers will be concerned about juice safety and these concerns will influence purchase decisions about apple cider and juice.

The specific aims are:

- To determine if the size of the cider mill, based on production volume, influenced compliance with Current Good Manufacturing Practices and adoption of intervention technology, such as thermal pasteurization and ultraviolet light irradiation and bacterial populations from 1997 through 2002 in Michigan.
- To determine cider mill processors perceptions about cider food safety and the FDA Juice HACCP Regulation.
- To determine Michigan apple cider and juice consumers' perceptions about food safety and apple cider or juice.

Data from Michigan Department of Agriculture (MDA) annual inspections of cider mills from 1997 through 2002 and bacterial analyses of end-product cider samples were used for this study. Microbial analysis included total aerobic plate count, total coliforms,

generic *E. coli*, and *E. coli* O157:H7. In August and September 2002, two surveys were mailed to cider processors asking about their processing practices and perceptions of the juice HACCP regulation. In October 2002, an e-mail survey was sent to Michigan consumers who purchased apple cider and juice to inquire about their perceptions of food safety and apple cider or juice. Dillman's (2000) survey research methods were used to design, write and implement the survey questions and data collection. Data were analyzed using Statistical Analysis Software (SAS), Cary, NC.

Table 1. History of Hazard Analysis and Critical Control Points (HACCP)

Year	Organization	Purpose	Description	Reference
1959	Pillsbury Company, U.S Army Natick Laboratories and NASA	Space foods	As a result of NASA food safety requirements for space foods served during manned space flights	Stevenson and Bernard, 1999
1973	Pillsbury Company	Canned and frozen foods	Cooperative project with FDA to develop inspections of food processing facilities	Stevenson and Bernard, 1999
1973	Food and Drug Administration (FDA)	Low-acid foods and acidified canned foods regulations	CFR 21, Part 113 outlines initial principles of HACCP	FDA, 1973
1985	National Academy of Sciences (NAS)	Food safety of processed foods	Issued report to establish microbial criteria of foods and endorsement of HACCP	NAS, 1985
1989	National Advisory Committee on Microbial Criteria for Foods (NACMCF)	Food safety	Microbial criteria for food and food ingredients and seven steps of HACCP established	NACMCF, 1989
1993	Food and Drug Administration (FDA)	Milk and milk products	Grade A Pasteurized Milk Ordinance (PMO) requires dairy processors to follow PMO based on HACCP principles	FDA, 1993
1995	Food and Drug Administration (FDA)	Seafood	CFR 21, Part 123 Procedures for the Safe & Sanitary Processing and Importing of Fish and Fisheries Products	FDA, 1995
1996	United States Department of Agriculture (USDA)	Meat and poultry	CFR 9, Parts 416 & 417 Pathogen reduction; HACCP systems for Meat and Poultry	USDA/FSIS, 1996

Table 1 (cont'd).

1997	National Advisory Committee on Microbial Criteria for Foods (NACMCF)	Food safety	HACCP Principles and Application Guidelines	NACMCF, 1997
1997	Codex Alimentarius Committee on Food Hygiene (CODEX)	Food safety of processed foods	International adoption of HACCP	CODEX General Principles of Food Hygiene, 1997
2001	Food and Drug Administration (FDA)	Juice	CFR 21, Part 120 HACCP; Procedures for the Safe and Sanitary Processing and Importing of Juice; Final Rule.	FDA, 2001

CHAPTER II. REVIEW OF LITERATURE

A. Juice Foodborne Illness Outbreaks and Bacterial Hazards

The FDA estimates there are between 16,000-48,000 juice-related illnesses per year in the United States (FDA, 2001). The majority of these illnesses are believed to results from the presence of pathogenic microorganisms in juice. Unpasteurized juices are of greatest concern because of a significant number of foodborne illness outbreaks associated with consumption of these products (Table 2). These outbreaks generally have resulted either from use of contaminated fruit or improper sanitation during processing. The quality of incoming fruit and appropriate methods to clean and sanitize fruit and processing equipment are most critical when processing unpasteurized juice (Besser, et al., 1993; FDA, 2001). The ability of some pathogens (e.g., *E. coli* O157:H7, *Salmonella* spp. and *Cryptosporidium parvum*) to survive under the mildly acidic conditions of apple and orange juice has further heightened concern about the safety of unpasteurized juice products (FDA, 2001; Zhao et al., 1993).

The presence of pathogens in untreated juice was reported as early as 1923 when *Salmonella* Typhimurium was traced to unpasteurized cider (Parish, 2000). Heightened awareness about pathogens in fresh juice occurred in 1974 when the Centers for Disease Control and Prevention (CDC) issued a report about an outbreak because of to *Salmonella* Typhimurium in commercial unpasteurized apple juice. The presence of *Salmonella* in the unpasteurized juice was believed to have resulted from the juice being made from apples that had fallen to the ground where they were exposed to manure. The contaminated apples were then processed under poor sanitation conditions (CDC, 1975). In 1980, fresh unpasteurized apple juice was suspected to be the cause of several cases of

hemolytic uremic syndrome (HUS) in Canada after the victims drank the fresh juice; however, because of a lack of samples the cause of the illnesses was not confirmed (Steele, et al., 1982; Parrish, 2000). In 1982, *E. coli* O157:H7 was identified as a human pathogen (Doyle, 1991). A confirmed HUS outbreak in the United States in 1991 was linked to consumption of fresh-pressed unpasteurized apple juice (FDA, 1998). *E. coli* O157:H7 was found in the unpreserved refrigerated apple juice and the organism was believed to have survived for over 20 days (Zhao, et al,. 1993). The juice was made from apples that had dropped from trees and were not washed before processing. It was concluded that fresh unpreserved apple juice could transmit *E. coli* O157:H7, and using only tree-picked, washed and brushed apples would reduce the risk of transmission of *E. coli* O157:H7 into the finished juice (Besser et al., 1993). In 1996, two foodborne illness outbreaks were traced back to the presence of *E. coli* O157:H7 in unpasteurized apple juice. One incident involved several people becoming ill at a church function after consuming unpasteurized cider (CDC, 1996; FDA, 1999) and the second was a multi-state HUS outbreak in the western U.S. and Canada. The latter outbreak involved 70 people, of which 50 percent were children under five years of age, and caused the death of one child (CDC, 1996). Again, these incidents were believed to have occurred due to improper handling of the fruit and poor sanitation during processing (Parish, 1997).

Unpasteurized orange juice contaminated with *Salmonella* spp. has been associated with several foodborne illness outbreaks. Testing of the contaminated orange juice from the 1995 outbreak confirmed the presence of three serotypes of *Salmonella* (Hartford, Gaminara and Rubislaw) and a second outbreak in 1999 was attributed to *Salmonella* Muenchen. In 2000, a third outbreak occurred and *Salmonella* Enteritidis

was found in the unpasteurized orange juice. These foodborne illness outbreaks all resulted from poor sanitation practices, processing equipment not being properly cleaned and the processing facility not adequately screened or secured to prevent the entrance of insects and animals (Cook, et al., 1998; FDA 2001; Parrish, 1997, 1998, 2000).

Two foodborne illness outbreaks associated with apple juice and the presence of *Cryptosporidium parvum* have occurred, one in 1996 and one in 2003 (Table 2). The 1996 outbreak was investigated since *Cryptosporidium parvum*, a protozoan parasite, is commonly recognized as a waterborne parasite. *Cryptosporidium* oocysts are extremely stable and can remain infectious for long periods of time in water and food. The investigation found oocysts to be resistant to sanitizers used in wash water for apples, and the CDC suggested that the apples might have been the source of the contamination (CDC 1996; Ohio Department of Health, 2003).

The bacterial agents of most concern in acidic juice (pH 4.6 or less) include *E. coli* O157:H7, various *Salmonella* spp. and the protozoan parasite *Cryptosporidium parvum*. *Listeria monocytogenes* is also considered a possible pertinent pathogen of concern due to its ubiquitous nature. These pathogens can thrive on damaged fruit. If this fruit is used in juice production, the pathogens have the ability to resist sanitizers and survive in acidic conditions.

It is believed that using damaged fruit along with inadequate processing controls are the reasons for juice-associated foodborne illness outbreaks (FDA, 2004). Pathogens contaminate fruit through contact with feces, contaminated water or soil, insects or equipment surfaces. Their presence in juice can be controlled through the appropriate use

Current Good Manufacturing Practices (CGMPs) and a lethality step in processing (FDA, 2002; FDA 2004).

B. Juice Characteristics and Bacterial Survival

Although juice-associated foodborne illness outbreaks were reported as early as 1923 (Table 2), research and food safety concerns were not focused on bacteria surviving and growing in juice. Fruit is high in moisture content, has a high percentage of carbohydrate and a low pH, ranging from 2.9 to 5.0 depending on the fruit. Fruit is also protected by a skin serving as a protective barrier that discourages microorganisms from invading the inside of the fruit (Jay, 1996).

There are two types of microorganisms that can adhere to the surface of fruit. The first is a natural floral consisting of aerobic non-pathogenic bacteria, yeast and molds that attach to the fruit surface. The second type of microorganisms found on fruit results from external forces such as wind, soil, dust, rain, floods, insects, birds and rodents. These microorganisms, which may include pathogens, can contaminate the fruit's surface and vary geographically and from orchard to orchard. When an injury occurs to the fruit's surface, microorganisms can penetrate to the interior and grow depending on the temperature, presence of moisture and length of exposure (Doores, 1993; Jay, 1996).

The pH of the apple may also be a factor in supporting the presence of pathogens. Fisher and Golden (1998) found Golden and Red Delicious apples tend to support the growth of *E. coli* O157:H7 due to their higher pH compared with other apple varieties. Another study found that mold on the apple's surface can cause damage and raise the apple's pH. If a pathogen, such as *E. coli* O157:H7, is present on a mold-damaged apple it can enter the interior and grow due to the higher pH (Doores, 1993).

Concerns about pathogens surviving in juice were validated by research that investigated the pH and cold tolerance of *E. coli* O157:H7. This pathogen can survive at pH below 4.0 and at typical refrigeration temperatures of approximately 4.4°C (40°F) (Riordan et al., 2001; Tauxe et al., 1997; Zhao et al., 1993)

This research study focuses on bacterial hazards in Michigan cider; however, other hazards can occur in cider processing such as chemical and physical hazards.

C. Chemical and Physical Hazards in Juice

In addition to bacterial hazards, chemical and physical hazards are a concern in juice. Chemical hazards can exist if sanitizers or other chemicals used to clean equipment are not properly used. For example, residual cleaning or sanitizing solution may contaminate the product if equipment or plumbing is not effectively rinsed following cleaning and sanitizing procedures. An example of this occurred in 2002, when orange juice was recalled due to the likely presence of equipment cleaning solution (FDA, 2002). Another chemical hazard associated with juice is the mycotoxin patulin in apple juice. Patulin is produced in rotting and moldy apples. Fallen and damaged apples are susceptible to the growth of patulin-producing molds. Improper or extended storage of apples (more than a few months) encourages patulin growth. High levels of patulin may occur in juice, including pasteurized juice, because thermal processing does not effectively destroy patulin. Exposure to high levels of patulin over time can be a health hazard. The FDA has established an action level for patulin of 50 micrograms per kilogram (FDA, 2001).

Undeclared food allergens in juice represent another chemical hazard that may result from cross-contamination from shared processing equipment. Many large juice

manufacturers use the same equipment to process milk. If the equipment is inadequately cleaned, any milk protein left on the equipment could contaminate the juice resulting in a milk allergen concern. Other chemical hazards that should be considered in a HACCP plan include pesticide residues from treated fruit, possible lead contamination stemming from the historical use of lead arsenate as an insecticide and tin if the fruit juice is packaged into cans (FDA, 2004).

Physical hazards are generally classified as any potentially harmful extraneous matter not normally found in food and capable of causing personal injury. Examples of physical hazards that may occur in juice include glass fragments because of breakage if juice is packaged in glass containers or metal that may arise from equipment during processing. Each potential hazard needs to be evaluated based on the processing operation and the likelihood of the hazard (FDA, 2004). Investigation in the chemical and physical hazards in cider is not included in this research.

D. Juice Hazard Analysis and Critical Control Points (HACCP)

In August 1997, the FDA published a notice of intent announcing a comprehensive program to address foodborne illness and hazards associated with juice products. The first regulation, promulgated in 1998, required a warning statement on the product label for juice products that were not processed using HACCP or a lethality step that would achieve a cumulative 5-log reduction of the pertinent pathogens. The warning statement reads; "WARNING: This product has not been pasteurized and, therefore, may contain harmful bacteria which can cause serious illness in children, the elderly, and persons with weakened immune systems." In addition, educational programs on juice safety and HACCP were established for juice manufacturers.

In 1998, the FDA announced its intention to require juice processors to develop and implement HACCP systems. A lengthy process whereby the agency sought public comments and scientific advice ensued. During the comment period additional consideration was given to four areas: 1) internalization and survival of pathogens in produce used for juice, 2) application of the 5-log reduction standard, 3) current methods used by juice processors to monitor the application of heat treatment to juice and 4) certain economic matters related to the juice regulation. For the areas of internalization and survival of pathogens, and application and measurement of the 5-log reduction standard, the FDA sought the guidance of the National Advisory Committee on Microbiological Criteria for Foods (NACMCF). NACMCF members concurred that it is theoretically possible for microorganisms to enter the interior of apparently sound, intact fruit under certain processing conditions, such as when temperature differences occur between the fruit and the wash water. The committee concurred that the likelihood of bacteria entering intact fruit via wash water in concentrations sufficient to cause foodborne illness was relatively low. However, once a pathogen is introduced into the fruit juice, it can survive the juice's acidic pH (FDA 1999; FDA 2001).

NACMCF also provided the FDA with five basic consensus decisions related to the application and measurement of a 5-log reduction standard for juice. The five decisions stated that the 5-log reduction need not start with the extracted juice but may begin with the exterior decontamination of fruit. However, processors should not begin calculation of the cumulative 5-log reduction until the fruit is cleaned and culled. Secondly, a possible method to minimize potential microbial infiltration into the fruit would be controlling the wash water temperatures, as well as excluding damaged fruit.

This was based on research concluding that microbes can penetrate into damaged fruit when warm fruit is washed with cold water (Annous et al., 1995; Kenney et al., 2001). Thirdly, the entire 5-log reduction must occur under one firm's control and in one processing facility. If processors transport fruit or juice to another facility for extraction, blending or final packaging, then a 5-log reduction must be accomplished in the second facility. Fourthly, bulk juice repacked at another facility must have a 5-log reduction process at the final packing facility. Lastly, as part of the HACCP verification program, firms must conduct microbial testing on the final product if the 5-log reduction process relies in part on fruit surface treatment. This testing would verify the 5-log reduction process by testing for generic *E. coli* as a means to assess the control of the process and utilize the appropriate bacteria sampling method, conducted as part of the HACCP plan. Although generic *E. coli* is not a pathogen, its presence is an indicator of fecal contamination that may indicate the presence of pathogens such as *E. coli* O157:H7, *Salmonella* spp. and *Cryptosporidium parvum*. If the end-product tests positive for generic *E. coli* then testing is to be conducted for specific pathogens of concern (FDA, 2001).

Based on the history of outbreaks from juice products, the Fresh Produce Subcommittee of the NACMCF and several other organizations recommended to the FDA that they move toward adopting mandatory HACCP for the juice industry to assist in reducing microbiological risks associated with juice. In response to this and other input, the FDA published the final regulation - Hazard Analysis and Critical Control Point (HACCP); Procedures for the Safe and Sanitary Processing and Importing of Juice; Final Rule (21 CFR Part 120) in January 2001. Required compliance with the juice

HACCP regulation was phased in over a three-year period with large, small and very small processors having to implement HACCP systems in January 2002, 2003 and 2004 respectively. FDA did not accept all of the NACMCF's recommendations and made the following exceptions; 1) the juice HACCP regulation only applies to 100% juice beverage products and 2) retail establishments or businesses that make and sell juice directly to consumers and do not sell juice to other businesses are exempt from the juice HACCP regulation, but must comply with FDA's food labeling regulation that requires a warning statement on packaged fruit and vegetable juice products that have not been processed using a lethality step to reduce the risk of pathogens (FDA, 2001).

E. Apple Production and Juice Processing

The juice HACCP regulation applies to the processing of juice. It does not directly apply to the growing, harvesting and transporting of fruits and vegetables that are used to process juice. However, growers, transporters and juice processors are encouraged to undertake some activities and functions that are not HACCP control measures but serve as prerequisites for a HACCP plan. These activities and functions include Good Agriculture Practices (GAPs), Current Good Manufacturing Practices (CGMPs) and Sanitation Standard Operating Practices (SSOPs) from the orchard to storage and distribution of the bottled juice. Juice processing research investigating possible contamination venues from growing and harvesting to the final product support the use of GAPs and CGMPs to reduce the risk of pathogens contaminating juice. The entire juice processing process needs to be evaluated since contamination can be attributed to many factors throughout processing (Dingman, 1999).

Practices in the orchard such as the water used, presence of animals, harvesting of dropped apples and timing of harvesting can increase the risk of coliforms, generic *E. coli* and *E. coli* O157:H7 being present on or in fruit. It is recommended that precautions be taken in the orchard to prevent animals from contaminating the water for irrigation. Processors also need to take safeguards to reduce the roaming of animals in the orchard due to potential contamination from fecal droppings. In addition, uncomposted manure is not to be used as a fertilizer since it is a source of *E. coli* and other pathogens. Workers also need to practice good personal hygiene and sanitation while in the orchard and while harvesting apples to prevent contamination of the apples, harvesting equipment and storage containers (Castelnuovo and Ingham, 2001; FDA, 1998; FDA, 2004).

In a study to determine potential orchard reservoirs of *E. coli* O157:H7, fourteen apple orchards located throughout the United States were investigated in late September 1999. Irrigation water in three of the orchards tested positive for generic *E. coli*. Orchards that allowed animals to roam had a higher incidence of generic *E. coli* and coliforms on the fruit than those that had fences to prevent roaming animals. *E. coli* O157:H7 was not detected in the soil of any of the orchards (Riordan et al., 2001). Ujlas and Ingham (2000) also determined that the proximity of the orchard to pastures where animals roamed and the potential for water run-off from livestock operations also increased the presence of *E. coli* and coliforms in the orchard soil.

Culling of the fruit to separate dropped, damaged or decayed fruit is particularly important in juice processing since damaged fruit is more likely to carry pathogens. Several studies investigating the presence of coliforms and generic *E. coli* on apples, before processing, found dropped apples had the highest counts of total coliforms and

generic *E. coli* (Riordan et al., 2001; Dingman, 1999; Uljas and Ingham, 2000). In a 1991 study, all of the cider producers surveyed used dropped apples to make apple cider (Besser et al. 1993). It is important to note that this study was conducted before the large outbreaks of *E. coli* O157:H7 associated with apple cider were widely recognized (Besser et al., 1993). In more recent surveys, dropped apples continue to be used, but to a lesser extent. Wright et al. (2000) found that 32 percent of apple cider producers surveyed used dropped apples while Uljas and Ingham (2000) found only 14 percent of producers surveyed used dropped apples. In Michigan, based on state inspections, the use of dropped apples to make juice was less than 10 percent in 2002 (Wojtala, 2003).

The timing and duration of apple storage may also influence the presence of generic *E. coli* and *E. coli* O157:H7. A Connecticut orchard study found that apples harvested and later stored in the season (mid-October to mid-November) had a higher incidence of *E. coli* and *E. coli* O157:H7 than apples harvested and stored earlier in the season (mid-September to early October). The higher incidence of *E. coli* in apples harvested and stored later was believed to be due to the apples coming in contact with more rodents and birds as the weather became colder. Storage containers also can be a source of contamination and need to be kept free from debris, cleaned after each use and then stored to prevent access to rodents, birds and wildlife. To reduce exposure to animals and pathogens it is recommended that apples be stored covered in a cool area (Dingman, 1999). Harvesting practices such as selecting undamaged tree-picked apples, good personal hygiene of workers and proper storage are important to help prevent juice contamination. However, research also has found that contamination cannot be directly tracked to harvesting practices (Riordan et al., 2001).

CGMPs are required for personnel, buildings and facilities, equipment and utensils, production and process controls and warehousing and distribution. CGMPs for personnel include disease control, cleanliness, educational training and supervision. The employee practices that can reduce the likelihood of pathogens include ensuring the workers are free of illness and frequently wash their hands with soap. Additional good employee practices to prevent contamination and foreign objects from entering juice include wearing of clean outer garments, hairnets or caps, removal of jewelry and other objects that may fall into food, equipment or containers, and avoid eating or drinking in the food processing area. In addition, employees are to be trained on proper food handling and supervisors are responsible for ensuring employees are following good personal hygiene practices (Stevenson and Bernard, 1999).

The juice processing building and facilities should be fully enclosed, have sufficient space for equipment, have hot and cold running water, have adequate storage for chemicals away from processing equipment and food, and be adequately screened to prevent the entry of animals or insects. Precautions need to be taken to ensure processing areas are cleaned and sanitized frequently to protect against food contamination (FDA, 1998).

Processing CGMPs start with the washing and brushing of apples used for juice production to reduce the risk of contamination. The wash water needs to be potable and not re-circulated and brusher units should be cleaned and sanitized on a regular basis. Wash water temperature is an important consideration. Research on wash water temperatures and apples found that when the water is more than 10 °F cooler than the fruit, bacteria are more likely to penetrate through wounds or the apple's stem or calyx

(Kenney et al., 2002). Sanitizers such as chlorine, organic acids, and hydrogen peroxide often are used to reduce the risk of bacterial contamination through wash water. Sanitizers can result in a 2- to 3-log reduction of total bacterial populations on apple surfaces. However, research also indicates that certain pathogens can become tolerant of sanitizers (Kenney et al., 2001; Sapers et al., 1999; Wright et al., 2000).

Bacteria such as *E. coli* can easily bind to small puncture wounds on the apple surfaces as well as onto the apple stems or the calyx end. If bacteria penetrate the apple subsurfaces through wounds they may be protected from decontamination treatments. Difficulty associated with removal of microorganisms from fruit surfaces reinforces the need for additional measures to control pathogens in juice products (Annous et al., 2001; Sapers et al., 1999; Wright et al., 2000).

Appropriate cleaning and sanitation of the hammer mill, press and press clothes are critical to prevent cross-contamination. Equipment needs to thoroughly cleaned and sanitized after each juice production run. To emphasize the need for proper sanitation of this processing step, Annous et al. (2001) found that cross-contamination can occur at the hammer mill and pressing stage due to protected bacteria in the apple subsurfaces being released during apple crushing. Improper sanitation of the mill, press and press clothes can allow pathogens to survive and infect additional batches of cider. After pressing the apples, cider is placed in a holding tank. Tanks can be a source of contamination if not covered and thoroughly cleaned and sanitized before use. Annous et al. (2001) did not find tanks to be a source of cross-contamination.

F. Interventions and Technologies to Reduce Bacterial Levels in Apple Juice

The juice HACCP regulation requires a 5-log pathogen reduction of the pertinent pathogens of concern. The pathogens of concern are *E. coli* O157:H7 and *Cryptosporidium parvum* for apple cider and juice, and *Salmonella* spp. for citrus juices (FDA, 2004). For citrus juices, pathogen reduction treatments can be applied to the surface of the citrus fruit prior to extracting the juice. For other fruit and vegetable juices, the 5-log pathogen reduction must occur after the juice has been extracted. The 5-log reduction must occur in a single facility that also packages the juice for sale. Exceptions to this portion of the HACCP regulation have been granted when high degree Brix juice concentrates are used, or when the bulk transport and packaging of shelf-stable single strength juice is transported in aseptic packaging.

The FDA has approved both thermal pasteurization and UV light irradiation as one-step processes to control microorganisms (FDA, 2004). The juice HACCP regulation allows for multiple processing steps to be used to achieve the 5-log reduction of pertinent pathogens and research has investigated a variety of methods (Table 3).

Chemical preservatives are effective germicides since they are able to denature bacterial enzymes resulting in cell death and thereby prolong shelf life of the product (Jay, 1996). Sodium benzoate and potassium sorbate are the most commonly used preservatives in apple juice. Sodium benzoate in combination with potassium sorbate is the most effective and these chemicals also tend to reduce the heat resistance of *E. coli* O157:H7 (Zhao et al., 1993). Preservatives alone can achieve up to a 3-log reduction in pathogens, but this reduction can take as long as twenty-one days (Kasper and Miller, 1994). When 50 milligrams of sulfur dioxide was added to a liter of cider, a 5-log

reduction of *E. coli* O157:H7 was achieved after approximately 4.5 hours at ambient temperatures. However sulfur dioxide alters the sensory characteristics of the cider and it may not be acceptable to consumers (Worobo et al., 1998). Dimethyl dicarbonate is also effective in achieving a 5-log reduction for *E. coli* O157:H7, but it is not approved for use in cider (Worobo et al., 1998). Researchers conclude that chemical preservatives need to be used in combination with other treatments to achieve a 5-log reduction, and not be the primary method to reduce bacterial load in cider (Miller and Kaspar, 1994; Worobo 1998).

A 5-log reduction of *E. coli* O157:H7 in cider was achieved with the combined use of copper ion water and sodium hypochlorite followed by sonication at 44 to 48 kHz (Rogers and Ryser, 2004). Additional investigation is needed to assess implementation, application, and feasibility of this process in actual production facilities and any effect on the sensory attributes on the cider.

Fermentation of cider is an effective method to reduce *E. coli* O157:H7 by more than a 5-log reduction after 3 days. However, the fermented cider contains ethanol and is no longer considered a juice (Semanchek and Golden, 1996).

Storing cider at -20°C, followed by thawing and refreezing cycles, achieved a 1-log reduction of *E. coli* O157:H7. Decreases in bacterial populations resulted after each freeze-thaw cycle (Yamamoto, 2001). Sage and Ingham (1998) studied freeze-thaw cycles and the injury of *E. coli* O157:H7, and found inconsistency in the rates at which cells are injured. The sensory characteristics of the resulting cider also may not be acceptable. Freezing would need to be used in combination with another method to achieve a 5-log reduction.

Ozone treatment technology involves pumping ozone into juice to destroy bacteria. In a study using ozone to inactivate *E. coli* O157:H7, it took 240 minutes at 4°C to achieve a 5-log reduction. At higher concentrations of juice solids, the length of ozone treatment had to be increased. In addition, sensory characteristics of the juice changed and were not acceptable by taste testers in the study. The length of time to achieve the required bacterial reduction and adverse effects on sensory characteristics may prevent ozone treatment from being a feasible and cost-effective treatment for juice processing (Williams, 2001).

Ultrafiltration is another technology effective in reducing bacterial levels. Ultrafiltration is essentially a sieving or filtering process using a membrane based on the size and shape of the compound. Flavor, color and nutrient characteristics are often maintained. Ultrafiltration of apple juice can achieve a 5-log reduction in aerobic plate count, molds and yeasts. Because of the relatively large size of solids in apple cider, multiple membranes are necessary to filter the juice and can result in variability in reduction of bacterial populations. Additionally, ultrafiltration technology may not be cost or time effective in cider mills (Ortega-Rivas et al., 1998).

Buchanan et al. (1998) investigated the effectiveness of low-dose gamma irradiation on reducing *E. coli* O157:H7 in apple juice. Gamma irradiation was effective at refrigerated temperatures, but juice having high solids contents required an increased dose of irradiation and longer exposure times to achieve the 5-log reduction. Sensory characteristics of the juice were also altered. Additional research is needed to further validate appropriate procedures for the use of gamma irradiation with juice.

High-pressure treatment involves the application of extremely high hydrostatic pressure in combination with time and temperature to reduce bacterial populations. High-pressure treatment also maintains sensory characteristics of the cider. High-pressure treatment in commercial settings has achieved a 5-log reduction of *E. coli* O157:H7 in juice when using pressures of 80,000 psi for 30 seconds (Balasubramaniam, 2000). High-pressure technology using 80,000 psi for 60 seconds achieved a 3-log reduction in *Cryptosporidium parvum* in inoculated apple and orange juice; however, the researchers recommended additional validation testing since results varied due to juice solids (Slifko et al., 2000).

Pulsed electrical field (PEF) treatment involves the application of rapidly varying electric fields through a liquid medium. Research using an electrical field strength of 80 kV/cm and frequency of 30 pulses at 42°C resulted in cell injury and death and achievement of a 5-log reduction of *E. coli* O157:H7 in inoculated apple cider (Iu et al., 2001). Care needs to be taken when using PEF to control pathogens because results can vary depending on the concentration of juice solids (Evrendilek et al., 2003; FDA, 2004).

UV light irradiation is a FDA approved treatment for the processing of juice. Research at Cornell University validated that UV light treatment using the *CiderSure* system consistently achieved a 5-log reduction of *E. coli* O157:H7 in apple juice. Several factors can influence the effectiveness of UV light treatment in reducing pathogen numbers. These factors include exposure time, the amount of juice solids and the presence of compounds such as benzoate that quench UV light (Duffy et al., 2000; FDA, 2004; Senkel et al., 1999; Wright et al., 2000; Worobo, 1998). Hanes et al. (2002) assessed the potential of UV light to inactivate *Cryptosporidium parvum* oocysts that

were inoculated into apple cider. Effectiveness of UV light treatment against *Cryptosporidium parvum* was assessed through a mouse feeding bioassay. Mice were administered apple cider inoculated with *Cryptosporidium parvum* before and after UV treatment. The *CiderSure* system was utilized to evaluate the effectiveness of UV light to inactivate the ooycts. Cider was inoculated at varying concentrations of *Cryptosporidium parvum* oocysts with the highest being 10^6. Mice drinking the untreated contaminated cider became ill or died. Mice given the UV treated cider, regardless of the pathogen concentration, had no adverse reactions, indicating that UV light effectively inactivates *Cryptosporidium parvum* oocysts (Hanes et al., 2002). Processors choosing to use UV light cannot label their juice as pasteurized since this implies thermal pasteurization. Labeling terms allowed with this lethality step include "treated with UV light to control pathogens", "treated with UV light to control harmful bacteria", or "UV treated". Juice processed using UV light cannot be labeled as "fresh" (FDA, 2004).

High temperature, short time (HTST) thermal pasteurization involves using a constant time and temperature and has consistently proven to be the most effective method to achieve a 5-log reduction of the pertinent pathogens in juice. One concern with thermal processing is that an undesirable cooked flavor can result either when the cider is heated at excessively high temperatures or for extended periods of times. Temperature and time combinations to achieve a 5-log reduction in *E. coli* O157:H7 without noticeable effects on the sensory characteristics of cider were reported by Splitstoessor et al. (1995). They determined that effective thermal pasteurization regimes were 71.1°C (160°F) for 6 seconds for apple juice and 71.1°C (160°F) for 11 seconds for cider containing >50% Red Delicious apples due to the higher pH (Splittstoesser et al.,

1995; Worobo, 1998). Mak et al. (2001) determined that 68.1°C (155°F) for 14 seconds or 71.1°C (160°F) for 6 seconds was sufficient to achieve a 5-log reduction of *E. coli* O157:H7, *Salmonella* spp., and *Listeria monocytogenes*. Sensory characteristics of the juice were still acceptable to consumers (Mak et al., 2001). Although thermal pasteurization is highly effective, the equipment is expensive and may not be feasible for many small cider producers (Kozempel et al., 1998; McLellan and Splitstoesser, 1996; Worobo, 2001).

The requirements of the juice HACCP regulation will impact the amount of time and money juice processors spend in additional surveillance and record-keeping as well as upgrades to their processing facilities and equipment (Kozempel et al., 1998, Worobo, 2001). Juice processors have been aware of the impending juice HACCP regulation since 1997. Investigation into how processors' practices have changed in anticipation of the juice HACCP regulation and their perceptions of HACCP can help determine if additional measures are needed to ensure compliance with the new regulation.

The overall goal of HACCP is to provide safe food to the public. Consumers state they are concerned about food safety and investigations into public perceptions of food safety, where they receive food safety information and their food safety concerns may also help determine how to educate both processors and consumers about juice safety.

G. Perceptions of Food Safety

Americans are faced with many decisions when choosing food and react to food safety information based on personal experience, information received and perceived risk (Sparks and Shepard, 1994). Prominent food safety issues, such as foodborne illness outbreaks, continue to occur and receive attention from the media and consumers. A

popular opinion study found that two-thirds of Americans are concerned about food safety (Roper, 2001). The International Food Information Council (1999) found that public concern about foodborne risks often exceeds concerns for other health and safety hazards, despite government assurances that the U.S. food supply is one of the safest in the world.

Consumer's reactions to food safety issues are influenced by their lifestyle, demographics and information sources (Yeung and Morris, 2001). In a study investigating personal food safety behaviors, it was found that belief in practicing positive health behaviors, such as eating healthier or exercising, socio-demographic factors and especially the presence of children in the household, are indicators as to whether or not a person follows food safety recommendations and how they evaluate personal risks (Schafer et al., 1993). Herrmann et al. (1997) studied reactions to food safety issues and found households with young children tend to be the most reactive and likely to make a change in their food behaviors due to a food safety issue.

A survey of consumers' attitudes about food safety found over 50 percent were concerned about food safety. Significant differences among sex, race, education, age and presence of children were found, with the greatest differences occurring with mothers of younger children, older women and women with higher education levels (Herrmann et al., 2000). Another study about food safety attitudes utilized focus groups and found adults of all ages were concerned about food safety but they "did not lose sleep over food safety". Older adults indicated they believed food safety was a recent phenomenon driven by the media (Roe et al., 2001).

Although consumers indicate they are concerned and knowledgeable about food safety, many consumers do not necessarily make food purchases based on food safety or practice food safety in the home. Of those actually following food safety recommendations, females, older individuals and those preparing food for large households were more likely to follow recommended food safety practices than men, younger adults and those in smaller households (Meer and Misner, 2000).

Studies have also examined whether or not poor food safety practices stemmed from a lack of knowledge. A survey on food safety knowledge found that 15 percent of consumers surveyed felt they were very knowledgeable about food safety, 65 percent considered themselves somewhat knowledgeable, 19 percent felt they were not very knowledgeable and one percent not knowledgeable at all (Bruhn and Schutz, 1999). Consumers often have a broad and moderate knowledge about food safety, and their concerns differ depending on the consumers' personal perspectives and needs (Roe et al., 2001).

Consumers are exposed to information from the mass media, health professionals, scientists, other credible individuals, and food labels. Although consumers vary in their concern, knowledge and food preparation practices, they seem to use two common information sources. Hermann et al. (2000), in a survey on nutrition and food safety information sources, found over 75 percent of consumers surveyed rely on news stories and food labels as their primary information sources. Another survey asking consumers where they learned about food safety practices, identified the media as the top source followed by family and friends (Meer and Misner, 2000).

In a food safety survey by Bruhn and Schutz (1999), in which consumers were asked what information sources were the most credible, they selected university scientists, health professionals, and science and consumer interest magazines; however, these were also the least referred to sources.

Journalists, scientists and government agencies communicate food safety issues, but during a food safety crisis consumers receive the most information from the media. In an analysis of food safety news stories over twelve years, journalists reported on the same story several times and in different publications creating clusters of information, especially in a time of crisis. In addition, journalists emphasized elements of the issue through colorful language to amplify the food safety risk (Ten Eyck, 2000). Haynes (2000), in an editorial on the media and health scares, stated health and food issues are often caused by journalists taking research findings out of context due to lack of understanding the research. Stories are often reported as fact when they are largely based on speculation. The reporting on food issues often results in consumers losing confidence in scientists and other authorities who have the most knowledge about food safety (Grose, 1988).

Sandman (1997) in a discussion on food safety risk perceptions commented that people often separate risks into two lists, those that kill you and those that alarm you. These lists are very different and he believes it is the way in which risks are communicated from the scientist to the journalist that has led to confusion and misunderstandings about food safety. To help consumers decipher research findings reported in the news and put more of a realistic focus on food safety issues, the International Food Information Council (1998) stresses it is important for government

agencies, health professionals, university scientists and journalists to create a framework in which risks from food and other concerns can be compared to help reduce food safety scares in the media.

As consumers translate information from news stories to their personal risk assessment, they may or may not use the information to make decisions about food. In an investigation into the public perception of food scares in the United Kingdom, Fife-Schaw and Rowe (1996) found that food choices tend to be personal and driven by a range of factors not present in many public debates over food hazards. Most food choices are habitual and decisions are made based on taste appeal, familiarity, nutritional profile and how the food made them feel after eating it. Eating is not considered to be hazardous, except in the time of a food scare (Sparks and Shepard, 1994). Research on the media and food safety issues concludes that severity, awareness, exposure and personal relevance to a potential food hazard affect how consumers perceive food risks and apply these risks to their attitude and behavior about food (Fife-Schaw and Rowe, 1996; Sparks and Shepard, 1994).

Consumers also rely on food labels as a reliable and important information source. Herrman et al. (2000) found that survey participants who were most interested in food safety were frequent readers of food labels. Consumers concerned about health and food safety read the food label to check ingredients, food additives, preservatives and allergens (Meer and Misner, 2000; Nayga et al., 1997). Food processors and manufacturers have included messages concerning safety, preparation and storage on labels for fresh meats and produce with the goal of increasing the foods' perceived quality. It is uncertain, however, if consumers actually use this information to prepare

and store food (Caswell and Mojduszka, 1996). When consumers were presented with food safety information on food labels, they felt this information was helpful in making a purchase decision but only if the statement was not too detailed and provided positive information to help them make food choices (Roe et al., 2001). To determine if including HACCP statements on meat packaging increased consumer confidence about the food and manufacturer, a series of focus groups were held with consumers. Those consumers who participated believed the HACCP statement helped to build confidence in the product and manufacturer, but they were not in agreement as to whether or not it warranted paying a higher price for the food. Many of the consumers indicated that they believed food safety programs should be mandatory and common practice in manufacturing and that they should not have to pay if a manufacturer followed HACCP (Ford et al., 1998).

Bocker and Hanf (2000) examined what happens to brand names, manufacturers, retailers and confidence in products after a food safety issue. They found that if trust in a product was established before a food scare, it is more easily regained. Therefore, if a consumer has had many safe experiences with a product, believes it has high quality, and trusts the manufacturer or distributor, the food scare will have little affect on long-term purchases. This also is supported by a study conducted on brand name recognition among college students. The students were presented with negative publicity on favorite brands for a variety of products. Those that initially trusted the brands continued to do so regardless of the bad news (Ahluwalia et al., 2000).

Trust in food labeling information, brand names and manufacturers affects both the consumer and food processor. Over the course of the past four decades, agriculture

has evolved from the local farmer producing the local food to our current national and international food distribution systems. The processors who tend to be the most affected by consumer concerns are the smaller farmers and processors who serve a smaller number of consumers. If a concern arises with products of a small producer, consumers can easily find another food source (Stevenson, 1998;Torjunsen et al., 2001). In addition, small processors generally lack the methods or financial means to fully test their products as would be normal among larger manufacturers, putting smaller processors at slightly higher risk for food safety issues (Auld et al., 1994). Although the food system has evolved, consumers still believe that locally produced food is fresher, safer and more nutritious (Jolly et al., 1989; Torjunsen et al., 2001).

Consumers and food processors often share many of the same food safety concerns including chemical contaminates, physical and microbial hazards (Auld et al., 1994; FDA, 2001; Jussaume and Higgins, 1998; Roper, 2001; Torjusen et al., 2001).

Consumers across socio-economics levels associate the presence or absence of chemicals they perceive as undesirable with the quality of the food. Concerns over pesticides, preservatives, artificial colors and flavors and other additives in food have generated an interest in organic foods, food cooperatives and locally grown foods (Auld et al., 1994; Jussaume and Higgins, 1998; Sloan, 1999; Wilkens and Hillers, 1994). In a survey of consumers shopping at food cooperatives and seeking organic foods, approximately 80 percent of those surveyed believed they were purchasing safer and higher quality food at the cooperative since it was produced by local farmers who used less pesticides and chemicals (Jolly et al., 1989). Other research supports this view that consumers are seeking both organic and locally grown foods because of their perceived

higher quality, concern about pesticides and knowledge of who produced the food (Goldman and Clancy, 1991; Jussaume and Higgins, 1998; Wilkens and Hillers, 1994).

Physical hazards include foreign material, such as glass or metal, and is generally attributed to poor manufacturing standards. Although physical hazards are a concern, they are typically not associated with illness due to good manufacturing practices, regular inspections of facilities, legislation and product liability risks helping to minimize their occurrence. In addition, when a physical hazard occurs it usually only impacts a small number of consumers (Lewis, 1998; Stevenson, 1998).

Microbial contamination is the most common food safety concern and the percentage of Americans who believe microbial organisms are serious sources of food safety risk increased from 36 percent in 1993 to 55 percent in 1998 (Wong et al., 2000). An opinion poll survey comparing food safety issues found that consumers are more worried about harmful bacteria than chemicals or foreign material in their food (Roper, 2001).

Studies into processor perceptions about food safety has been limited and comprised mainly of focus groups with smaller processors (Torjunsen et al., 2001; Zepeda et al., 2003). Focus groups have found that although processors are concerned about food safety risks in their products, they are just as concerned about staying in business (Zepeda et al., 2003). In focus groups with both local processors and consumers, trust between the two groups was the top reason for growing and purchasing food (Torjunsen et al., 2001). Interviews and focus groups with small farmers found that they believe trust of the consumer is often more important than adopting government regulations because of its impact on their overall operating costs (Gilling et al., 2001). A

report from the U.S. General Accounting Office (2000) regarding compliance with HACCP regulations in the seafood industry found only 44 percent of processors were practicing HACCP two years after the mandated implementation date. Wright et al. (2000) reported that small cider processors in Virginia were very concerned about the possibility of being forced to implement HACCP due to implementation costs and many stated that they would rather go out of business than to implement HACCP.

In summary, consumers are concerned about food safety and look to the media for information. Consumers perceive microbial contamination as a primary food safety risk and cause of foodborne outbreaks. Consumers tend to have confidence in locally produced food made by smaller processors. Smaller processors rely on trust of the consumer and are concerned that regulations to improve food safety may be too costly and ultimately put them out of business. These findings provide a research opportunity to explore the perceptions of processors and consumers regarding juice and food safety.

Table 2. Juice associated foodborne illness outbreaks in North America (Partial Listing)

Unpasteurized Juice	Year	Associated Pathogen	Location of Outbreak	# of reported illnesses	Reference
Apple juice	1923	*Salmonella* Typhimurium	Not identified	23	Parish, 2000
Orange juice	1944	*Salmonella* Typhimurium	Ohio	18	Parish, 1997
Apple juice	1974	*Salmonella* Typhimurium	New Jersey	296	CDC, 1975
Apple juice	1980	Unconfirmed *E. coli* O157:H7	Ontario, Canada	14	Parish, 2000
Apple juice	1991	*E. coli* O157:H7	Massachusetts	23	FDA, 1991
Watermelon juice	1993	*Salmonella* spp.	Florida	18	Parrish, 2000
Apple juice	1993	*Cryptosporidium parvum*	Maine	160	FDA, 1993
Orange juice	1995	*Salmonella* spp.	Florida	62	Parrish, 1998
Apple juice	1996	*E. coli* O157:H7	California, Colorado, Washington and British Columbia, Canada	70	CDC, 1996
Apple juice	1996	*E. coli* O157:H7	Connecticut	14	CDC, 1996
Apple juice	1996	*Cryptosporidium parvum*	New York	31	CDC, 1996
Apple juice	1996	*E. coli* O157:H7	New York	1	CDC, 1996
Apple juice	1997	*E. coli* O157:H7	Ontario, Canada	9	Parrish, 2000
Orange juice	1999	*Salmonella* Muenchen	Florida	423	Parrish, 2000
Orange juice	2000	*Salmonella* Enteritidis	Florida	88	Parrish, 2000
Apple juice	2003	*Cryptosporidium parvum*	Ohio	10	Ohio Dept. of Health, 2003

CDC: Centers for Disease Control and Prevention; FDA: United States Food and Drug Administration

Table 3. Effectiveness of interventions and technologies on pathogens in apple juice

Intervention/Technology	Pathogen used for juice inoculation	Conditions	Achieved bacterial population reduction	Reference
Sodium benzoate and Potassium sorbate	*E. coli* O157:H7	0.1% for 21 days	3-log reduction in *E. coli* O157:H7	Miller and Kasper, 1994
Copper ion, sodium hypochlorite and sonication	*E. coli* O157:H7	Combination of copper ion and sodium hypochlorite in H_20 followed by sonication at 44 to 48 kHz	5-log reduction in *E. coli* O157:H7	Rogers and Ryser, 2004
Fermentation	*E. coli* O157:H7	3 days at 20°C	5-log reduction in *E. coli* O157:H7	Semanchek and Golden, 1996
Freezing	*E. coli* O157:H7	Froze juice to –20°C for 3 days	1-log reduction in *E. coli* O157:H7	Yamamoto, 2001
Ozone	*E. coli* O157:H7	Ozone pumped into apple cider at 4°C for 240 min.	5-log reduction in *E. coli* O157:H7, results varied due to juice solids	Williams, 2001
Ultrafiltration	Aerobic plate count, yeast, mold and aciduric bacteria	Membrane pore (50,000 daltons) and transmembrane pressure (155kPa)	5-log reduction achieved for total aerobic plate count, results varied due to juice solids	Ortega-Rivas et al., 1998
Low-dose gamma irradiation	*E. coli* O157:H7	Dose of 1.8kGy	5-log reduction in *E. coli* O157:H7, results varied due to juice solids	Buchanan et al., 1998
High pressure	*E. coli* O157:H7	30,00 psi	5-log reduction in *E. coli* O157:H7, results varied due to juice solids	Mermelstein, 1999
High pressure	*Cryptosporidium parvum* oocysts	80,000 psi	3-log reduction in *Cryptosporidium parvum* oocysts	Slifko et al., 2000
Pulsed electric fields	*E. coli* O157:H7	Treated with 30 pulses and 80kV/cm at 42°C	5-log reduction in *E. coli* O157:H7, results varied due to juice solids	Iu et al., 2001
Ultraviolet light radiation	*E. coli* O157:H7	Quartz tubes using *CiderSure* UV pasteurizer	5-log reduction in *E. coli* O157:H7, results can varied due to juice solids	Duffy et al., 2000
Ultraviolet light radiation	*E. coli* O157:H7	*CiderSure* UV pasteurizer	Mice fed cider treated with UV light and a 5-log reduction in *E. coli* O157:H7 did not become ill	Hanes, et al., 2002

Table 3 (cont'd).

Thermal pasteurization (HTST)	*E. coli* O157:H7	<50% Red Delicious juice 160°F for 6 seconds or >50% Red Delicious juice 160°F for 11 seconds	5-log reduction in *E. coli* O157:H7	Splittstoesser et al., 1995
Thermal pasteurization (HTST)	*E. coli* O157:H7, *Salmonella* spp., *Listeria monocytogenes*	68.1°C for 14 seconds or 71.1°C for 6 seconds	5-log reduction of all inoculated pathogens	Mak et al., 2001

CHAPTER III. MICHIGAN APPLE CIDER MILLS 1997-2002 CURRENT GOOD MANUFACTURING PRACTICES AND INTERVENTION TECHNOLOGY

A. ABSTRACT

In response to a series of foodborne-illness outbreaks resulting from consumption of unpasteurized juice contaminated with pathogens (*Salmonella* spp., *E. coli* O157:H7 and *Cryptosporidium parvum*), the U.S. Food and Drug Administration (FDA, 2001), promulgated the juice Hazard Analysis and Critical Control Point (HACCP) regulation. This juice regulation requires juice manufacturers to implement a HACCP plan that includes control measures that achieve a cumulative 5-log reduction of pathogens or include a warning statement on juice containers about the risk of pathogens.

Apple cider is an important commodity to the state of Michigan. Michigan ranks as one of the top three states in cider production with approximately 30 percent of Michigan apples processed into cider each year (Michigan Apple Association, 2004; Michigan Agricultural Statistics, 2003). To investigate possible food safety concerns, Michigan cider mills were inspected annually from 1997 through 2002, and processors were mailed a survey in 2002 to evaluate use of Current Good Manufacturing Practices (CGMPs) and intervention technology (thermal pasteurization and ultraviolet (UV) light irradiation). Cider end-product samples were analyzed for bacterial populations and the pertinent pathogen *E. coli* O157:H7.

Cider mills producing more than 20,000 gallons of cider per year were the first to implement CGMPs and utilize thermal pasteurization or UV light irradiation. In general, mills using intervention technology produced cider with lower bacterial counts. However, bacterial levels in several samples were not as low as would be expected from

cider treated by pasteurization or UV light, suggesting that some processors either were not properly using thermal pasteurization or UV light irradiation equipment or the cider was contaminated after being processed. *E. coli* O157:H7 was not detected in any cider samples obtained during 1997 to 2002.

B. INTRODUCTION

Reports of foodborne illness outbreaks associated with consumption of juice have raised public concern regarding the safety of juice products (CDC, 1996; Parish, 1997). The source of several these outbreaks was unpasteurized apple juice contaminated with the pathogens *E. coli* O157:H7 or *Cryptosporidium parvum* resulting from contamination or unsanitary conditions during growing, harvesting or processing (FDA, 2001). This pathogen contamination could have been prevented if processors had followed Good Agriculture Practices (GAPs) and Current Good Manufacturing Practices (CGMPs) and used intervention technologies such as thermal pasteurization or UV light irradiation during the processing of juice (FDA, 2001; Parrish, 2000).

To address public concerns, the FDA published in 1998 a notice of intent to require juice processing plants to implement HACCP (FDA, 2001). HACCP is an approach designed to help manufacturers identify, evaluate, and control chemical, physical, and biological hazards in the food supply. Following an extended public comment period, the FDA published the juice HACCP final rule in the Federal Register in January 2001 (FDA, 2001). The final juice HACCP regulation required compliance to occur in phases based on the size of the juice manufacturing business. In January 2002, implementation of the FDA juice HACCP regulation was expected for large juice manufacturers (those operations having more than 500 employees). Small businesses

(those operations employing fewer than 500 employees and not considered a very small operation) were to comply no later than January 2003. Lastly, very small juice manufacturers (defined as those operations that have either total annual sales of less than $500,000; or have total annual sales greater than $500,000 but their total food sales are less than $50,000; or are operations that employ fewer than an average of 100 full-time equivalent employees and sell fewer than 100,000 units of juice in the U.S.) were required to comply with the regulation in January 2004 (FDA, 2001). The juice HACCP regulation requires a cumulative 5-log reduction of the pertinent pathogens of concern in juice through the use of intervention technologies such as thermal pasteurization or UV light irradiation. Juice processors who operate solely as retail establishments are exempt from the HACCP requirement, but are required to include a warning statement about the risk of pathogens on their juice containers. All juice processors, regardless of how they sell juice, were advised to follow GAPs and CGMPs in their juice processing to reduce risk of contamination.

The majority of the cider industry in the U.S. is comprised of very small juice processors (<20,000 gallons per year) who sell their cider retail (Uljas and Ingham, 2000; Cummins et al., 2002) and only operate during the cider season, typically the months of September, October and November (Dingman, 1999; Wright et al., 2000; Cummins et al., 2002). Surveys in Virginia and Iowa have found that very small cider processors are slow to adopt CGMPs and thermal pasteurization or UV light irradiation (Cummins et al., 2002; Wright et al., 2000).

Effective CGMPs can help minimize contamination of apple juice. Thermal pasteurization or UV light irradiation has proven effective in decreasing bacterial levels

when apple juice is inoculated with pathogens (Senkel et al., 1999; Uljas and Ingham, 2000; Worobo et al., 1998). However, the effectiveness of CGMPs to prevent juice contamination and thermal pasteurization to decrease bacterial levels in cider samples produced at commercial cider mills was less than expected, suggesting ineffective implementation of these controls (Cummins et al., 2002; Wright, 2000).

Michigan is one of the top four apple producing states in the U.S. and one of the top three states in cider production, with approximately 30 percent of Michigan apples processed into cider each year (Michigan Apple Association, 2004; Michigan Agricultural Statistics, 2003). Michigan cider mills are similar to those in other states with the majority of processors being small family businesses, producing less than 20,000 gallons of cider per year, and open only during the fall cider season.

To better understand the food safety risks in Michigan cider mills, between 1997 and 2002 the Michigan Department of Agriculture (MDA) conducted annual inspections of these operations. During these inspections, MDA personnel collected product samples for bacterial analyses, determined compliance with GAPs and CGMPs, and if thermal pasteurization or UV light irradiation was used to reduce the risk of pathogens. Since most Michigan cider mills fall under the FDA's definition of very small processors, MDA segregated cider mills into three smaller sub-groups to determine if differences existed based on cider production volume. As defined by MDA, the three groups of Michigan cider mills are small mills producing less than 4,000 gallons of cider per year, medium-size mills producing 4,000 to 20,000 gallons of cider per year and large cider mills producing more than 20,000 gallons of cider per year (Wojtala, 2003). The MDA

definitions of cider mill size are used in this study. The term cider is used to define unfiltered apple juice.

The objectives of this study were, based on data from the MDA inspections, to determine a) if production volume had an effect on whether cider mills adopted GAPs, CGMPs and thermal pasteurization or UV light irradiation between 1997 and 2002, and b) whether year, cider mill production volume, thermal pasteurization or UV light irradiation influenced bacterial populations in cider.

C. MATERIALS AND METHODS

Cider mill inspections: MDA personnel conducted annual cider mill inspections during the months of September, October and November in 1997 through 2002. Important elements of the inspection were to determine annual cider production volume (in gallons) at the mill, compliance with GAPs and CGMPs, and if the mill had adopted thermal pasteurization or UV light irradiation technology (Appendices B, C, D, E, F and G). MDA classified cider mills into three groups based on annual cider production volume, small mills (<4,000 gallons per year), medium size mills (4,000-20,000 gallons per year) and large mills (>20,000 gallons per year; Wojtala; 2003).

Determination of GAPs and CGMPs: In 1997, MDA personnel completed a questionnaire for each cider mill to determine the status of GAPs and CGMPs in each operation (Appendix B). In September 2002, a questionnaire from Michigan State University was mailed to Michigan cider processors to allow processors to self-report their status of GAPs and CGMPs (Appendix I). Participants were informed that the survey was voluntary, confidential, and conducted for Michigan State University (Appendix H). The study protocol was approved by Michigan State University

Committee on Research Involving Human Subjects (Appendix A). The questionnaire followed survey guidelines developed by Dillman (2000) and included pilot testing with cider processors (n=5) for clarity. A second mailing to non-respondents was conducted two weeks after sending the initial survey. Names and addresses for the questionnaire were provided by MDA (n = 134) and represented cider mills that had received a state food license between 1997 and 2002. Of the 134 surveys mailed, 30 were returned because of inaccurate addresses or the mill was not operating in 2002. Of the remaining 104 processors, 54 completed and returned the survey representing a 52% return rate (54 out of 104).

Cider sampling and microbiological analyses: During the annual inspection, MDA personnel purchased a sample of cider (0.5-1 gallon) that had been processed and bottled within the last 14 days. Cider samples were kept refrigerated and analyzed within two days after purchase in the MDA State Laboratory (East Lansing, MI). Microbiological analyses included presence and concentrations of *E. coli* O157:H7 (Assurance® EIA EHEC, BioControl Systems, Inc., Washington, WA; based on AOAC 996.10), generic *E. coli* (ColiComplete®, BioControl Systems, Inc., Washington, WA; based on AOAC 992.30), total coliforms (ColiTrak®, BioControl Systems, Inc., Washington, WA; based on AOAC 992.30) and total aerobic plate count (TPC; AOAC 966.23). The pH of each cider sample was also determined using a pH meter.

Statistical analyses: For statistical analyses SAS Version 8 was used (SAS Institute Inc., Cary, N.C. USA 2001). The processor practices surveys for GAPs and CGMPs in 1997 and 2002 were analyzed using Fisher's exact test in PROC FREQ. Incidence rates of bacterial populations were analyzed statistically in PROC GENMOD. The fixed

effects were use of control measures (untreated, thermal pasteurization, UV light irradiation), mill production volume (<4,000, 4,000-20,000, and >20,000 gal/yr), and cider production year (1997-2002). Groups were based on cider mill size (small, medium and large). Significant differences among groups were determined using a chi-square test. Bacterial levels were statistically analyzed using PROC MIXED and the same fixed effects. A completely unrestricted variance-covariance matrix (for inspection year) was used to account for repeated measures taken from samples at individual mills across time. Group differences were estimated using a t-test. Significance was declared at $P \leq 0.05$, and tendency of significance was declared at $P \leq 0.10$. For bacterial data, least-square means and standard errors of means (SEMS) are shown (Figure 2, Tables 9, 10 and 11).

D. RESULTS AND DISCUSSION

To our knowledge, this is the first reported study that compares the use of GAPs and CGMPs of cider processors during implementation of the juice HACCP regulation. The objective of the annual MDA cider mill inspections was to evaluate the safety of Michigan cider. MDA inspectors evaluated compliance with GAPs and CGMPs including inspection and storage of apples, sanitation and manufacturing practices and upgrades to equipment and facilities. Inspection reports indicated whether or not the cider mill was in compliance with CGMPs, and noted any violations found at the cider mill. MDA inspectors also suggested possible improvements such as upgrades to the facility or equipment and adoption of thermal pasteurization or UV light irradiation to enable cider processors to reduce the likelihood of pathogen contamination and to prepare for the impending juice HACCP regulation (Wojtala, 2003).

Between 1997 and 2002 the number of Michigan cider mills declined by 40%, from 157 mills in 1997 to 93 mills in 2002 (Figure 1). The majority (81%) of Michigan cider mills are seasonal businesses producing less than 20,000 gallons of cider per year and sell cider directly to consumers. The decline in the number of Michigan cider mills is consistent with surveys in other states which also found that the number of cider mills producing less than 20,000 gallons of cider per year and operated seasonally by local farmers had declined in recent years (Cummins et al., 2002; Wright et al., 2000).

The 1997 and 2002 surveys were compared for similar questions and only the answers to these common questions were analyzed. In some incidences processors did not answer all of the questions in each survey. Therefore, only answers in which we had data from the same processors in 1997 and 2002 were used.

Cider processors improved upon their apple inspection and storage practices from 1997 to 2002 (Table 4). A higher percentage (35% vs. 50%) of processors purchasing apples kept records to document the source of apples (hand-picked versus dropped). More processors reported storing apples in cold storage and inspecting apples for cleanliness in 2002 when compared to 1997. Apple inspection and cold storage were practices MDA personnel emphasized at the inspections. Processors were encouraged to reduce the likelihood of bacterial hazards by only using wholesome and clean apples and to protect apple integrity with cold storage (Wojtala, 2003). Research with cider processors in other states found bacterial counts to be lower when apples were held in cold storage and washed before processing (Cummins et al., 2002; Dingman, 1999). Several questions were asked in 1997 and 2002 regarding use of dropped, damaged, bruised and wormy apples. These questions could not be directly compared because of

inconsistencies. In 2002, only four processors (all of whom used thermal pasteurization) stated they used apples with possible damage (unfirm, windfall, grounders or drops) and this is legal per the juice HACCP regulation.

Improvements to reduce bacterial contamination in processing facilities in 2002 included more facilities that were adequately screened/sealed to prevent rodent/insect, entry and fewer facilities allowing domestic animals in the processing area (Table 5). In 2002, more cider mills tested their water supply annually and had hot and cold running water in all processing areas. Processors also increased the use of thermal pasteurization and microbial testing in 2002 (Table 5). In the 2002 survey, in which processors self-reported their improvements, they also noted upgrades to processing equipment such as use of a wet brusher and more use of food grade plastic instead of wood in the processing area. Those using press racks and cloths did more thorough cleaning and had dedicated a washing machine to be used only for press cloths. These improvements in CGMPs occurred in cider mills regardless of size and indicate that processors followed through on recommendations made by MDA personnel.

When investigating differences in mill size and effective compliance with CGMPs, the larger processors demonstrated the most rapid improvement in compliance with CGMPs (Figure 2). This may be due to larger processors having more financial resources to upgrade their facility and equipment than smaller processors (Wojtala, 2003; Wright et al., 2000). Overall, the compliance with CGMPs in Michigan improved (Table 5) from 1997 to 2002, and these improvements are consistent with surveys from Iowa (Cummins et al., 2002), Virginia (Wright et al., 2000), and Wisconsin (Uljas and Ingham

2000) in which cider processors also took measures to improve CGMPs during this timeframe.

Cider mill size influenced the type of intervention technology used at the mill (Table 6). Thermal pasteurization was the first technology to be used to reduce the risk of pathogens, and by 2002 50% of the large mills and 23% of the medium-sized mills were using pasteurization. UV light irradiation was first adopted in 1999 by a smaller number of mills. By 2002, 8% of small mills (<4,000 gallons of cider per year) were using UV light irradiation and none used thermal pasteurization (Table 6). The purchase and installation of thermal pasteurization or UV light irradiation equipment represents large capital investment. Due to their low production volumes, smaller processors generally cannot afford to incorporate these technologies (Kozempel et al., 1998; Wojtala, 2003). Large mills often use thermal pasteurization, rather than UV light irradiation, due to the ability to process larger volumes of cider in a shorter amount of time, even though the equipment is expensive and requires substantial expertise to operate.

Cider samples were collected between September and November of each year, with 67% of the samples collected in mid- to late-October. Of the 582 samples collected and analyzed between 1997 and 2002, none of the samples were confirmed as positive for the presence of *E. coli* O157:H7. Over the six years, five samples from mills producing untreated cider initially screened as positive for *E. coli* O157:H7, but *E. coli* O157:H7 was not confirmed by enrichment culture in any of the samples. The pH ranged between 3.6 and 4.4 over the six years and no correlations were found with bacterial populations and no difference were found between year, cider mill size or intervention technology.

Bacterial counts observed in this study were similar to those reported by Cummins et al. (2002). Averaged across all years, generic *E. coli*, an indicator of fecal contamination, was found in 34 (5.8%) samples with an average count of 93 CFU/ml and least-square mean of 45 CFU/ml (Table 7). As previously reported in other cider mill studies (Duffy et al., 2000; Cummins et al., 2002), generic *E. coli* counts were positively correlated with total coliforms counts (Table 8).

Total coliforms, an indicator of general sanitary conditions, were found in 409 (70.3%) samples from 1997 to 2002 with an average count of 359 CFU/ml and a SEM of 22 CFU/ml (Table 7). The counts for total coliforms were positively correlated with total aerobic plate counts (Table 8). Total aerobic plate counts were detected in all samples with an average count of 112,501 CFU/ml and a SEM of 46,809 CFU/ml for all years (Table 7).

Cider production year had only minor effects on bacterial populations (Table 9). Total aerobic plate counts were significantly higher in 2002 than 1997 and 2001 with the other years being intermediate. A potential reason for the higher counts in 2002 was because of weather conditions resulting in apples taking longer to mature and delaying harvest (Michigan Agricultural Statistics, 2003), both of which have been reported to increase bacterial populations on apples (Riordan et al. 2001).

Annual production volume was associated significantly with bacterial counts (Table 10). The association between production volume and bacterial counts has not been previously reported. Mills that produce over 20,000 gallons per year had lower incidences of generic *E. coli* than small and medium-size mills and lower total aerobic plate counts than medium-size mills (Table 10; Figure 3). This effect was independent

from the fact that a higher proportion of larger processors used thermal pasteurization or UV light irradiation, as the statistical methods used to compare bacterial counts based on mill size controlled for the use of these technologies. These results are partially explained because larger facilities were more likely to adopt CGMPs, at an earlier time (Figure 2).

Thermal pasteurization and UV light irradiation significantly influenced bacterial counts (Table 11). The use of thermal pasteurization or UV light irradiation was associated with lower incidence rates for generic *E. coli* and total coliforms and lower total aerobic plate counts (Table 11). Cummins et al. (2002) and Senkel et al. (1999) reported similar results for thermal pasteurization.

The presence of generic *E. coli* in one thermally pasteurized sample and the decrease in total aerobic plate counts by only 90% suggested that some cider samples might not be using pasteurization or UV light irradiation equipment properly, or that the cider was contaminated after processing. Several thermally pasteurized and UV light irradiated cider samples, had total aerobic plate counts above 4 log CFU/ml, which is unexpectedly high for cider that has been processed using these control measures (Figure 4). Reasons for these high total aerobic plate counts, may be improperly installed or operated equipment or post-processing contamination.

E. CONCLUSION Our results demonstrate that using GAPs, CGMPs and thermal pasteurization or UV light irradiation is associated with lower bacterial counts in apple cider. However, overall bacterial populations in Michigan apple cider did not significantly decrease between 1997 and 2002. This may be due to processors not consistently following GAPs, CGMPs or using intervention technology to effectively

reduce bacterial populations. Michigan cider processors may need further education and guidance on their cider processing practices. In addition, to fully understand where bacterial contamination may be occurring in cider processing, in-line sampling during processing should be used to identify specific areas for improvement. Additional investigation of cider practices and in-line sampling can help both educators and processors learn how to improve cider processing and ensure safe cider in Michigan.

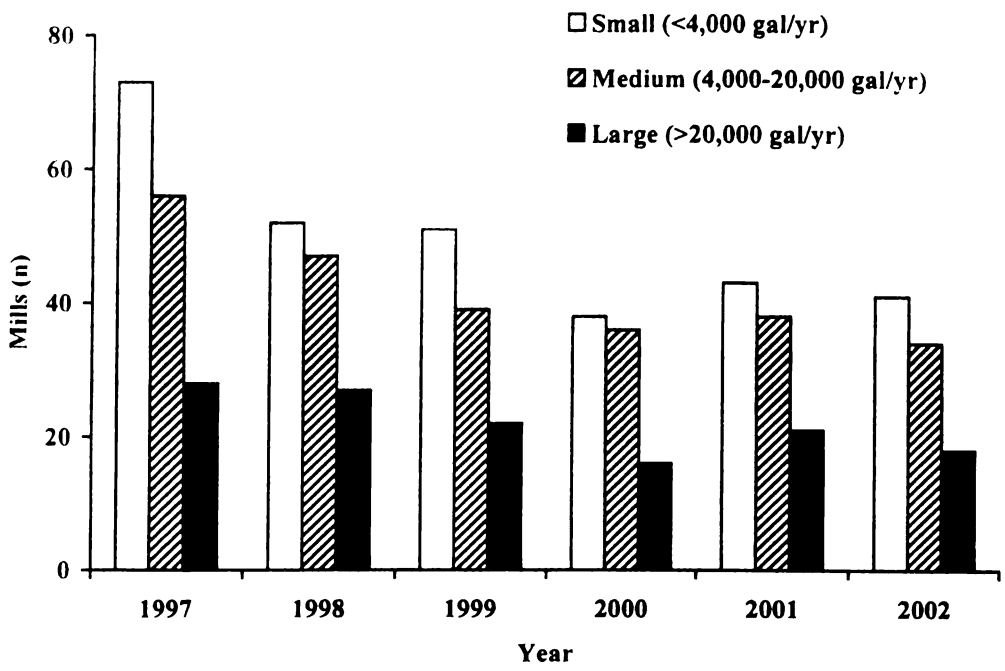

Figure 1. Number of active cider mills in Michigan stratified by production volume of mill (1997-2002)

TABLE 4. Apple inspection and storage practices of Michigan cider processors in 1997 and 2002

Apple storage and handling	n=*	Year 1997	2002
		% answering "yes"	
If apples purchased, are records kept to document the source of supply of apples (e.g., hand-picked versus dropped)	40	35	50
Apples stored in cold storage	52	63[a]	90[b]
Apples inspected for cleanliness	54	85[a]	100[b]
Apples inspected for wholesomeness	53	92	100
Apples washed before processing	54	91	98

a,b Numbers with a different superscript within a row differ at $P \leq 0.05$

*Mills with data in 1997 and 2002 totaled 54, however the number of responses varies between questions because answers were not provided for each mill for both years.

TABLE 5. Processing facilities and manufacturing practices in Michigan cider mills in 1997 and 2002

Processing facilities and manufacturing practices	n=*	Year 1997	2002
		% answering "yes"	
Processing operations in a separate enclosed room or facility	54	91	94
Processing facility adequately screened/sealed to prevent rodent/insect entry	52	67[a]	98[b]
Domestic animals allowed in your processing facility	54	9[a]	0[b]
Processing water tested annually	54	81[a]	100[b]
Hot and cold water under pressure provided in all processing areas	54	83[a]	96[b]
Toilet facility completely enclosed and conveniently located	50	92	98
Toilet facility equipped with hot and cold running water	51	71[a]	92[b]
Employees wear gloves	53	60	75
Employees wear clean outer garments	53	96	100
Chemicals, equipment, supplies, and utensils not used for cider processing stored in an area separate from processing area	54	96	94
Wet brusher used	53	79	87
Rice hulls or other pressing aids used in processing	54	13	13
Press racks, cloths, and food contact equipment stored off the floor in well-ventilated area when not in use	42	93	100
Press racks and cloths sanitized daily after operations	42	100	100
Dedicated washing machine for press cloths	41	78[a]	95[b]
Pressed apple pomace removed nightly from processing Area	54	100	96
Preservatives used	54	19	15
Thermal pasteurization used	54	2[a]	9[b]
Ultraviolet light (UV) irradiation used	54	0	4
Only new containers and caps used to package cider	54	98	100
Conduct microbial testing on end-product	53	8[a]	25[b]

a,b Numbers with a different superscript within a row differ at $P \leq 0.05$

*Mills with data in 1997 and 2002 totaled 54, however the number of responses varies between questions because answers were not provided for each mill for both years.

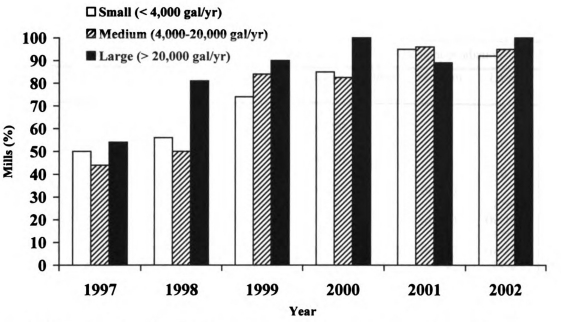

Figure 2. Percentage of cider mills having adequate compliance with Current Good Manufacturing Practices stratified by production volume of mill

TABLE 6. Proportion of Michigan cider mills that used thermal pasteurization or UV light irradiation between 1997 and 2002

	Untreated			Thermal pasteurization			UV light irradiation		
Year	Small*	Medium	Large	Small	Medium	Large	Small	Medium	Large
1997	100% (n=72)	100% (n=59)	92% (n=26)	0	0	8% (n=26)	0	0	0
1998	100% (n=52)	100% (n=48)	85% (n=26)	0	0	15% (n=26)	0	0	0
1999	98% (n=46)	82% (n=45)	52% (n=21)	2% (n=46)	11% (n=45)	48% (n=21)	0	7% (n=45)	0
2000	97% (n=34)	78% (n=40)	19% (n=16)	3% (n=34)	20% (n=40)	69% (n=16)	0	2% (n=40)	12% (n=16)
2001	97% (n=37)	72% (n=47)	39% (n=18)	0	19% (n=47)	44% (n=18)	3% (n=37)	8% (n=47)	17% (n=18)
2002	92% (n=38)	67% (n=39)	31% (n=16)	0	23% (n=39)	50% (n=16)	8% (n=38)	10% (n=39)	19% (n=16)

*Small, medium, and large mills produced <4,000, 4,000-20,000, and >20,000 gal/yr, respectively

TABLE 7. Bacterial counts in Michigan cider samples

Bacterial test	Overall
Generic *E. coli*:	(n = 582)
Test positive (%)	5.8 ± 1.0
Average count (log CFU/ml)	1.19 ± 0.12
Range (log CFU/ml)	0-3.0
Total coliforms:	(n = 582)
Test positive (%)	70.3 ± 1.9
Average count (log CFU/ml)	1.94 ± 0.04
Range (log CFU/ml)	0-3.0
Total aerobic plate count:	(n = 546)
Average count (log CFU/ml)	3.84 ± 0.05
Range (log CFU/ml)	1-7.4

n = the total number of samples from 1997-2002. Some mills were sampled each year and other mills were sampled less frequently

TABLE 8. Correlations between bacterial concentrations in Michigan cider 1997-2002

	Generic *E. Coli*	Total coliforms	Total aerobic plate count	pH
Generic *E. coli*		0.20 (<.0001)* n = 582	0.06 (0.19) n = 545	-0.04 (0.31) n = 520
Total coliforms			0.53 (<.0001) n = 545	0.16 (.0003) n = 520
Total aerobic plate count				0.07 (0.13) n = 519
pH				

*Probabilities in parenthesis
n = number of observations

TABLE 9. Bacterial populations in Michigan cider samples by year between 1997 and 2002

Bacterial analysis	Year					
	1997 (n = 147)	1998 (n = 126)	1999 (n = 111)	2000 (n = 62)	2001 (n = 66)	2002 (n = 69)
Generic *E. coli*:						
Test positive (%)	7.5±2.2	5.6±2.0	0.9±0.9	9.7±3.8	9.1±3.6	4.3±2.5
Average count (log CFU/ml)	1.73±0.45[a]	1.08±0.50[ab]	1.10±0.83[ab]	1.44±0.51[ab]	0.70±0.44[b]	1.12±0.60[ab]
Range (log CFU/ml)	0-3.0	0-1.6	0-1.0	0-2.4	0-0.6	0-1.2
Total coliforms:						
Test positive (%)	72.1±3.7	77.8±3.7	66.1±4.5	66.1±6.1	71.2±5.6	62.3±5.9
Average count (log CFU/ml)	1.64±0.17	1.76±0.17	1.76±0.17	1.62±0.19	1.72±0.17	1.66±0.18
Range (log CFU/ml)	0-3.0	0-3.0	0-3.0	0-3.0	0-3.0	0-3.0
Total aerobic plate count:						
Average count (log CFU/ml)	3.23±0.13[b]	3.38±0.13[ab]	3.32±0.13[ab]	3.32±0.19[ab]	3.16±0.14[b]	3.56±0.13[a]
Range (log CFU/ml)	1.0-6.2	1.0-7.4	1.0-5.9	1.7-5.8	1.0-5.8	1.5-6.6

a,b Numbers with different superscripts within a row differ at $P \leq 0.05$

TABLE 10. Bacterial counts in Michigan cider from mills with different production volumes

Bacterial test	Production volume (gal/year)		
	Small (< 4,000)	Medium (4,000-20,000)	Large (> 20,000)
Generic *E. coli*:	(n = 237)	(n = 237)	(n = 108)
Test positive (%)	7.2 ± 1.7[a]	6.8 ± 1.6[a]	0.9 ± 0.9[b]
Average count (log CFU/ml)	1.10 ± 0.45	1.05 ± 0.38	1.43±0.79
Range (log CFU/ml)	0-3.0	0-3.0	0-2.0
Total coliforms:	(n = 237)	(n = 237)	(n = 108)
Test positive (%)	76.4 ± 2.8	70.9 ± 3.0	55.6 ± 4.8
Average count (log CFU/ml)	1.68 ± 0.16	1.71 ± 0.16	1.70 ± 0.18
Range (log CFU/ml)	0-3.0	0-3.0	0-3.0
Total aerobic plate count:	(n = 222)	(n = 222)	(n = 102)
Average count (log CFU/ml)	3.36 ± 0.13[ab]	3.54 ± 0.12[a]	3.08 ± 0.14[b]
Range (log CFU/ml)	1-6.2	1-7.4	1-5.8

a,b Numbers with different superscripts within a row differ at $P \leq 0.05$

n = the total number of samples from mill size from 1997-2002. Some mills were sampled each year and other mills were sampled less frequently.

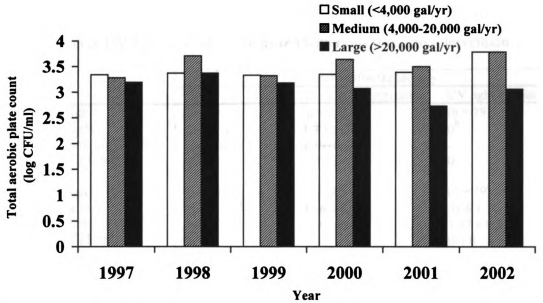

Figure 3. Total aerobic plate counts of Michigan cider between 1997 and 2002 stratified by production volume of mill
*No significant difference found within or between years

TABLE 11. Bacterial populations in Michigan apple cider from mills using thermal pasteurization or UV light irradiation compared with mills using no intervention technology

	Intervention technology		
Bacterial test	Untreated	Thermal pasteurization	UV light irradiation
Generic *E. coli*:	(n = 504)	(n = 59)	(n = 19)
Test positive (%)	6.5 ± 1.1[a]	1.7 ± 1.7[b]	0[b]
Average count (log CFU/ml)	1.20 ± 0.27	1.19±0.78	-
Range (log CFU/ml)	0-3.0	0-0.56	0
Total coliforms:	(n = 504)	(n = 59)	(n = 19)
Test positive (%)	75.8 ± 1.9[a]	35.6 ± 6.3[b]	31.6 ± 11.0[b]
Average count (log CFU/ml)	1.92 ± 0.07	1.69 ± 0.21	1.47 ± 0.37
Range (log CFU/ml)	0-3.0	0-3.0	0-3.0
Total aerobic plate count:	(n = 476)	(n = 52)	(n = 18)
Test positive (%)	100%	100%	100%
Average count (log CFU/ml)	3.94 ± 0.07[a]	2.97 ± 0.16[b]	3.08 ± 0.25[b]
Range (log CFU/ml)	1-7.4	1-5.8	1-4.6

a,b Numbers with different superscripts within a row differ at $P \leq 0.05$

n = the total number of samples from 1997-2002. Some mills were sampled each year and other mills were sampled less frequently.

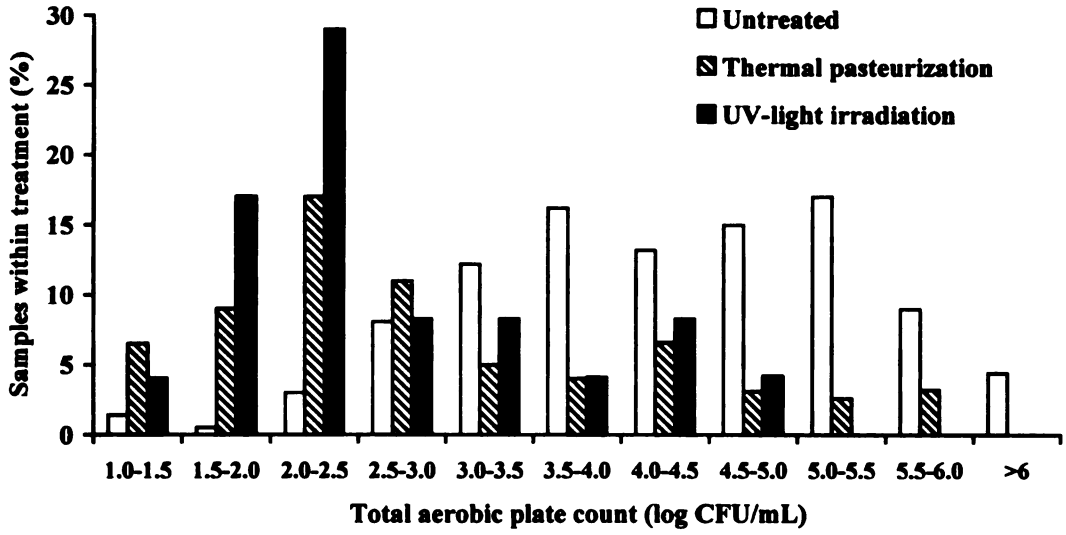

Figure 4. Total aerobic plate counts in Michigan apple cider from mills using thermal pasteurization or UV light irradiation compared with mills using no intervention technology

CHAPTER IV. MICHIGAN CIDER PROCESSORS' PERCEPTIONS AND DECISIONS IN RESPONSE TO JUICE HACCP REGULATION

A. ABSTRACT

The juice industry has experienced a number of foodborne illness outbreaks because juice contained microbial pathogens such as *E. coli* O157:H7, *Salmonella* spp. and *Cryptosporidium parvum*. To reduce consumer risk, the U.S. Food and Drug Administration (FDA) issued a Hazard Analysis and Critical Control Point (HACCP) regulation for the juice industry in 2001. Compliance with the regulation began in 2002 and required many juice manufacturers to change processing methods and spend additional time and money to bring their equipment and employees up-to-date. It has been predicted that small juice processors will be the ones most impacted by the juice HACCP regulation. The apple cider industry offers an interesting case to test this prediction because this industry is comprised of many small processors who manufacture cider only seasonally. To gain insight into processors' perceptions of the juice HACCP regulation, two mail surveys were sent to Michigan cider processors in August and September 2002 to evaluate their perceptions about the juice HACCP regulation, and their expectations concerning its effectiveness. Processors also were asked if the HACCP regulation would result in unnecessary expense and regulatory oversight, and if it would improve consumer confidence in cider safety.

Cider processors were divided in their perceptions of the juice HACCP regulation. Processors who did not perceive the need for the juice HACCP regulation (48%) indicated that the regulation would be ineffective in decreasing foodborne illness linked to juice consumption, result in unnecessary expense and governmental oversight, and not

improve consumer confidence in cider. Processors in favor of HACCP implementation (31%) had taken measures to improve the safety of their cider, but only a few (10%) had a HACCP plan in place at the time of the survey. Many processors were not motivated to comply with the juice HACCP regulation, because processors selling directly to consumers are not required to implement HACCP as long as they include a warning statement about pathogens on their juice container. Adoption of HACCP by juice processors may be slow, as has been the case in other food industries also subject to HACCP regulations.

B. INTRODUCTION

The FDA has estimated that 16,000-48,000 foodborne illnesses occur annually in the U.S. from consumption of juice containing pathogens (FDA, 2001). Since 1996, several juice-associated foodborne illness outbreaks have occurred that have been linked to the presence of the pathogens *E. coli* O157:H7 and *Cryptosporidium parvum* in unpasteurized apple juice. One of these outbreaks was linked to consumption of unpasteurized apple juice produced by a large juice manufacturer, Odwalla, who distributed the juice to several western U.S. states and British Columbia in Canada (CDC, 1996; FDA, 2001). This outbreak received extensive media coverage because over 100 people became seriously ill and the death of a child in the U.S. In 1998, the FDA promulgated a regulation in which a warning label would be required on juice packages when the juice was not treated with a lethality step to achieve a 5-log reduction of pathogens (*E. coli* O157:H7, *Salmonella* spp., and *Cryptosporidium parvum*). The required statement reads: "WARNING: This product has not been pasteurized and, therefore, may contain harmful bacteria which can cause serious illness in children, the

elderly, and persons with weakened immune systems." In 2001 the FDA issued the final juice HACCP regulation, requiring large, small, and very small juice manufacturers, as defined by the regulation, to implement HACCP beginning in January of 2002, 2003, and 2004, respectively. An exemption to the final juice HACCP regulation was made for juice manufacturers selling their juice only in their own retail outlet and directly to consumers. However, retail juice not treated to achieve a 5-log reduction of pathogens must continue to include the warning label on juice packaging (FDA, 2001).

HACCP is required in other sectors of the U.S. food industry and is accepted as a food safety standard throughout the world by the Codex Alimentarius Commission (Stevenson and Bernard, 1999). In the U.S., HACCP requirements were first mandatory for seafood plants no later than December 1997. This was followed by the imposition of HACCP requirements for meat and poultry processing plants no later than December 2000. An investigation by the U.S. General Accounting Office (USGAO) into HACCP implementation in the seafood industry, two years after the HACCP regulation was in effect, found only 44% of processors were using HACCP. This poor compliance was believed to stem from a lack of processor knowledge, disagreement by industry with the seafood HACCP regulation, and limited enforcement by FDA inspectors (USGAO, 2001). Successful adoption of HACCP depends upon processors' consensus that it is beneficial to improving food safety of their products, and regulatory agencies ensuring that HACCP systems are in place and effective (Gilling et al., 2001).

Approximately 98% of apple juice sold in the U.S. is pasteurized (Apple Products Research and Education Council, 2004) and is primarily manufactured by large juice processing facilities that already use a lethality step to reduce the risk of pathogens.

These large processors can more readily adopt a HACCP plan because their available resources and presence of controls for pathogens in juice. The remaining 2% of apple juice is unpasteurized and unfiltered, and more commonly referred to as apple cider. Apple cider is primarily made by small cider processors who have a cider mill located on their farm or orchard. Generally, these cider processors only make small amounts of cider for a few months each year. This cider is then sold through the processors' own retail operations or, until recently, wholesale to other retail establishments. Small processors may not be able to afford the cost and time associated with HACCP implementation. Previous research has indicated that cider processors in New York, Iowa, Wisconsin and Virginia were concerned about implementing HACCP, especially because of additional equipment costs and the adverse effect pasteurization may have on the sensory attributes of cider (Cummins, 2002; Uljas and Ingham, 2000; Worobo, 2001; Wright et al., 2000). Therefore, small cider processors who have sold cider wholesale may choose to sell their cider directly to consumers and continue to use the FDA-mandated warning statement on their juice containers to avoid HACCP implementation (Cummins, 2002; Wojtala, 2003; Worobo, 2001). When surveying cider processors in Virginia, Wright et al. (2000) reported that small cider processors would seriously consider ceasing operation rather than incurring the cost to implement HACCP. Another trend found with processors in several states was that there has been a decline since 1996 in the number of cider mills (Cummins, et al., 2002; Dingman, 1999; Uljas and Ingham, 2000; Wright et al., 2000) and we found this to be true in Michigan as well (Figure 1; Chapter III). This decline could be because of a number of reasons, including increased regulations with few perceived benefits by cider processors.

The objective of this study was to determine perceptions of Michigan cider processors towards the juice HACCP regulation and steps they have taken to comply with the regulation. Michigan is one of the top four apple producing states and apples have the highest production among fruit in Michigan (Michigan Agricultural Statistics, 2003). Michigan also ranks as one of the top three states in cider production, with approximately 30 percent of Michigan apples processed into cider each year (Michigan Apple Association, 2004; Michigan Agricultural Statistics, 2003). Apples and cider are important commodities to Michigan agriculture. The implementation of a new regulatory system is likely to have consequences within this domain, bringing both benefits and costs to processors, regulators, and consumers. We were interested in the attitudes and perceptions of one of these groups – processors – to gauge the likelihood that HACCP would be implemented across the state, and what lingering concerns, if any, would continue to plague the industry.

C. MATERIALS AND METHODS

Two surveys with letters were mailed in August and September 2002 to assess Michigan apple cider processors' practices and perceptions about the juice HACCP regulation (Appendices H, I, J and K) informing participants that the mail survey was voluntary, confidential, and conducted for Michigan State University. The study protocol was approved by Michigan State University Committee on Research Involving Human Subjects (Appendix A). The questionnaires were pilot tested with cider processors (n=5) for clarity. Processors' names and addresses were provided by the Michigan Department of Agriculture (MDA) from their list of cider mills having a current food processing license (n = 118).

A multiple mailing procedure was used to enhance return rates (Dillman, 2000). Participants who returned completed surveys were sent a thank you note (Appendix M). To enhance return rates, non-respondents were mailed both surveys again in late September (Appendix L). Of the remaining 118 processors, 52 completed and returned both surveys. Survey responses were analyzed using SAS Version 8 (SAS Institute Inc., Cary, N.C. U.S.A. 2001) and descriptive statistics were generated. Processors were categorized based upon the question "HACCP implementation is necessary to ensure the safety of cider." Three groups were defined: 1) processors agreeing with the need for HACCP (31%), 2) processors neutral to the need for HACCP (21%) and 3) processors disagreeing with the need for HACCP (48%) and responses of groups were compared using a t-test.

D. RESULTS AND DISCUSSION

There is considerable research regarding food risk assessment by consumers and how it influences their purchasing decisions (Schafer et al., 1993; Sparks and Shepherd, 1994; Hansen et al., 2003; Zepeda et al., 2003). In comparison, there has been relatively little research of food risk assessment by food processors and how it influences their processing decisions. Of the research that has been conducted on food processors, the smaller food processing businesses tend to be somewhat adversarial to HACCP and slow to comply with HACCP regulations (Gilling et al., 2001; USGAO, 2001). Based on this background, we were interested in how the Michigan cider industry perceived and responded to the juice HACCP regulation. Similar to other U.S. states, most Michigan cider mills have few employees, often are family-owned and operated, are open only during the fall season and are very small juice manufacturers as defined by FDA (Tables

12 and 13). These cider mills are representative of small cider processors throughout the U.S. based on demographic information provided in other studies (Cummins, et al., 2002; Dingman, 1999; Uljas and Ingham 2000; Wright et al., 2000).

Need for and effectiveness of HACCP

Michigan cider processors are divided in their perceptions about whether or not there is a need for and the effectiveness of the juice HACCP regulation. Of the processors completing the survey, 31% indicated they either strongly agreed or agreed with the need for HACCP, 21% were neutral and 48% either strongly disagreed or disagreed with HACCP (Table 14). The processors perceiving a need for HACCP pointed out that HACCP is effective in ensuring cider safety and public health (Table 15). Comments from these processors included; "Pasteurization is the only way to go," "Pasteurization is essential for safety" and "Our mill takes extraordinary safety precautions to make sure our cider is healthy."

Processors opposing HACCP perceived no need for this program nor did they consider it to be effective in reducing foodborne illness in juice (Table 15) because they related their perceptions to the fact that Michigan cider has not been implicated in a foodborne illness outbreak. They pointed out that the risk of becoming ill from untreated cider is small in Michigan because their mills were inspected annually by state inspectors, they followed current good manufacturing practices (CGMPs), and only used wholesome apples to make cider. These processors supported their perceptions with comments such as "Michigan juice has been a safe product from the beginning", "Our cider was processed under the most sanitary conditions", and "We have passed every one of our state inspections." Processors opposed to HACCP requirements also tended to make

defensive statements and place blame for juice outbreaks on processors who they considered less conscientious than themselves with comments such as; "the biggest problem was not small producers, it was caused by a completely unsafe practice and a large processor," and "most of the cider is made by small producers producing a safe product." These processors also were more likely to market their cider as "unpasteurized," "no preservatives," and "made with Michigan apples." Several processors commented that the selling point for their cider was its great taste because their cider was not treated to alter the natural characteristics of the juice.

Processors opposed to HACCP were also skeptical of processors who favored HACCP and the effectiveness of the programs these supportive processors had in place with comments such as "There are processors with written plans, but some do not operate within the guidelines." "The regulations do not eliminate the unsanitary processor." Processors not seeing the need for or effectiveness of HACCP appear to base their beliefs and decisions on personal experience and local situations. Previous research has found this viewpoint to be somewhat common because people often do not see the relevance or need to take precautions towards a food safety issue until it personally affects them (Sparks and Shepard, 1994; Zepeda et al, 2003).

Expense and oversight of HACCP

When Michigan processors were asked if the juice HACCP regulation would result in unnecessary expense, 70% of all processors agreed (Table 14). The overall concern about the expense to implement HACCP may be justified with estimated implementation costs ranging between $24,700-36,700 in the first year and estimates of up to $10,600 for subsequent years for small seasonal cider processors (FDA, 2001). The

costs for the first year of implementation equaled the annual sales of 75% of all cider processors (Table 12).

Sixty-percent of all processors agreed that HACCP would result in unnecessary oversight (Table 14). Concerns about unnecessary oversight were primarily directed toward the government with statements such as; "The state government interferes in our business," "I tell my the customers some oversight is good but too much just kills the little operations and they have fewer options," "Isn't it too bad government has to stick its nose in everywhere?" "This may be our last year because we will not jump through all the hoops," and "The regulations are killing me for a product I make little money on." These statements suggest that processors may feel victimized by the government's juice regulations because they perceive themselves as already using good judgment in their juice-making, they have been inspected annually by state food inspectors, and there have been no foodborne illness outbreaks linked to Michigan cider at this time.

Fifty percent of processors agreeing with HACCP stated they believed HACCP would not affect profits and 17% thought it could even increase profits. These processors had already taken the most initiative towards complying with the juice HACCP regulation, with 80% of them stating they had spent over $5,000 in the last five years to upgrade their equipment and facility (Table 16).

Of the processors opposing HACCP, 65% felt the program would decrease their profits and most (60%) had spent less than $2,500 in the last five years to upgrade or purchase equipment to prepare for the juice HACCP regulation (Table 16). Many of these processors feared that the juice HACCP regulation would run them out of business. Comments like "my customers feel bad that so many of us are being forced out of the

cider business" and "we are losing our industry to foreign juice concentrate used by big processors" illustrate their pessimistic views towards HACCP. Some processors appear to already have the mind-set that it is just a matter of time before they lose their cider business so it is unnecessary to spend time and money to implement HACCP.

Training, Inspectors and the Media

Of the processors surveyed, 43 percent agreed that HACCP training was easily accessible and convenient and 35 percent indicated that it was not easily accessible or convenient (Table 15). When asked if they had an adversarial relationship with their inspector, over half of the processors disagreed with this statement and considered inspectors to be knowledgeable about HACCP (Table 15). This positive view of inspectors may be surprising, because the food inspector is a government employee and their role is to enforce the juice HACCP regulation. In personal interviews with processors many viewed inspectors as a source of guidance rather than as a policing official and were proud that they had passed annual inspections, though the feeling of a mutually beneficial relationship was not shared by all. It is puzzling that so many processors, who take pride in their juice, view the HACCP regulation as unnecessary government oversight when a primary goal of HACCP is for the processor to take ownership of food safety and to reduce the risk of hazards, rather than depending on annual government inspections to identify potential problems.

Processors also made accusations about the media with statements such as "the media is to blame for making it look like all cider has a problem" or "the media usually gets the story wrong and blows small things into large ones" and "small processors always take the heat." Such statements indicate that processors may feel the government

has been influenced by the media becausee legislation for the juice industry has begun only after the widely publicized 1996 outbreaks. Processors may not be accepting of HACCP because they believe that the government should be more concerned with larger producers because the 1996 Odwalla juice outbreak was from a large juice manufacturer that distributed to many states and Canada (CDC, 1996). If this is their belief, it is unsubstantiated because juice outbreaks have been reported as early as 1923, and several outbreaks have occurred since the 1996 outbreaks. Previous to the Odwalla outbreak in 1996, outbreaks tended to be localized and juice was made by relatively small juice processors. The media featured the Odwalla outbreak and the government investigated it further because it was so widespread and a child died from consuming contaminated juice (Parrish, 1997; Parrish, 2000; FDA, 2001).

Processors' views about unnecessary expense and oversight, the government, and the media are again supported by research regarding how relevant and personal a food safety situation is perceived. Cider processors perceive themselves as already producing a safe product, as trustworthy, and that a foodborne illness outbreak is unlikely to happen to them. Therefore, they view the additional expense and oversight of the juice regulation as unnecessary. This belief is common when people are not willing to accept that they are just as vulnerable as anyone else to food safety and health risks and have not the will power to prevent an unfortunate situation (Schafer et al., 1993).

Consumer confidence and HACCP

Because the majority of the cider processors sell directly to consumers, we wanted to learn how they perceived their customers and HACCP. Processors overall perceived that their consumers ranged from adults with children under five years of age

to adults over 65 years of age. Significant differences were found among processor groups for adults without children and adults over 65 years of age (Table 17). Processors agreeing with HACCP differed significantly from other processors regarding their perceptions of their consumers and were more likely to believe that HACCP would increase consumer confidence (Table 18). Half of all processors, however, did not perceive HACCP as making consumers more confident in buying cider from their mill (Table 18). This view is most likely because only 4% of the processors believe consumers have a good understanding of HACCP, 48% indicate consumers were aware of HACCP but not certain what it meant, and the remaining 48% perceive consumers as not at all aware of HACCP and did not care (Table 18). This finding is consistent with focus groups regarding HACCP awareness in the meat industry in which only a small percentage of consumers had heard about HACCP and understood it even less (Ford et al., 1998).

When processors were asked why consumers purchased their cider, they listed trust, taste, and a fun fall activity that supports tradition as most important (Table 19). "Trust cider mill" was the most common reason processors perceived that consumers purchased their cider (88%; Table 19). Although the majority of mills (77%) do not use pasteurization or other means to destroy microbial pathogens, processors were convinced that consumers trusted their mill because of the stringent sanitary conditions applied from apple harvesting to cider bottling. This consumer trust may be based on years of buying cider at their mill as indicated by the following comments about the FDA warning label "Consumers did not understand, why now! They have been drinking cider all their life" and "Most older folks say they've been drinking unpasteurized cider their whole life and

it hasn't killed them yet." Consumers' trust is not considered to be the same as healthy or safe, which only 65% and 52% of processors, respectively, mentioned as reasons that consumers purchased cider (Table 19).

Taste was the second reason processors felt consumers purchased their cider. Processors opposing HACCP believed that their customers are concerned about the effect pasteurization has on the flavor and taste of cider. Processors supported this belief by writing comments in the survey about what they had heard from their customers, "Pasteurized cider doesn't taste as good," "I'm not concerned with safety, I want the good untreated stuff," and "If it is pasteurized, I don't want it." These processors further supported their views by writing additional notes on the survey that included "Most of our customers want unpasteurized cider," "they want natural cider – not pasteurization," "not concerned as long as it is not pasteurized," and "I have far greater number of customers who comment that they buy our cider because it is unpasteurized." This demonstrates why 80% of processors opposing HACCP use the attribute "unpasteurized" to promote their cider (Table 20). Consumer research indicates that the majority of consumers are not able to distinguish pasteurized and unpasteurized cider by taste and even if they can distinguish by taste, consumers will adjust over time to the taste of treated cider (Yulianti, 2003).

Processors opposing HACCP are not oblivious to the fact that they have lost customers because of concerns about the health risk of unpasteurized cider. Processors reported that because of consumers' personal situations, such as families with young children, the elderly and people with poor health, they have heard comments such as

"Unpasteurized cider can possibly have a negative effect on young children and very old adults."

Processors selling unpasteurized cider are required to include a warning statement on their product containers so we wanted to learn what processors had heard from consumers about the warning. In the opinion of processors, only a minority of consumers (21%) noticed the warning label for untreated apple cider (Table 18). Processors commented that they were asked "Is there a problem, why the label?" and "Does this mean your cider is the same as it always has been?" Processors also indicated that they often had to explain why the warning was on the juice container and then reported hearing comments such as; "It is necessary?" "That's a bunch of nonsense," "It is ridiculous," and "Another idiotic government idea." One processor commented, "After they get done laughing at the government's reasoning the inevitable comparison to cigarettes follows." The cider processors' comments about the FDA warning statement suggests that some Michigan cider processors believe the warning label is not necessary and further justifies their decision to disagree with the need for HACCP.

Another top reason consumers buy cider is likely because they want to support small cider processors so they can purchase locally grown fruits and fruit products and enjoy a fun fall activity (69%) that supports tradition (67%; Table 19). The cider qualities promoted by our surveyed processors included no preservatives, fresh, unpasteurized, delicious or great tasting, and 100% juice (Table 20) indicating they are promoting some of the attributes of interest to consumers. Survey research regarding produce and organic foods has found that many consumers also believe locally grown

and processed food is fresher, safer and more nutritious (Bruhn and Schutz, 1999; Torjunsen et al., 2001).

E. CONCLUSION

Cider processors participating in this study were divided in their perceptions of the juice HACCP regulation and in particular how they perceive the need for and effectiveness of HACCP to decrease foodborne illnesses. Processors who agreed with HACCP thought this program would not affect their profit and that consumers were more concerned about the safety of cider. Although a higher percentage of these processors had taken measures to comply with the juice HACCP regulation by installing equipment that would reduce the risk of pathogens, few had followed through to develop a HACCP plan by September 2002. Processors that disagree with HACCP thought the program would decrease their profits and that consumers were more concerned about the taste of cider and rejected pasteurized cider because of the perceived detrimental effect on taste.

A major reason for disagreement with HACCP was wariness of the government and the decision to mandate HACCP. The regulation was viewed as the government's way of interfering with and not being realistic about the juice industry, especially small cider processors. However, a majority of the processors were positive about food inspectors, considered them knowledgeable, and took pride in passing annual inspections conducted by the regulatory agencies.

Differences in perceptions of consumer purchase decisions were aligned with the processors' views toward HACCP. This has led to differences in marketing strategies (safety versus taste) because processors viewed consumers as either wanting treated and safe cider or untreated, tasty and natural cider.

When processors were asked what motivates consumers to purchase their cider, "trust the cider mill" was at the top of the list for all processors. However, many Michigan cider processors do not perceive the need to take additional measures to further ensure this trust by implementing HACCP. Cider processors may not be realistic about food safety risks and losing the trust of consumers. Studies have shown that small processors tend to be the most affected by consumer concerns in the time of a crisis because consumers can easily find another food source (Stevenson, 1998; Torjunsen et al., 2001).

Based on the findings of this study, it appears that the juice industry may be heading in the same direction as other food industries, such as the seafood industry, in which processors were slow to adopt HACCP. This may be because cider processors that are resistant to change believe they cannot afford HACCP and are uncertain about how to implement this food safety program. These reasons have overshadowed processors' perception that trust is why consumers purchase their cider.

Table 12. Characteristics of cider mills and processors' agreement with HACCP implementation is necessary for cider safety (n = 52)

		HACCP implementation necessary for cider safety[+]		
Characteristics	**Overall**	**Strongly agree or agree (n=16)**	**Neutral (n=11)**	**Strongly disagree or disagree (n=25)**
	Response (%)	**Number responding (n)**		
FDA classification of business:				
Very small	92	14	10	24
Small	4	1	1	0
Large	4	1	0	1
Annual production (gallons):				
<2,000	27	5	2	7
2,000-3,999	31	3	2	10
4,000-19,999	21	3	3	5
20,000-99,999	13	2	3	2
>100,000	8	2	1	1
Total annual sales of mill ($):				
<5,000	33	5	4	8
5,000-9,999	15	1	0	6
10,000-49,999	27	5	3	6
50,000-99,999	12	1	1	4
>100,000	13	3	3	1
Type of cider sales:				
Retail only	83	10	9	17
Wholesale only	8	2	2	2
Wholesale and retail	9	3	0	6
Employees working at mill:				
<5	79	10	8	23
5-10	6	3	0	0
11-20	2	0	0	1
21-50	7	2	1	1
>50	6	1	2	0
Years mill in operation:				
< 1	2	1	0	0
1-5	4	0	1	1
6-10	19	2	2	7
11-20	19	2	2	5
>20	56	8	6	12

Table 12 (cont'd).

		HACCP implementation necessary for cider safety[+]		
Characteristics	**Overall**	**Strongly agree or agree (n=16)**	**Neutral (n=11)**	**Strongly disagree or disagree (n=25)**
	Response (%)	**Number responding (n)**		
Years worked at mill:				
< 1	2	1	0	0
1-5	8	0	1	3
6-10	23	2	2	8
11-20	17	3	2	4
>20	50	7	6	10

* FDA classification of businesses (juice manufacturers/cider mills) based on size:
Very small businesses (as defined in 21 CFR 120) are those operations that have either total annual sales of less than $500,000, or have total annual sales greater than $500,000 but their total food sales are less than $50,000, or are operations that employ fewer than an average of 100 full-time equivalent employees and sell fewer than 100,000 units of juice in the United States.
Small businesses (as defined in 21 CFR 120) are those operations employing fewer than 500 persons.
Large businesses (as defined in 21 CFR 120) are all businesses not defined as "small businesses" or "very small businesses" (FDA, 2001).
[+]Processors were divided into three groups based on their agreement with the question "HACCP implementation is necessary to ensure the safety of cider." The number of processors listed were those that either strongly agree or agree with HACCP (n=16), processors neutral to HACCP (n=11) and processors either strongly disagree or disagree with HACCP (n=25).

Table 13. Comparison of juice manufacture size definitions according to the U.S. Food and Drug Administration (FDA) and according to the Michigan Department of Agriculture (MDA) (n = 52)

	U.S. Food and Drug Administration*		
Michigan Department of Agriculture[+]	Very Small	Small	Large
Small	26	0	0
Medium	15	0	0
Large	7	2	2

* FDA classification of businesses (juice manufacturers/cider mills) based on size:
Very small businesses (as defined in 21 CFR 120) are those operations that have either total annual sales of less than $500,000, or have total annual sales greater than $500,000 but their total food sales are less than $50,000, or are operations that employ fewer than an average of 100 full-time equivalent employees and sell fewer than 100,000 units of juice in the United States.
Small businesses (as defined in 21 CFR 120) are those operations employing fewer than 500 persons.
Large businesses (as defined in 21 CFR 120) are all businesses not defined as "small businesses" or "very small businesses" (FDA, 2001).
[+]Small, medium, and large mills produced <4,000, 4,000-20,000, and >20,000 gal/yr, respectively

Table 14. Processors' perceptions of the need and effectiveness of the juice HACCP regulation and rationalizations for these perceptions

	Responses (%)				
Perception	Strongly agree	Agree	Neither	Disagree	Strongly disagree
HACCP implementation necessary to ensure cider safety	8	23	21	33	15
HACCP reduces incidence of foodborne illness' linked to juice consumption	10	25	33	20	12
HACCP regulation results in unnecessary expense	27	43	14	16	0
Juice HACCP regulation results in unnecessary oversight	23	37	21	17	2
HACCP training is easily accessible and convenient	2	41	22	27	8
Inspectors who visit my plant have adversarial relationship towards me	8	18	23	35	16
Inspectors who visit my plant are knowledgeable about HACCP	11	45	31	9	4

Table 15. Processors' perceptions of the juice HACCP regulation

Perception		HACCP implementation necessary for cider safety*		
	% Overall	Agree (n=16)	Neutral (n=11)	Disagree (n=25)
	Responses (%)			
HACCP reduces incidence of foodborne illness' linked to juice consumption		c	b	a
Strongly agree and agree	35	88	9	12
Neutral	33	12	91	21
Strongly disagree and disagree	32	0	0	67
HACCP regulation results in unnecessary expense		a	a	b
Strongly agree and agree	70	44	64	92
Neutral	14	12	27	8
Strongly disagree and disagree	16	44	9	0
Juice HACCP regulation results in unnecessary oversight		d	de	e
Strongly agree and agree	60	44	40	82
Neutral	21	12	60	9
Strongly disagree and disagree	19	44	0	9
HACCP training is easily accessible and convenient		a	ab	b
Strongly agree and agree	43	64	46	29
Neutral	22	14	27	25
Strongly disagree and disagree	35	22	27	46
Inspectors who visit my plant have adversarial relationship towards me				
Strongly agree and agree	26	27	30	25
Neutral	23	7	40	25
Strongly disagree and disagree	51	66	30	50
Inspectors who visit my plant are knowledgeable about HACCP		b	a	b
Strongly agree and agree	56	60	20	70
Neutral	31	27	50	25
Strongly disagree and disagree	13	13	30	5

a,b,c numbers with different superscripts within a row differ at $P \leq 0.05$.
d,e numbers with different superscripts within a row differ at $P \leq 0.10$.
* Processors were divided into three groups based on their agreement with the question "HACCP implementation is necessary to ensure the safety of cider." The number of processors listed were those that either strongly agree or agree with HACCP (n=16), processors neutral to HACCP (n=11) and processors either strongly disagree or disagree with HACCP (n=25).

Table 16. Responses of processors to the juice HACCP regulation

Responses		HACCP implementation necessary for cider safety*		
	% Overall	Agree (n=16)	Neutral (n=11)	Disagree (n=25)
Decisions:	**Responses (%)**			
Equipment costs in anticipation of HACCP in the last 5 years (in $):		a	b	b
<1000	35	13	45	44
1,000-2,500	12	7	9	16
2,501-5,000	14	0	46	40
>5,000	39	80	0	0
Changes made in how cider is sold due to HACCP:				
No change	39	33	50	39
Sell more retail	19	22	0	23
Sell only retail	42	45	50	38
Anticipated changes in profits due to HACCP?		c	d	d
Decrease	57	33	64	65
No change	37	50	36	31
Increase	6	17	0	4
	Yes responses (%)			
Steps toward HACCP implementation:				
Intend to process cider according to Juice HACCP regulation	62	75^{a}	82^{a}	44^{b}
Attended cider school or HACCP training	62	83^{a}	70^{ab}	48^{b}
Implemented SSOPs	44	69^{a}	40^{ab}	32^{b}
Implemented 5-log reduction step	23	44^{a}	18^{ab}	12^{b}
Implemented HACCP plan	10	15^{a}	10^{a}	8^{a}
Perceptions:				
What motivates you to make cider?				
Believe cider is a safe product	75	75	82	72
Supplement income	67	56	73	72
Family tradition and business	62	69	73	52
Enjoy customers who purchase cider	52	63	55	44
Enjoy processing cider	40	44	36	40
Another way to use extra apples	38	31	55	36
Fun to make	17	19	18	16

a,b numbers with different superscripts within a row differ at $P \leq 0.05$.
c,d numbers with different superscripts within a row differ at $P \leq 0.10$.
* Processors were divided into three groups based on their agreement with the question "HACCP implementation is necessary to ensure the safety of cider." The number of processors listed were those that either strongly agree or agree with HACCP (n=16), processors neutral to HACCP (n=11) and processors either strongly disagree or disagree with HACCP (n=25).

Table 17. Processors' perceptions of visiting frequency of consumers to their cider mill

Perceptions	% Overall	HACCP implementation necessary for cider safety*		
		Agree (n=16)	Neutral (n=11)	Disagree (n=25)
	Responses (%)			
Adults with children < 5 years				
Very often	45	50	60	38
Often	48	43	40	52
Not often	7	7	0	10
Not at all	0	0	0	0
Adults with school-age children 5-9 years				
Very often	61	64	67	57
Often	34	25	33	38
Not often	5	7	0	5
Not at all	0	0	0	0
Adults with school-age children >9 years				
Very often	55	50	67	54
Often	38	36	33	41
Not often	7	14	0	5
Not at all	0	0	0	0
Adults without children		a	b	c
Very often	74	57	100	74
Often	22	29	0	26
Not often	2	7	0	0
Not at all	2	7	0	0
Adults >65 years		c	a	b
Very often	66	39	100	70
Often	27	38	0	30
Not often	7	23	0	0
Not at all	0	0	0	0

a,b,c numbers with different superscripts within an age category differ at $P \leq 0.05$.

* Processors were divided into three groups based on their agreement with the question "HACCP implementation is necessary to ensure the safety of cider." The number of processors listed were those that either strongly agree or agree with HACCP (n=16), processors neutral to HACCP (n=11) and processors either strongly disagree or disagree with HACCP (n=25).

Table 18. Processors' perceptions of consumers' response to the juice HACCP regulation and rationalizations for these perceptions

		HACCP implementation necessary for cider safety*		
Perceptions	**% Overall**	**Agree (n=16)**	**Neutral (n=11)**	**Disagree (n=25)**
	Responses (%)			
HACCP will make consumers more confident in buying cider from mill		a	b	b
Agree strongly or agree	16	43	0	8
Neutral	33	29	70	21
Disagree strongly or disagree	51	28	30	71
Consumers awareness of Juice HACCP regulation				
Yes, and have good understanding	4	0	10	4
Yes, but not sure what it means	48	57	40	46
Not aware at all	25	36	40	12
No, and don't care	23	7	10	38
How often consumer notice FDA warning label (if needed)				
Never	12	0	12	14
Seldom	67	100	50	67
Often	12	0	13	14
Very often	9	0	25	5
How often do your feel your customers purchase cider?				
Only for special occasions	2	0	0	4
Throughout the year	22	25	20	21
2-3 times a month in the fall	35	58	30	25
Once a week in the fall	41	17	50	50

a,b,c numbers with different superscripts within a row differ at $P \leq 0.05$.

* Processors were divided into three groups based on their agreement with the question "HACCP implementation is necessary to ensure the safety of cider." The number of processors listed were those that either strongly agree or agree with HACCP (n=16), processors neutral to HACCP (n=11) and processors either strongly disagree or disagree with HACCP (n=25).

Table 19. Processors' perceptions of consumers' motivations to purchase cider

Perceptions	% Overall	HACCP implementation necessary for cider safety*		
		Agree (n=16)	Neutral (n=11)	Disagree (n=25)
	Yes responses (%)			
What motivates consumers to purchase cider?				
Trust your cider mill	88	88	82	92
Great taste	85	81	91	84
Fun fall activity	69	75	55	72
Tradition	67	81[a]	45[b]	68[ab]
Healthy product	65	75	64	60
100% juice	54	44	55	60
Feel it is safe	52	69	36	48

a,b numbers with different superscripts within a row differ at $P \leq 0.10$.

* Processors were divided into three groups based on their agreement with the question "HACCP implementation is necessary to ensure the safety of cider." The number of processors listed were those that either strongly agree or agree with HACCP (n=16), processors neutral to HACCP (n=11) and processors either strongly disagree or disagree with HACCP (n=25).

Table 20. Cider qualities promoted by processors

Perceptions	% Overall	HACCP implementation necessary for cider safety*		
		Agree (n=16)	Neutral (n=11)	Disagree (n=25)
	Responses (%)			
Do you promote your cider as having these qualities?				
No preservatives	79	69	82	84
Fresh	75	69	82	76
Unpasteurized	63	38^{a}	64^{ab}	80^{b}
Delicious or great tasting	63	75	55	60
100% juice	54	45	60	45
Healthy	42	69^{a}	27^{b}	32^{b}
Made with Michigan apples	38	27	36	62
Safe	31	56^{a}	27^{ab}	16^{b}
Passed food safety inspections	25	44^{a}	0^{b}	24^{a}
Pasteurized	23	44^{a}	18^{ab}	12^{b}
Contains preservatives to maintain freshness	13	13	27	8
Organic or natural	6	13	9	0

a,b,c numbers with different superscripts within a row differ at $P \leq 0.05$.
d,e numbers with different superscripts within a row differ at $P \leq 0.10$.
* Processors were divided into three groups based on their agreement with the question "HACCP implementation is necessary to ensure the safety of cider." The number of processors listed were those that either strongly agree or agree with HACCP (n=16), processors neutral to HACCP (n=11) and processors either strongly disagree or disagree with HACCP (n=25).

CHAPTER V. APPLE CIDER AND JUICE FOOD SAFETY: A CONSUMER PERCEPTION SURVEY

A. ABSTRACT

In the 1990's a series of foodborne-illness outbreaks raised public health concerns about unpasteurized juice containing pathogens. In response, the U.S. Food and Drug Administration (FDA) implemented the juice Hazard Analysis and Critical Control Point (HACCP) regulation, in which juice manufacturers must process juice in a way that includes a lethality step, such as pasteurization, to reduce the presence of pathogens and subsequent health risks. An exception to the juice HACCP regulation was made for processors selling juice directly to consumers, such as from a farm or orchard, in which they do not need to process juice using HACCP. If a processor wishes to sell juice directly to the public without using a lethality step, s/he must include a warning statement on the juice container to inform consumers about health risks associated with drinking the juice.

Several juice related foodborne illness outbreaks have been caused by microbial pathogens present in unpasteurized apple juice. Consumers may have become aware of apple juice-associated outbreaks through the media or noticed the warning label on juice containers. However, there has been little research conducted on how consumers perceive the safety of juice and in particular the safety of apple cider or juice.

This chapter focuses on the food safety perceptions of Michigan consumers who drink apple cider and juice. An e-mail survey was sent in October 2002 to 497 Michigan consumers who drink apple cider and juice. Our objective was to learn their food safety concerns about apple cider and juice, food safety information sources, knowledge about

juice safety and factors that influence their apple cider and juice purchase decisions. Surveyed consumers expressed concern about the possible presence of bacterial, chemical, and physical hazards in apple cider and juice. However, they were not able to distinguish statements required on the juice label and had limited knowledge about HACCP. Only 20% of consumers understood that HACCP is a food safety program. Apple cider and juice purchase decisions by consumers were influenced first by taste, then safety. Consumers vary in where they purchase apple cider and juice and considered grocery stores as having the safest juice and farms as having the freshest but not necessarily the safest juice.

B. INTRODUCTION

The FDA estimates that annually in the U.S. 16,000-48,000 people become ill from drinking juice that contains microbial pathogens (FDA, 2001). To decrease the incidence of foodborne illnesses associated with juice products in 1998, the FDA promulgated a regulation that required the statement "WARNING: This product has not been pasteurized and, therefore, may contain harmful bacteria which can cause serious illness in children, the elderly, and persons with weakened immune systems" be placed on the labels of juice products that had not been treated with a processing technology, such as pasteurization or UV light irradiation, that ensures a 5-log reduction of pertinent pathogens of concern (*Salmonella* spp., *E. coli* O157:H7, and *Cryptosporidium parvum*). In 2001, the final juice HACCP regulation was promulgated. This juice HACCP regulation required juice manufacturers to implement a HACCP plan which includes a lethality step that results in a 5-log reduction of the pertinent pathogens. The regulation was phased in based on juice manufacturer size starting in January 2002 with full

compliance no later than January 2004 (FDA, 2001). An exemption to the juice HACCP regulation was made for manufacturers that sell juice directly to consumers in that they were not required to implement HACCP or the lethality step. However, if they choose this option, the warning statement must be on juice packages (FDA, 2001).

During the 1990's, consumers' food safety concerns increased in regards to the presence of harmful bacteria, chemicals, and foreign material in food. Although consumers express concern about food safety, many tend to have limited knowledge about food safety and do not follow food safety recommendations (Bruhn, 1997; Bruhn and Schutz, 1999; Herrmann et al., 2000; Roper, 2001). Consumers often base food purchase decisions on their personal traditions and beliefs about the food (Davidson et al., 2003; Robinson and Smith, 2003; Spinks and Bose, 2002). Generally, the food attributes that continue to be of importance to consumers are taste, food safety and health benefits of the food (Ford et al., 1998; Goldman and Clancy, 1992; Jolly et al., 1989; McEachern and McClean, 2002).

Because foodborne illness outbreaks associated with apple juice have been a concern, we wanted to learn about the food safety perceptions of Michigan consumers in regards to apple cider and juice. Apples, apple cider and juice are important commodities to Michigan agriculture and food safety concerns about these products could have a negative impact on this industry. Michigan ranks as one of top four apple producing states and one of the top three states in cider production with approximately 30 percent of Michigan apples processed into apple cider or juice (Michigan Apple Association, 2004; Michigan Agricultural Statistics, 2003). The objective of this study was to evaluate Michigan consumers' concerns about the safety of refrigerated apple cider and juice, their

knowledge about food safety terminology and juice labeling requirements, and whether or not food safety concerns influence their apple cider and juice purchase decisions.

C. MATERIALS AND METHODS

In October 2002, an email survey was sent to 1,000 Michigan primary household shoppers over 18 years of age. Participants were informed that the e-mail survey was voluntary, confidential, and conducted for Michigan State University. The study protocol was approved by Michigan State University Committee on Research Involving Human Subjects (Appendix A). The survey was pilot tested (n=125). A market research company, (Market Facts Inc., Chicago, IL) provided the consumer e-mail list and sent the survey to Michigan consumers. The survey followed Dillman's (2000) survey methods for mail and e-mail surveys (Appendix N). More than 85% of the surveyed consumers returned the e-mail questionnaires (n=851). Market Facts Inc., also provided additional demographic data they had on file for the consumers participating in the survey. Data were analyzed using SAS and descriptive statistics were generated. For statistical analyses, surveys from consumers that purchased and/or drank apple cider, juice or both within the last year (n=497) were used.

D. RESULTS AND DISCUSSION

Because food safety continues to be a primary concern of consumers (International Food Information Council, 1999; Roper, 2003), we were interested in how Michigan apple cider and juice consumers perceive the risk of foodborne illnesses from refrigerated juices. To assess consumer concerns, we used an e-mail survey, which has the advantage of a very high return rate (85% in this study). A disadvantage of e-mail surveys is that they tend to represent consumers who are Caucasian and have higher

education and income levels when compared to U.S. census data (Bauman and Airey, 2001). We found this to be true when demographics of our survey respondents were compared to U.S. census data for adults over the age of 18 years (Table 21).

Food safety concerns

Food safety concerns have been investigated in a number of food safety surveys and consumers continue to be concerned with bacteria, pesticides, mold, foreign material, processing chemicals, insects and allergens in their food (Bruhn, 1997; Bruhn and Schutz, 1999; Meer and Misner; 2000; Li-Cohen and Bruhn, 2002; Roper, 2001, 2003). Our Michigan apple cider and juice consumers had the same food safety concerns as consumers in these other food safety studies (Table 22).

Consumers may not put food safety concerns into perspective relative to other safety risks. The International Food Information Council (1999) reported that food safety concerns often exceed concerns about other health and safety issues such as cigarette smoking or wearing a seat belt. Consumer surveys on food safety also have found that although consumers indicate they are concerned about food safety, their knowledge about these concerns is often limited and they do not necessarily follow through with actions to prevent food safety risks (Sparks and Shepard, 1994; Meer and Misner; 2000; Li-Cohen and Bruhn, 2002). Consumers' food safety concerns need serious consideration by educators and manufacturers in order to help consumers make more informed food choices and be confident about our food supply.

Information sources and knowledge

Consumers become aware and knowledgeable about food safety concerns through a variety of resources. The primary sources of food safety information for over 50% of

our respondents were national and local television programs and local newspaper reports (Table 23). Bruhn and Schutz (1999) reported that even though consumers use the media as their main food safety resource they do not necessarily perceive this as the most reliable. Physicians and health professionals are considered to be the most reliable source but are not used very often (Bruhn and Schutz, 1999). Our respondents referred to physicians 22% and other health professionals 10% of the time (Table 23). Family members were sources of food safety information for 37% of our respondents (Table 23). Relatives are often perceived as the most believable and trustworthy information source for food safety, but the advice is often based on personal experience (Herrmann et al., 2000).

A significant proportion of respondents are using the internet as a source of food safety information. For food safety information, 28% of those surveyed indicated using national websites and 14% use local sites (Table 23). Public opinion polls find the internet is being used by more consumers and is considered by consumers to be a reliable and important communication tool (Roper, 2004). Of the food safety resources, the media is still the most accessible information source and increases consumers' awareness of health and food safety risks. However, the media also can contribute to creating consumer confusion about these risks. The confusion leads consumers to believe that no matter what they decide about food there is more than likely a health or food safety risk (Hansen et al., 2003; Roe et al., 2001). A possible reason for confusion is the approach many media reports take to over-emphasize one aspect of a food safety concern and not necessarily provide objective views or information from all the groups involved (Hansen et al., 2003; Sandman, 1987; Ten Eyck, 2002).

Consumers perceive themselves as knowledgeable about food issues, regulations and safety, but they cannot differentiate between food label requirements and marketing information on packaging (Nayga et al., 1998). Food purchases are often based on familiarity with the product, convenience, packaging and sales information that interests the shopper rather than on nutrition or food safety (Herrmann, 2000; Kristal et al., 1998). Our respondents support this finding since their answers about juice labeling requirements (Table 24) implied that they chose statements based on familiarity or what they wanted on a label versus what is required. Consumers cannot be expected to be food labeling experts, but this finding and other research indicates that food labeling may not be serving its intended purpose to educate consumers and provide information to make healthy food purchases (Herrmann, 2000; Kristal et al., 1998).

Lack of knowledge about industry food safety programs was evident as only 20% of our respondents were aware that HACCP was a food safety program (Table 25), which was similar to results reported previously by Ford et al. (1998). Similarly, Bruhn and Schutz (1999) and Herrmann et al. (2000) reported that consumers have only a limited knowledge of food safety terms. Potential reasons for consumers' limited knowledge about HACCP could be that HACCP is an abbreviation and an extensive media campaign by food safety experts has not taken place since the primary focus of HACCP education has been for food manufacturers about this program rather than consumers. Ford et al. (1998) demonstrated that once consumers were educated about HACCP they believed that having a statement about HACCP would improve confidence in the product and manufacturer.

Michigan apple cider and juice consumers were familiar with the food safety term pasteurization (70%) and that this process decreases the risk of pathogens (Table 25). Knowledge about pasteurization may be due to the food industry having used this term for many years. With regards to apple cider and juice, pasteurized and not pasteurized were perceived not only as an indicator of food safety but also for taste. Pasteurized was perceived by 13% of surveyed consumers as having more of a cooked taste and not pasteurized was perceived by 20% of consumers as having more of a fresh taste (Table 25). A reason for the differences in taste perception may be that in some instances pasteurization involves the use of high temperatures for relatively long time periods and causes changes in the taste of juice products. Pasteurization regimes necessary for pathogen control in refrigerated juice products can use moderate heat for relatively short time periods (e.g., 71.1°C (160°F) for 6 seconds) with little or no adverse affect on taste. Today many consumers do not notice taste differences between pasteurized and non-pasteurized cider (Boylston et al., 2003).

Our respondents' food safety information sources and knowledge are consistent with consumers participating in other food safety surveys (Bruhn and Schutz, 1999; Ford et al., 1998; Li-Cohen and Bruhn, 2002; Meer and Misner; 2000). An opportunity exists to improve communications about the safety of apple cider and juice through the media and labeling.

Purchase decisions

When asked what would most likely influence their decision to purchase apple cider or juice, respondents were most interested in the apple cider or juice taste attributes followed by safety attributes (Table 26). Surveyed consumers were provided with

several statements that may appear on the juice container. Among these statements "100% juice" (94%) and "fresh" (87%; Table 26) were rated the highest. Research continues to find that taste prevails when consumers make purchase decisions regardless of their concerns about food (Ford et al., 1998; Goldman and Clancy, 1992; Jolly et al., 1989; McEachern and McClean, 2002). The terms "100% juice" and "fresh" also have implications in how consumers perceive the ingredients and processing. Jolly et al. (1989) and Goldman and Clancy (1992) reported that when "fresh" is used to describe a food, purchase decisions are influenced since the food is perceived as being recently made, consists of whole or natural ingredients, is less likely to contain bacteria or contaminants and has a better flavor. When our respondents were asked where they would purchase "fresh" or "100% juice" the most likely locations were farms, orchards and farmer's markets (Table 27).

After taste, 79% of surveyed consumers chose "passed food inspection" as influencing purchases (Table 26). The strong confidence in food safety inspections may be due to consumers being more familiar with food inspections because they have been conducted since the turn of the century (Juska et al., 2003). Ford et al. (1998) also reported that passing food safety inspection is a strong incentive for consumers to buy meat products. Caswell and Mojduszka (1996) and Roe et al. (2001) reported that consumers react more to food safety information on food labels if the information is positive. Our respondents supported this finding in that 45% were less likely to purchase juice bearing the FDA warning statement about the risk of pathogens (Table 26). When our consumers were asked where they prefer to buy "safe" juice almost half (48%) selected grocery stores (Table 27). Our surveyed consumers may be choosing the

grocery store as a safe place to purchase juice due to faith that retailers have strong food safety standards, convenience and a wider selection of products including shelf-stable juice.

Our respondents were familiar with pasteurization and 60% of those surveyed indicated this term would influence their apple cider and juice purchase (Table 26) since they know it deceases one of their food safety concerns-the presence of pathogens (Table 25).

Apple cider and juice perceived as "organic or natural"' would be a purchase incentive for over 50% of our respondents (Table 26), and this may be due to consumers' impression that "organic" implies less chemical use and processing. This also points out that there is potentially a growing market for organically produced apple cider and juice in Michigan. Organic and natural food is considered to be more environmental friendly and associated with the absence of pesticides and other chemicals (McEachern and McClean, 2002). Research over the last 15 years indicates there is an increasing demand for organic and natural foods because consumers perceive the food to be healthier, safer and less processed. This same research also notes that consumers are seeking and purchasing organic and natural food from local food cooperatives and community-supported agriculture groups (CSA). The cooperatives and CSAs are supplied with fresh produce and products from local farms and orchards (Goldman and Clancy, 1992; Jolly et al., 1989; Jussaume and Higgins, 1998; Torjunsen et al., 2001). More consumers are seeking out locally grown and processed food due to familiarity, tradition and trust in the food as well as wanting to support local farmers (Bocker and Hanf 2000; Guptill and Wilkins, 2002). When we asked our respondents what retailers they perceived as

offering organic and natural juice, 34% chose health food stores versus 21% identifying local farms or orchards, while 21% stated there was no difference in retailers (Table 27).

Almost half (48%) of Michigan cider consumers associated the local farm or orchard with "not pasteurized" juice (Table 27). Unpasteurized juice is required to have the warning label about pathogens and 45% of surveyed consumers indicated this statement would negatively impact their juice purchase (Table 26). Based on consumer research (Roper, 2003), a market exists for organic and natural foods from local farms but our respondents did not necessarily view Michigan farm or orchards as the safest place to purchase apple cider or juice.

When making a purchase decision about apple cider and juice, our respondents first consider taste then safety. Including familiar terms such as "passed food inspections" on juice containers may improve consumer confidence. Our respondents also considered pasteurized juice to be safer since they know this processing method reduces the risk of pathogens.

An interesting finding from this survey is how Michigan apple cider and juice consumers are viewing Michigan farms and orchards as a place to purchase apple cider and juice. Consumers view local farms as having the freshest juice, a top reason for purchase, and as a source of organic and natural food, but do not perceive Michigan cider processors as offering the safest product. Michigan apple cider processors need to take into consideration what Michigan apple cider and juice drinkers are looking for on the label and communicate that their product is 100% juice, has a great taste, is processed locally and is safe. Processors using HACCP need to emphasize these characteristics

since the juice HACCP regulation does not allow for the term "fresh" to be used on pasteurized or UV light treated juice (FDA, 2001).

E. CONCLUSION

Our respondents had similar food safety concerns, resources and knowledge as consumers surveyed in other food safety studies (Bruhn and Schutz, 1999; Li-Cohen and Bruhn, 2002; Meer and Misner; 2000). Taste was the priority of all of our respondents when making an apple cider and juice purchase and the attributes "fresh" and "100% juice" on the label were most likely to influence their purchase decision.

Safety also influenced purchase decisions. The majority of respondents were familiar with pasteurization but only 20% of our respondents were aware that HACCP is a food safety program. Two groups of consumers emerged from this study, consumers who want safe pasteurized apple cider and juice and selected the grocery store as most likely to have safe product, and consumers who want organic and less processed apple cider and juice but indicated the health food store as the retailer most likely to offer product with these attributes. An opportunity exists for Michigan apple cider processors implementing HACCP to reach both consumer groups. They need to communicate to apple cider and juice consumers that they make great tasting cider that is 100% juice from locally grown apples and it is safe because of the food safety program (HACCP) used to process their cider.

Table 21. Demographic characteristics of Michigan e-mail respondents and the U.S. population

Demographic characteristics (n=497)	% of respondents	% of U.S. population (2000 census)
Gender		
Female	56	51
Male	35	49
Prefer not to answer	9	-
Ethnicity		
African American	3	12
Asian American	1	2
Caucasian	92	72
Hispanic/Latino	1	13
Other	3	1
Age Group (years)		
0-18	-	27
18-25	6	7
26-35	18	14
36-45	22	16
46-55	26	14
56-65	18	9
> 66	10	13
Education level		
Some high school	2	20
High school graduate	20	29
Some college or technical school	40	27
College graduate	26	16
Postcollege graduate	12	8
Household income level in 2002		
<$15,000	9	16
$15,000-$24,999	10	13
$25,000-$39,999	17	18
$40,000-$59,999	21	19
> $60,000	43	33
Population (in millions) where live		
<0.5	19	21
0.5-2	18	11
>2	45	68
Marital status		
Married	65	52
Single	35	48

Table 21 (cont'd).

Demographic characteristics (n=497)	% of respondents	% of U.S. Population (2000 census)
Members in household		
One	19	26
Two	38	33
Three	17	15
Four	17	14
> Five	9	11
Age in years of child(ren) in household		
<6	12	21
6-17	27	37
None under 18	69	52

Table 22. Michigan apple cider and juice consumers' concerns about potential hazards in refrigerated juice (n = 497)

	Level of concern (1-5)				
Condition	**Very (1)**	**(2)**	**(3)**	**(4)**	**Not at all (5)**
	(%)				
Pesticides	67	17	10	3	3
Bacteria	67	15	11	4	3
Mold	68	12	10	5	5
Foreign material (glass, wood, metal)	69	10	6	7	8
Processing chemicals	56	23	14	4	3
Insects	64	14	9	7	6
Allergens	50	19	16	7	8
Artificial ingredients	37	27	27	4	5
Preservatives	31	26	31	7	5

Table 23. Michigan apple cider and juice consumers' sources of food safety information (n = 497)

Source	% of respondents
National television programs or news broadcast	67
Local television programs or news broadcast	60
Local newspaper articles	52
National newspaper or magazine articles	45
Family or friends	37
Internet-national websites	28
Local radio broadcasts	23
Physician	22
National radio broadcasts	20
Internet-local websites	14
Other health professional	10
Other (not specified)	7

Table 24. Michigan apple cider and juice consumers' knowledge of juice labeling requirements (n = 497)

Label statement	% of respondents
Keep refrigerated	95
Contains preservatives to maintain freshness	91
Pasteurized	89
Contains 100% juice	86
Not pasteurized	79
No preservatives	79
Has passed a food inspection test	73
Organic or Natural	68
Has not been treated to reduce pathogens	61
Fresh	52
Safe	50
Delicious or great tasting	18

Table 25. Michigan apple cider and juice consumers' knowledge of food safety terms (n = 497)

Term	% of respondents
HACCP: (could select only one)	
Manufacturer has a food safety program in place	20
Manufacturer uses certified Grade A fruit to make juice	6
Manufacturer is a member of an independent organization	2
Manufacturer won an award	<0.5
Don't know	72
Pasteurized: (could select only one)	
Juice is organic and natural	2
Juice will have more of a cooked taste	13
Juice will have more of a fresh taste	6
Juice has less risk of pathogens	70
Juice may have more risk of pathogens	2
Don't know	10
Not Pasteurized: (could select only one)	
Juice is organic and natural	21
Juice will have more of a cooked taste	1
Juice will have more of a fresh taste	20
Juice has less risk of pathogens	2
Juice may have more risk of pathogens	63
Don't know	11

Table 26. Labeling statements likely to influence Michigan apple cider and juice consumers' purchase decisions (n = 497)

	Level of purchase likelihood (1-5)				
Statement	**Much more (1)**	**More (2)**	**Neither (3)**	**Less (4)**	**Much less (5)**
	(%)				
100% Juice	69	25	6	<0.5	0
Fresh	55	32	23	<0.5	0
Passed food inspection	46	33	19	1	1
No preservatives	36	33	28	2	1
Safe	37	29	31	2	1
Delicious or great tasting	37	26	35	1	1
Keep refrigerated	36	22	41	1	<0.5
Pasteurized	31	29	36	2	2
Organic or natural	28	28	39	3	2
Contains preservatives to maintain freshness	7	15	48	22	8
Not pasteurized	6	10	45	22	17
Warning statement that juice not treated to reduce pathogens	5	8	42	24	21

Table 27. Michigan apple cider and juice consumers preferred retailer to purchase refrigerated apple cider or juice with the following characteristics (n = 497)

Characteristic	Local Farm or Orchard	Farmer's market	Health food store	Grocery store	Mass merchandiser	No difference
	% of respondents					
Fresh	47	11	2	21	2	17
No preservatives	33	8	19	17	2	21
Safe	4	2	10	48	4	32
Delicious or great taste	29	9	3	27	3	29
Organic or natural	21	6	34	17	1	21
Not pasteurized	45	13	7	12	2	21

CHAPTER VI. SUMMARY, CONCLUSIONS AND FUTURE RESEARCH

Summary:

In the late 1990's the public became concerned about the safety of juice after a series of foodborne illnesses attributed to consumption of unpasteurized juice contaminated with pathogens. The pertinent pathogens most successful at surviving and growing in juice and likely to result in a foodborne illness include *Salmonella* spp., *E. coli* O157:H7 and *Cryptosporidium parvum*. Apple juice and cider were the sources of the pathogen, *E. coli* O157:H7, in several of the juice-associated foodborne illnesses (FDA, 2001).

In 1997, the FDA published a notice of intent announcing a comprehensive program to address foodborne illness related to juice and ultimately improve the safety of juice. The notice of intent proposed three areas, 1) a juice HACCP regulation, 2) a warning label on juice products not treated to achieve a 5-log reduction of pertinent pathogens and 3) juice safety and HACCP education programs for processors (FDA, 1997). In 1998, the FDA published the final regulation for labeling of juice and extended the comment period for the juice HACCP regulation. After a review of juice research and comments from both processors and the NACMCF, the FDA published the juice HACCP final regulation in January 2001, and required HACCP implementation in January 2002, 2003, and 2004 for large, small, and very small juice manufacturers, respectively. Juice processors selling juice directly to consumers were allowed a "retail exemption" in which they are not required to implement HACCP but must include a warning label about the risk of pathogens on the juice containers (FDA, 2001).

The safety of cider is of special interest to the State of Michigan since it is one of top four apple producing states and one of the top three states in cider production with approximately 30 percent of Michigan apples processed into cider each year (Michigan Apple Association, 2004; Michigan Agricultural Statistics, 2003).

From 1997 through 2002, the MDA conducted annual cider mill inspections and collected samples of retail cider for bacterial analyses. The inspections took place during the traditional cider season, September through November. Important elements of the inspections included evaluation of agricultural and manufacturing practices, whether cider was sold wholesale or retail and the annual cider production volume at the mill. The MDA state laboratory conducted bacterial analyses of the cider which included tests for the presence of *E. coli* O157:H7, generic *E. coli*, total coliforms, total aerobic plate counts and pH.

To investigate changes processors had made in agricultural and manufacturing practices and their perceptions about the juice HACCP regulation two mail surveys were sent to processors in September 2002. In October 2002, an e-mail questionnaire was sent to Michigan juice consumers to evaluate their concerns regarding the safety of refrigerated apple juice and cider, knowledge about food safety and food safety concerns that might influence purchase decisions.

Improvements were found in both agricultural and manufacturing practices at cider mills between 1997 and 2002. The improvements included better record keeping of purchased apples and more processors inspecting apples for cleanliness and wholesomeness and storing apples in cold storage. Facilities improvements included adequately screening the facility to prevent entry of animals, improved water systems,

use of intervention technology to destroy microbial pathogens and more mills conducting microbial analyses of finished product. Cider mills producing more than 20,000 gallons of cider per year were the first to use CGMPs and had lower bacterial counts in their cider.

Two-thirds of cider mills producing more than 20,000 gallons of cider per year implemented thermal pasteurization or UV light irradiation to achieve a 5-log reduction in microbial pathogens. Generally, mills using either thermal pasteurization or UV light irradiation had lower bacterial counts in final products. However, some cider samples labeled as either pasteurized or UV light treated had higher bacterial levels than would be expected for cider treated with these processes. This indicates that some processors were not properly using thermal pasteurization or UV light irradiation equipment, or that the cider was contaminated after processing.

E. coli O157:H7 was not detected in any of the cider samples tested during 1997 to 2002. However, 5.8% of all samples contained generic *E. coli*, indicating potential fecal contamination. The presence of generic *E. coli* is a concern since it indicates that processors need to be more diligent in preventing bacterial contamination during apple harvesting, storage, handling and processing.

The processor perception survey revealed that 48% of processors did not perceive the juice HACCP regulation as necessary for cider safety and indicated it would result in unnecessary expense and governmental oversight. These processors also believed the juice regulation would not decrease the risk of foodborne illness in juice or improve consumer confidence. Reasons not to implement HACCP included additional expense to upgrade the manufacturing facility and equipment, and the time needed to develop a

HACCP plan for a seasonal business. These processors also stated that customers trusted their cider mill and preferred untreated cider due to the taste. Processors who believed that HACCP was necessary for cider safety had taken measures to improve their processing facilities and practices. Processors, regardless of their view on the need for HACCP, had favorable attitudes towards regulatory personnel inspecting their facilities.

Michigan consumers who purchase apple cider or juice had similar food safety resources, knowledge and concerns as consumers in other food safety studies. Among factors influencing their decisions to purchase cider or juice, taste was considered most important, followed by safety. Although consumers expressed food safety concerns they were not necessarily knowledgeable about juice labeling requirements or food safety programs such as HACCP. Most consumers could not distinguish between marketing terms and juice labeling requirements and only 20% of the consumers were aware that HACCP is a food safety program. When asked about factors influencing where they would purchase apple cider and juice, respondents selected the grocery store as having the safest juice, health food stores as most likely to offer organic and natural juice, and the farm or orchard as having freshest or 100% juice.

Conclusions:

This study has provided insights into the manufacturing practices at Michigan cider mills and the perceptions of both cider processors and consumers. From this study it is concluded that:

- Further education about food safety and HACCP is needed for cider processors not perceiving the need for HACCP and electing the "retail exemption" of the juice HACCP regulation. Processors who do not use intervention technology or

implement HACCP are putting themselves at risk for a juice-associated foodborne illness outbreak. A single outbreak of foodborne illness associated with Michigan apple cider would have a negative impact on the entire Michigan cider industry.

- Cider mills using thermal pasteurization and UV light equipment may still be at risk of producing unsafe cider due to equipment not operating properly as we found higher than expected bacterial counts in end-product samples from some cider mills using these intervention technologies.
- Michigan cider processors implementing HACCP and selling cider directly to consumers have a marketing opportunity to promote their cider as locally made, great tasting and safe. These attributes influenced our surveyed consumers' purchase decisions about apple cider and juice, but they currently view the grocery store and health food stores as more likely to have product with these attributes rather than a local farm or orchard.

Future Research:

Many opportunities exist for future research and include:

- Investigation into the operating procedures of thermal pasteurization and UV light irradiation equipment in Michigan cider mills to determine if equipment is operating properly to achieve a 5-log reduction of microbial pathogens. Several pasteurized and UV light irradiated end-product cider samples had higher than expected bacterial counts in this study. However, these observations were based on single samples collected each year and additional sampling is needed to substantiate this finding.

- Experimental research onsite at cider mills to investigate processing steps from harvesting to bottling that may introduce microbial hazards into cider. Although improvements were made in CGMPs from 1997 to 2002, the data was collected by state personnel in 1997 and self-reported by processors in 2002. Inspectors and processors may have different interpretations of processing practices. Researchers who actually visit cider mills, assess manufacturing processes and conduct in-line sampling for microbial analyses may detect risks not found in this study and suggest areas for improvement.
- Investigation into the real and perceived constraints of HACCP implementation through focus groups and interviews with cider processors may determine how HACCP implementation can be successful in the juice industry. The processor perception survey in this study provided several insights into the views of cider processors. Research using focus groups and interviews allows for probing into processors' decision-making and provides a better opportunity to determine ways to assist processors in overcoming negative perceptions about HACCP.
- Additional consumer research including sensory testing, focus groups and interviews is needed. Sensory research comparing pasteurized, UV light treated and untreated cider produced in Michigan will determine if consumers notice a difference in taste. Consumer research using focus groups or interviews can further investigate the concerns and needs of

Michigan apple cider and juice consumers and provide insight into their purchase decisions and views about Michigan cider mills.

This study has provided important insights into the Michigan cider industry that can be used to construct both experimental and observational research to help ensure the safety of Michigan cider and improve consumer confidence.

APPENDICES

APPENDIX A

UCRIHS FORM

MICHIGAN STATE
UNIVERSITY

July 30, 2004

TO: Toby TEN EYCK
316 Berkey Hall
MSU

RE: **IRB # 01-589** CATEGORY: 2-G EXPEDITED
RENEWAL APPROVAL DATE: August 18, 2003
EXPIRATION DATE: July 18, 2004

TITLE: APPLE JUICE AND HACCP: HAZARD SURVEILLANCE, TRAINING, AND PERCEPTIONS

The University Committee on Research Involving Human Subjects' (UCRIHS) review of this project is complete and I am pleased to advise that the rights and welfare of the human subjects appear to be adequately protected and methods to obtain informed consent are appropriate. Therefore, the **UCRIHS APPROVED THIS PROJECT'S RENEWAL.**

Letter reprinted to reflect the addition of the secondary investigator (Donna Thede).

RENEWALS: UCRIHS approval is valid until the expiration date listed above. Projects continuing beyond this date must be renewed with the renewal form. A maximum of four such expedited renewals are possible. Investigators wishing to continue a project beyond that time need to submit a 5-year renewal application for complete review.

REVISIONS: UCRIHS must review any changes in procedures involving human subjects, prior to initiation of the change. If this is done at the time of renewal, please include a revision form with the renewal. To revise an approved protocol at any other time during the year, send your written request with an attached revision cover sheet to the UCRIHS Chair, requesting revised approval and referencing the project's IRB# and title. Include in your request a description of the change and any revised instruments, consent forms or advertisements that are applicable.

PROBLEMS/CHANGES: Should either of the following arise during the course of the work, notify UCRIHS promptly: 1) problems (unexpected side effects, complaints, etc.) involving human subjects or 2) changes in the research environment or new information indicating greater risk to the human subjects than existed when the protocol was previously reviewed and approved.

If we can be of further assistance, please contact us at 517 355-2180 or via email: UCRIHS@msu.edu.

Sincerely,

Peter Vasilenko, Ph.D.
UCRIHS Chair

OFFICE OF
RESEARCH ETHICS AND STANDARDS

University Committee on Research Involving Human Subjects
Michigan State University
202 Olds Hall
East Lansing, MI
48824
517/355-2180
FAX: 517/432-4503
b: www.msu.edu/user/ucrihs
E-Mail: ucrihs@msu.edu

PV: jm

cc: Donna Thede
9750 Huntington Rd.
Battle Creek, MI 49017

APPENDIX B

1997 MICHIGAN DEPARTMENT OF AGRICULTURE CIDER PROCESSOR SURVEY

FI-229 (6/97)

MICHIGAN DEPARTMENT OF AGRICULTURE
LANSING, MI 48909

Estab. No. Establishment Type	**SPECIAL REPORT**	Date	Time
Person or Firm Name		Inspector	
Street Address	City	Zip Code	County

APPLE CIDER INSPECTION 1997

Date of Operation: Starting:_____ Ending:_____

Years in Operation:_____ Gallons Produced Per Week_____

A. FACILITY REQUIREMENTS

		YES	NO
1.	Are processing operations in a separate enclosed room or building?		
2.	Are processing area walls and ceilings impervious and floors made of concrete or an impervious surface that is easily cleaned?		
3.	Is the processing facility adequately screened/sealed to prevent insect/rodent entry?		
4.	Are toilet facilities completely enclosed and conveniently located?		
5.	Are toilet facilities equipped with hot and cold running water, soap, single use disposable paper toweling with an "employee hand wash" notice?		
6.	Is lighting adequate, and are lights properly shielded in processing and exposed food areas?		
7.	Is ground free of improperly stored equipment, spray materials, litter, waste, uncut weeds, grasses and other pest harborage?		
8.	Is wash/waste water properly disposed of? Municipal sewage?___ Septic tanks?_____ Describe other:_____		
9.	Are equipment, utensils, chemicals, and supplies not used for cider processing stored in an area separate from the processing area?		
10.	Are food contact surfaces constructed of food grade materials which are safe, durable, corrosion-resistant, non-absorbant, and easily cleaned and sanitized? List detergents used:_____ List sanitizers used:_____		
11.	Are racks, cloths, and food equipment stored properly off the floor and in a well-ventilated area when not is use?		
12.	Is hot/cold running water under pressure provided in all processing areas and in a sufficient volume? Capacity of hot water heater:_____		
13.	Has well water been recently tested and found acceptable? Date of test:_____ Date that processing began:_____		
14.	Are lines/tubing properly installed, made of food grade materials, and protected from abrasion or breakage?		
15.	Are lines composed of material other than copper or copper alloy? Indicate material:_____		

16.	Are lines/tubing, clamps, couplings, and fittings dismantled, cleaned and sanitized after each production day, prior to start up, and after an extended interruption?		
17.	Are all raw ingredients and packaging materials protected when pesticides are applied? List pesticides used in processing area:_____		
18.	Are food contact surfaces cleaned and sanitized after insecticide/rodenticide application, and before commencement of any food-processing operation?		
Comments:			

B. EMPLOYEES

19.	Is one person assigned the responsibility for the sanitation of the facility? Name:_____ Title:_____		
20.	Are employees in processing areas wearing clean outer garments and maintaining personal hygiene?		
21.	Are employees washing hands before starting work, after every absence, and when they become soiled?		
22.	Are employees wearing effective hair restraints?		
23.	Are gloves used, are they designed for food handling operations?		
24.	Are tobacco products prohibited from use in food processing, storage or packaging areas?		
25.	Are gloves replaced or hands washed when employees move from a non-food contact area or cleaning operation to a food contact area?		
Comments:			

C. RECEIVING

R1.	If apples are purchased, are records maintained to trace various lots? Purchased from (source):_____		
R2.	Are apples adequately stored and free from insect and rodent activity?		
26.	Are incoming apple containers inspected and found free of filth?		
R3.	Are apples kept in cold storage prior to use?		
27.	Is receiving area free of animals?		
28.	Is there verification that the apples used did not come from orchards fertilized with human or animal waste?		
Comments:			

D. INSPECTION

29.	Are all apples being inspected before washing and brushing?		
30.	Are wormy, decayed, damaged or rotten apples discarded?		

E. WASHING & BRUSHING

31.	Are apples effectively washed by a wet brusher prior to crushing? What type of brusher is used? Make:_____ Model:_____ Length of brush bristle:_____ Length of brushing segment:_____ When was the brusher installed?_____ New or used:_____ How is brusher cleaned/sanitized?_____ Method:_____ Frequency:_____		
32.	Are apples free of visible filth and debris after cleaning?		
R4.	Is used are detergents and sanitizers applied to apples according to manufacturer's or label directions? What detergents are used:_____ What sanitizer is used:_____ What concentration is used?_____ Test strip reading today:_____		
Comments:			

F. CRUSHING & PRESSING

33.	Are crushing and pressing equipment cleaned and sanitized at the end of production and prior to start-up?		
34.	Is equipment dismantled on a regular basis, cleaned and sanitized?		
35.	Are press cloths designed for food processing and replaced when necessary?		
36.	Are press cloths stored off the floor or in a clean container between runs?		
37.	Are all cloths washed, rinsed, sanitized and dried after each production day?		
38.	If a washing machine is used, is it solely dedicated for washing press cloths?		
39.	Are press racks made of food-grade plastic or hardwood, smooth and easy to clean and free of excessive cracks and crevices?		
40.	Is all pressed pomace properly removed, and not left overnight in processing area?		
R5.	Is a method in place to ensure proper and safe addition of additives? Yes:_____ No:_____		
R6.	Is a pressing aid used? List:_____		
Comments:			

G. AFTER PRESSING

41.	Is cider bottle in new, clean containers?		
R7.	Are unused containers and caps stored in original packaging, inverted and off the floor?		
42.	Are the containers labeled with the following information? Product Identity? Ingredients (if additives are used?) Sell by date? If no, describe methods of sale in comment section below. Name and address of manufacturer, packer or distributor? Net Quantity? Keep refrigerated statement?		
R8.	Is microbiological testing performed on processed cider? Yes:_____ No:_____ Frequency of testing:_____ Method:_____ Organisms:_____		
R9.	What other types of activities are done on the premise? Hayrides, pony rides, petting zoo, other food/non-food processing etc? _____ How close are the live stock and penned animals to the processing building/apple storage areas?_____		
R10.	Is custom pressing done? Yes:_____ No:_____ Is equipment broken down, cleaned, and sanitized between each customer?_____ How are custom pressed apples inspected?_____ By whom?_____		
R11.	Are any containers refilled? Indicate circumstances:_____		
R12.	Does operator check the strength of the sanitizer used?_____ Method:_____		

Comments:

Copy Received By (signature)	Division	Inspector (signature)

APPENDIX C

1998 MICHIGAN DEPARTMENT OF AGRICULTURE CIDER PROCESSOR SURVEY

1998 APPLE CIDER INSPECTION SURVEY

Establishment ID Number:_____ Date:_____

Firm Name:_____ Inspector:_____ County#:_____

Street Address:_____ City:_____ Zip code:_____

- Please indicate whether the following items are in compliance with GMP's for Michigan Apple Cider.
  - If NOT in compliance, please describe in the COMMENTS section.

A. FACILITY REQUIREMENTS

ITEM	MEETS GMP	DOES NOT MEET GMP	ITEM	MEETS GMP	DOES NOT MEET GMP
Separate processing area			Food contact surfaces		
Processing area screened/sealed			Cider equipment materials (tubing etc.)		
Floors			Clean-up water		
Walls			Cider equipment storage		
Ceilings			Packaging material storage		
Restroom location			Well water testing		
Handwash station			Lights		
Equipment storage (non-cider)			Surrounding outside area		

B. EMPLOYEES C. RECEIVING

ITEM	MEETS GMP	DOES NOT MEET GMP	ITEM	MEETS GMP	DOES NOT MEET GMP
Garments/hygiene			Apple containers		
Handwashing			Apple storage		
Hair restraints			Receiving area		
Personal items/smoking					

D. PROCESSING

ITEM	MEETS GMP	DOES NOT MEET GMP
Apples inspected		
Apples cleaned		
Pressing equipment and tubing cleaning/sanitizing		
Use of preservative		

E. LABELING

ITEM	MEETS GMP	DOES NOT MEET GMP
Standard label requirements		

F. ADDITIONAL QUESTIONS

ITEM	YES	NO
Are dropped apples used in processing?		
Does processing include a 5-log reduction step?		
Is FDA warning label/placard present?		
Is there custom pressing done on-site?		

G. MISCELLANEOUS

Cost mill incurred for meeting the GMPs for 1998 season: $_____
List major items:

Estimate number of months operating this year:_____

Estimate number of gallons produced per week:_____

H. COMMENTS-Please describe any non-compliance areas.

APPENDIX D

1999 MICHIGAN DEPARTMENT OF AGRICULTURE CIDER PROCESSOR SURVEY

AG-031

MICHIGAN DEPARTMENT OF AGRICULTURE
LANSING, MI 48909

Estab. No.	**SPECIAL REPORT** (In accordance with P.A. 380, Public Acts 1995 as amended)	Date	Time
Person or Firm Name		Inspector	
Street Address	City	Zip Code	County

1999 Apple Cider Survey

1.	Expected 1999 production:_____gallons
2.	Is the mill operating or planning to operate this season? Yes No If no, why? What are the short term and long term plans for this mill?
3.	Is the mill in substantial compliance with GMPs? Yes No
4.	Describe any changes made to facility/process/equipment this season:
5.	What processing interventions are used: ☐ HTST pasteurizer ☐ UV light unit ☐ Other (describe) List the manufacturer, brand, model specifications, etc.: Percentage of total cider production treated by these interventions:_____
6.	Percentage of product sold: Wholesale Retail
7.	Does the mill custom press cider? Yes No
8.	Is the FDA warning label present on containers? Yes No Elsewhere?

APPENDIX E

2000 MICHIGAN DEPARTMENT OF AGRICULTURE CIDER PROCESSOR SURVEY

AG-031 (Rev.08/99)

MICHIGAN DEPARTMENT OF AGRICULTURE
LANSING, MI 48909

Estab. No.	**SPECIAL REPORT** (In accordance with P.A. 380, Public Acts 1995 as amended)	Date	Time
Person or Firm Name		Inspector	
Street Address	City	Zip Code	County

Subject

2000 Apple Cider Survey

1.	Expected 2000 production:
2.	Is the mill operating or planning to operate this season? ☐ Yes ☐ No If no, why? What are the short term and long term plans for this mill?
3.	Is the mill in substantial compliance with GMPs? ☐ Yes ☐ No ☐ Marginal
4.	Describe any changes made to facility/process/equipment this season:
5.	What processing interventions are used: ☐ HTST pasteurizer ☐ UV light unit ☐ Other (describe) ☐ None List the manufacturer, brand, model specifications, etc.:
6.	Percentage of product sold: Wholesale Retail
7.	Does the mill custom press cider? Yes No
8.	Is the FDA warning label present on containers? Yes No Elsewhere? Yes No
9.	Additional remarks on accompanying Special Report? Yes No

Copy Received By (signature)	Division	Inspector (signature) Phone

APPENDIX F

2001 MICHIGAN DEPARTMENT OF AGRICULTURE CIDER PROCESSOR SURVEY

AG-031

MICHIGAN DEPARTMENT OF AGRICULTURE
LANSING, MI 48909

Estab No.	**SPECIAL REPORT** (In accordance with P.A. 380, Public Acts 1995 as amended)		Date	Time
Person or Firm Name			Inspector	
Street Address		City	Zip Code	County

Subject

2001 Apple Cider Survey

1.	Expected 2001 production:
2.	Is the mill operating or planning to operate this season? ☐ Yes ☐ No If no, why? What are the short term and long term plans for this mill?
3.	Is the mill in substantial compliance with GMPs? ☐ Yes ☐ No ☐ Marginal
4.	Check one. Is this firm: ☐ A wholesale processor (disregard custom pressing for a moment)? ☐ A Retail Establishment (all cider pressed is sold by owner on site or at farmers market)?
5.	Does the mill custom press cider? Yes No
6.	What processing interventions are used: ☐ HTST pasteurizer ☐ UV light unit ☐ Other (describe) ☐ None List the manufacturer, brand, model specifications, etc.:
7.	Percentage of product sold: Wholesale Retail
8.	Does the mill custom press cider? Yes No
9.	Is the FDA warning label present on containers? Yes No Elsewhere? Yes No
10.	Additional remarks on accompanying Special Report? Yes No

Copy Received By (signature)	Division	Inspector (signature) Phone

APPENDIX G

2002 MICHIGAN DEPARTMENT OF AGRICULTURE CIDER PROCESSOR SURVEY

AG-031 (Rev.08/99)

MICHIGAN DEPARTMENT OF AGRICULTURE
LANSING, MI 48909

Estab. No.	**SPECIAL REPORT** (In accordance with P.A. 380, Public Acts 1995 as amended)	Date	Time
Person or Firm Name		Inspector	
Street Address	City	Zip Code	County

Subject

2002 Apple Cider Survey

1.	Expected 2002 production: gallons.
2.	Is the mill operating or planning to operate this season? ☐ Yes ☐ No If no, why? What are the short term and long term plans for this mill?
3.	Is the mill in substantial compliance with GMPs? ☐ Yes ☐ No ☐ Marginal
4.	Check one. Is this firm: ☐ A wholesale processor (disregard custom pressing for a moment)? ☐ A Retail Establishment (all cider pressed is sold by owner on site or at farmers market)?
5.	Does the mill custom press cider? Yes No
6.	What processing interventions are used on the juice? ☐ HTST pasteurizer ☐ UV light unit ☐ Other (describe) Percentage of total cider production treated by these interventions:
7.	Percentage of product sold: Wholesale Retail
8.	Does the firm have ☐ written SSOPs ☐ written HACCP plan ☐ started to work on them ☐ no action taken on them
9.	Does the operator plan to move toward a HACCP system in the near future? ☐ Yes ☐ No If no, what are the main obstacles (time, cost, don't see a need, lack of knowledge, etc.)
10.	Is the FDA warning label present on containers? Yes No

Copy Received By (signature)	Division	Inspector (signature) Phone

APPENDIX H

LETTER FOR PROCESSORS' PRACTICES SURVEY

August 19, 2002

Dear Cider Processor:

Enclosed is part one of a two-part survey being conducted as part of a research project in the Food Science and Sociology Departments at Michigan State University. We would like for you to participate in both surveys. The first survey asks about your processing practices and changes you have made due to the new juice regulations and HACCP. The second survey asks about your perceptions of the new juice regulations, HACCP and your retail customers. The second survey will be mailed to you within the next few days.

Please be assured that your participation in this research will be kept confidential. At the end of each survey we ask for personal information only for the purposes to send you a copy of the results if you would like to receive them.

The intention of this research is to learn from you how the new juice rule will affect your business and customers. The results will be shared with the Michigan Department of Agriculture and other interested groups in the hopes that they might be able to use the information to determine ways to help cider processors overcome any concerns due to the new juice rule. Again, your personal information will be kept confidential.

Once you complete both surveys, they will be analyzed and you will receive a report comparing your responses to those of other cider processors completing both surveys. Please use the enclosed stamped envelope to return your survey no later than September 9, 2002.

If you have any questions about this study, please contact one of the following individuals. Thank you for participating in this study.

Dr. Leslie D. Bourquin
Dept. of Food Science and Human Nutrition
& National Food Safety and Toxicology Center
Michigan State University
139A G. M. Trout Bldg.
East Lansing, MI 48824-1224
Phone: 517-355-8474 Ext. 112
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9750 Huntington Road
Battle Creek, MI 49017
Phone: 269-961-2827
Fax: 269-961-2827
thededon@msu.edu

If you have questions about your rights or role as a subject of research, you may contact Dr. Ashmir Kumar, Chair for Research Involving Human Subjects at 517-255-2180. If you have any questions about this survey please contact the researcher, Donna Thede, at 269-961-2827.

APPENDIX I

CIDER PROCESSORS' PRACTICES SURVEY

Whether or not you are operating this season, please complete the questionnaire based on your previous experience and to the best of your knowledge. Please check the appropriate column with your response and comment whenever you would like to include additional information.

Question	Yes	No	Not applicable	Comments:
Is your mill operating or planning to operate this season? (If no or not sure, please state why)				
Do you grow apples for your cider?				
Do you buy apples for your cider?				
Is manure used as a fertilizer in your orchard (including composted manure)?				
Do domestic or wild animals graze in the orchard?				
Does pesticide use conform with regulations, including licensed applicator?				
If irrigation is used, is the water source: -Untested well water?				
If irrigation is used, is the water source: -Tested well water? If yes, what is tested for and frequency?				
If irrigation is used, is the water source: -Surface water (pond, stream)?				
If irrigation is used, is the water source: -Other (describe)?				
Are apples inspected for cleanliness?				
Are apples inspected for wholesomeness?				
Are unfirm, windfall, grounders or unwholesome apples discarded?				
Are drop apples used to make unpasteurized cider?				
Are drop apples used to make pasteurized cider?				

Are badly bruised apples discarded?				
Are rotten apples discarded?				
Are apples with worm damage discarded?				
Are apples stored in cold storage? For how long?				
Are apples stored at room temperature? For how long?				
Are written contract specifications used for suppliers (eg., use of drops, sorting and washing, pesticide application)?				
Are records kept to document the source of supply of apples (eg., hand picked vs. drops)				
Are records kept documenting the varieties of apples used? If yes, please state the relative proportions of apple varieties used in your cider.				
Is well water used in the processing facility?				
Is municipal water used in the processing facility?				
Is processing water tested at least annually?				
Is there hot and cold water under pressure provided in all processing areas?				
Are processing operations in a separate enclosed room or building?				

Is the processing facility adequately screened/sealed to prevent insects/rodent entry?				
Are domestic animals allowed in your processing facility? (dogs, cats)				
Are press cloths used?				
Is there a washing machine in which only press cloths are washed?				
Are press racks made of food-grade plastic?				
Are press racks made of hardwood?				
Are press racks and cloths washed daily after operations?				
Are press racks and cloths sanitized daily after operations?				
Are racks, cloths and food contact equipment stored properly off the floor in a well-ventilated area when not in use?				
Are equipment, utensils, chemicals and supplies not used for cider processing stored in an area separate from the processing area?				
Are apples washed before processing?				
Is a wet brusher used?				
Are detergents used? If yes, what detergents?				
Are apples sanitized prior to processing? If yes, what sanitizer?				
Are preservatives used? If yes, list them and concentrations used.				
Are rice hulls or other pressing aids used in processing? If yes, specify press aids used.				
Is pressed pomace removed and not left overnight in processing area?				

Are only new containers and caps used to package cider?				
If refilling is allowed, are consumer containers checked for cleanliness before filling container?				
Do you custom press cider for other people?				
Do you include FDA warning statements on containers of cider?				
Is microbiological testing other than the MDA sampling conducted on cider?				
Are toilet facilities completely enclosed and conveniently located?				
Are toilet facilities equipped with hot and cold running water with soap and disposable paper towels with an "employee hand wash" notice?				
Do employees wear gloves?				
Do employees wear hairnets?				
Do employees wear clean outer garments?				
Does your mill have written SSOPs?				
Does your mill have written GMPs?				
Does your mill have a written HACCP plan in place?				
Does your mill pasteurize or use other technologies to achieve a 5-log reduction of pathogens in cider? If yes, state type of pasteurizer or other technology (e.g. UV).				
Have any equipment upgrades been made in the last five years in anticipation of the new FDA Juice Rule and HACCP. If yes, specify upgrades.				

Please circle your response to the following questions:

During the last five years, approximately how much has been spent in preparation to have HACCP implemented into your cider mill?

A. $0-$1,000
B. $1,001-$2,500
C. $2,501-$5,000
D. Over $5,000

How do you typically sell your cider? (circle all that apply)

A. Retail sales at your mill and direct to the consumer
B. At a farmer's market with your mill's name on label
C. To a retail store with your mill's name on the label
D. Through custom pressing to a wholesale customer
E. To a distributor/wholesaler who sells the product under another name.

Due to the new Juice Rule and HACCP have you made any of the following changes in how cider is sold?

A. Sell more retail product
B. Sell less retail product
C. Sell only retail product
D. Sell only wholesale product
E. Sell less wholesale product
F. Sell more wholesale product
G. Made no changes in how cider is sold

How do you feel the new Juice Rule will affect your cider mill's profit?

A. Increase profit
B. Decrease profit
C. No change

Are any of the following included on your cider container label? (circle all that apply)

A. Ingredients
B. Nutrition Facts
C. Brand name
D. Keep refrigerated
E. Size or weight of container and cider
F. Product descriptions
G. Date code or freshness date
H. Pasteurized
I. Unpasteurized with FDA warning statement
J. Fresh
K. Organic
L. 100% juice
M. Made in Michigan
N. Other_____

Do you have any of the following activities at your mill? (circle all that apply)

A. Hayrides
B. Pony rides
C. Sell food, donuts, baked goods
D. Petting zoo
E. Other_____

What is your role at the cider mill:

A. Owner
B. Employed by owner, please specify your title_____

How many employees are working at the cider mill?

A. Less than five
B. 5-10
C. 11-20
D. 21-50
E. 51-100
F. Greater than 100

What is the total annual sales of cider at the mill?
A. $500,000 or greater
B. $499,999 to $200,000
C. $199,999 to $100,000
D. $99,999 to $50,000
E. $49,999-$10,000
F. $9,999-$5,000
G. Less than $5,000

Approximately how many gallons of cider are produced annually at the cider mill?
A. 1,000,000 or more
B. 999,999 to 500,000
C. 499,999 to 100,000
D. 99,999-20,000
E. 19,999-4,000
F. 3,999-2,000
G. 1,999-1,000
H. Less than 1,000

How long has the cider mill been in operation?
A. Less than 1 year
B. 1 – 5 years
C. 6 – 10 years
D. 11 – 20 years
E. More than 20 years

How long have you owned or worked at the cider mill?
A. Less than 1 year
B. 1 – 5 years
C. 6 – 10 years
D. 11 – 20 years
E. More than 20 years

According to the definitions outlined in the Juice HACCP Final Rule (21 CFR Part 120), what is the size of your firm? The size of the business is determined by the magnitude of the corporate operation, not of the business unit (i.e. the overall size of the company, not the juice processing portion of the company).

A. Large
B. Small (Small businesses employ fewer than 500 persons)
C. Very Small (Very small businesses must meet one of the following three criteria: annual sales of less than $500,000, total annual sales greater than $500,000 but total food sales less than $50,000, or operations that employ fewer than an average of 100 full-time equivalent employees and sell fewer than 100,000 gallons of juice in the United States)
D. Don't know

We would like to send you a copy of the results. If you would like to receive the results please provide the following information. Again, your individual information will be kept confidential.
Name:_____

Cider mill name:_____

Street Address:_____

City, State and Zip Code:_____

County:_____

Thank you for completing this survey. Please mail the survey in the enclosed stamped envelope.

APPENDIX J

LETTER FOR PROCESSORS' PERCEPTIONS SURVEY

August 20, 2002

Dear Cider Processor:

Enclosed is part two of the two-part survey being conducted as part of a research project in the Food Science and Sociology Departments at Michigan State University. This second survey asks about your perceptions of the new juice regulations, HACCP and your retail customers. This survey will help us understand your thoughts and there are no right or wrong answers.

Please be assured that your participation in this research will be kept confidential. At the end of the survey we ask for personal information only for the purposes to send you a copy of the results if you would like to receive them.

As explained in the first letter, the intention of this research is to learn from you how the new juice rule will affect your business and customers. The results will be shared with the Michigan Department of Agriculture and other interested groups in the hopes that they might be able to use the information to determine ways to help cider processors overcome any concerns due to the new juice rule. Again, your personal information will be kept confidential.

Once you complete both surveys, they will be analyzed and you will receive a report comparing your responses to those of other cider processors completing both surveys. Please use the enclosed stamped envelope to return your survey no later than September 10, 2002.

If you have any questions about this study, please contact one of the following individuals. Thank you for participating in this study.

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If you have questions about your rights or role as a subject of research, you may contact Dr. Ashmir Kumar, Chair for Research Involving Human Subjects at 517-255-2180. If you have any questions about this survey please contact the researcher, Donna Thede, at 269-961-2827.

APPENDIX K

CIDER PROCESSORS' PERCEPTIONS SURVEY

This set of questions is about the new Food and Drug Administration (FDA) Juice Rule and implementation of Hazard Analysis and Critical Control Point (HACCP) system. Specify the extent that you agree or disagree with the following statements. Please check the appropriate column with your response.

	Agree strongly	Agree	Neither agree Nor disagree	Disagree	Disagree strongly	Don't Know
HACCP implementation is necessary to ensure the safety of cider.						
HACCP implementation will reduce the incidence of foodborne illness linked to consumption of juice products.						
The juice HACCP regulation will result in unnecessary oversight to the juice industry.						
The juice HACCP regulation will result in unnecessary expense to the juice industry.						
Regulatory personnel / inspectors who visit my plant are knowledgeable about HACCP.						
Regulatory personnel / inspectors who visit my plant have an adversarial relationship with myself or employees.						
HACCP training has been easily accessible and at convenient times for myself or employees.						
HACCP will make consumers more confident in buying cider from my mill.						

Please circle your response or write comments to the following questions:

How often do you hear from consumers who have concerns about your product?

A. At least once a week
B. Couple of times a month
C. Several times a year
D. Once in awhile
E. Never
F. Don't know

When you do hear from consumers, what are the top three things they are concerned with?

_____

_____

_____

Do you think consumers are aware of regulatory processes within the juice processing industry?

A. Yes, and they have a good understanding of what is going on.
B. They know about it, but are not sure what it means.
C. They don't know anything about it.

D. They don't know, and they don't care.
E. Don't know

Would you use a safe food manufacturing system such as HACCP as a marketing tool?
A. Yes.
B. No.
C. Maybe.
D. Don't know

How much marketing research do you conduct?
A. The company has a regular marketing research program (do marketing research at least once a year)
B. The company does marketing research when we change our product.
C. The company does marketing research when a new product is being developed.
D. Marketing research is done on an irregular basis.
E. No marketing research is done.
F. Don't know.

What do you think motivates consumers to purchase cider? (circle all that apply)
A. Fun to drink
B. Fun fall activity
C. Tradition
D. Feel it is safe
E. Great taste
F. Trust your cider mill
G. 100% juice
H. Healthy product
I. Other_____

What motivates you as the cider mill processor to make cider? (circle all that apply)
A. Fun to make
B. Family tradition and business
C. Believe cider is a safe product
D. Another way to use extra apples
E. Enjoy consumers who purchase cider
F. Supplement income
G. Enjoy processing cider
H. Other_____

Do you promote or advertise your cider as having any of the following qualities? (circle all that apply)
A. No preservatives
B. Contains preservatives to maintain freshness
C. Pasteurized
D. Unpasteurized
E. Passed food safety inspections
F. Safe
G. Healthy
H. Fresh
I. Delicious or great tasting
J. Organic or Natural
K. 100% juice
L. Made with Michigan apples
M. Other_____

If you could educate consumers on three things that have to do with the juice processing industry, what would they be?

The following questions will help us understand who purchases cider. Please check the appropriate column with your response.

How often is cider purchased by:	Very Often	Often	Not Often	Not at all	Not sure
Families with children under five years of age?					
Families with school-age children five to nine years of age?					
Families with school-age children over nine years of age?					
Adults without children?					
Adults 65 years or older?					

How often do you feel your retail customers purchase your product?

A. Once a week in the fall
B. Two to three times a month in the fall
C. Throughout the year
D. Only for special occasions
E. Not sure

If you have a FDA warning label on your apple cider containers how often do customers notice this label?

A. Very often
B. Often
C. Not very often
D. Not at all
E. Not applicable

If you have a FDA warning label on your apple cider containers, what have customers said about the warning?

Do you intent to process your cider according to the FDA HACCP regulation?
Yes
No
Don't Know

Please explain:_____

_____

We would like to send you a copy of the results. If you would like to receive the results please provide the following information. Again, your individual information will be kept confidential.

Name:_____

Cider mill name:_____

Street Address:_____

City, State and Zip Code:_____

County:_____

Thank you for completing this survey. Please mail the survey in the enclosed stamped envelope.

APPENDIX L

FOLLOW-UP LETTER TO NON-RESPONDING CIDER PROCESSORS

September 27, 2002

Dear Cider Processor:

Enclosed are two surveys for a research project in the Food Science and Sociology Departments at Michigan State University. Our records show that we sent these surveys to you in late August but we have not received a response from you. We apologize if you are receiving this letter in error and if this is the case please disregard this reminder.

If you have not had the opportunity to respond to these surveys, we hope that you will find a few moments to complete the surveys for us. Your opinions and comments are important to us so we can gain a full understanding of the practices and perceptions of Michigan cider processors.

Please be assured that your participation in this research will be kept confidential. At the end of the survey we ask for personal information only for the purposes to send you a copy of the results if you would like to receive them.

The intention of this research is to learn from you how the new juice rule will affect your business and customers. The results will be shared with the Michigan Department of Agriculture and other interested groups in the hopes that they might be able to use the information to determine ways to help cider processors overcome any concerns due to the new juice rule. Again, your personal information will be kept confidential.

Once you complete both surveys, they will be analyzed and you will receive a report comparing your responses to those of other cider processors completing both surveys. Please use the enclosed stamped envelope to return the surveys no later than October 11, 2002.

If you have any questions about this study, please contact one of the following individuals. Thank you for participating in this study.

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If you have questions about your rights or role as a subject of research, you may contact Dr. Ashmir Kumar, Chair for Research Involving Human Subjects at 517-255-2180. If you have any questions about this survey please contact the researcher, Donna Thede, at 269-961-2827.

APPENDIX M

THANK YOU LETTER TO PARTCIPANTS

September 17, 2002

Dear Processors:

Thank you for completing the surveys we recently sent to you. We greatly appreciate the time you took to complete and mail the survey back to us.

We are still waiting for additional surveys to be returned so we can compute the results and share them with you. The results promised to you will arrive closer to the beginning of 2003.

Once again, thank you for helping us with this research.

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APPENDIX N

CONSUMER E-MAIL SURVEY

Introduction: This Internet survey is part of a Michigan State University Food Science Department research project on refrigerated apple juice and cider. You have been sent this survey since you are an adult 18 years or older and living in the state of Michigan. This is a voluntary research project and you are not obligated to participate. If you would like to have your email address removed from future mailings please reply to this message.

If you have questions about your rights or role as a subject of research, you may contact Dr. Ashmir Kumar, Chair for Research Involving Human Subjects at 517-255-2180. If you have any questions about this survey please contact the researcher, Donna Thede, at thededon@msu.edu

If you would like to participate in this survey, please fill out the questions to the best of your knowledge. We appreciate your time in helping us with this research project.

For the following questions, please answer only for refrigerated ready to drink fruit juices – those kept in the refrigerated section of your grocer or other retailer. Do not include fruit juices or fruit juice concentrate that requires mixing with water that are kept in the un-refrigerated or frozen sections of your grocer or other retailer.

1. What is your age? (Select one)

   Under 18 years [TERMINATE]
   18-25 years
   26-35 years
   36-45 years
   46-55 years
   56-65 years
   66 or older
   Prefer not to answer

2. Please indicate which of the following refrigerated ready to drink fruit juices you or members of your household drank and/or purchased in the past 12 months. (Select all that apply)

	Member of household drank in past 12 months	Member of household purchased in past 12 months
Refrigerated apple juice	❑	❑
Refrigerated apple cider	❑	❑
Refrigerated cranberry juice or juice cocktail	❑	❑
Refrigerated grape juice	❑	❑
Refrigerated grapefruit juice	❑	❑
Refrigerated orange juice	❑	❑
Refrigerated mixed berry juice	❑	❑
Refrigerated fruit juice blends	❑	❑
Other refrigerated fruit juice	❑	❑
None – nobody in household drank any refrigerated fruit juice in past 12 months	❑	TERMINATE
None – nobody in household purchased any refrigerated fruit juice in past 12 months	[SKIP TO Q. 6]	❑

3. Who in the household is primarily responsible for which brand of refrigerated fruit juice is purchased?

I am	❑
Other female, age 18 or older	❑
Other male, age 18 or older	❑

4. In the past 12 months, have you or a household member purchased refrigerated fruit juice or cider that was made by a local farm or orchard? (Select one)

Yes
No
Don't know

5. If a refrigerated fruit juice label contained any of the following wording on the package, how would this influence your likelihood of purchasing the juice? (Please select the appropriate answer for each statement.)

	Much more likely to purchase	Somewhat more likely to purchase	Neither more nor less likely to purchase	Somewhat less likely to purchase	Much less likely to purchase
Organic or natural					
No preservatives					
Contains preservatives to maintain freshness					
Safe					
Pasteurized					
Not pasteurized					
Keep pasteurized					
Delicious or great tasting					
Fresh					
100% juice					
Warning statement that juice not treated to reduce pathogens					
Passed food safety inspections					

6. Please select the type of retailer that you feel sells the best refrigerated fruit juice with the following characteristics: (Select one for each statement)

	Grocery store	Mass Merchandiser (Wal-Mart, K Mart, Target, etc.)	Health Food Store	Community or Local Farmer's Market	Local Farm or Orchard	No difference between stores or locations
Safest juice						
Organic or natural juice						
Juice with no preservatives						
Juice that is not pasteurized						
Best tasting juice						
Freshest juice						

7. Which of the following do you think the government requires manufacturers of refrigerated fruit juice to put on labels? (Select one for each statement.)

The government requires manufacturers to tell if a refrigerated fruit juice...

	Agree	Disagree
Is organic or natural		
Has no preservatives		
Contains preservatives to maintain freshness		
Is safe		
Is pasteurized		
Is not pasteurized		
Should be kept refrigerated		
Is delicious or great tasting		
Is fresh		
Contains 100% juice		
Has not been treated to reduce pathogens		
Has passed a food safety inspection		

8. How concerned are you about the following in refrigerated fruit juice? Please rate each statement on how concerned you are where a "5" represents the "Very Concerned" and a "1" represents "Not at all concerned". You may choose any number from 1 to 5 to rate your level of concern. (Please select one for each statement.)

	Very concerned (5)	Concerned (4)	Neither (3)	Not concerned (2)	Not at all concerned (1)
Allergens					
Artificial ingredients					
Bacteria					
Foreign material (glass, wood, metal)					
Insects					
Mold					
Pesticides					
Preservatives					
Processing chemicals					

9. Suppose a juice manufacturer promotes their refrigerated fruit juice as processed using HACCP. Which one of the following statements best describes what this would mean to you? (Select one.)

Manufacturer uses certified Grade A fruit to make juice
Manufacturer has a food safety program in place
Manufacturer is a member of an independent organization
Manufacturer won an award
Don't know

10. If a refrigerated fruit juice label included the statement "pasteurized", what would this mean to you? (Select all that apply.)

Juice is organic and natural
Juice will have more of a cooked taste
Juice will have more of a fresh taste
Juice has less risk of pathogens
Juice may have more risk of pathogens
Don't know

11. If a refrigerated fruit juice label included the statement "not pasteurized", what would this mean to you? (Select all that apply.)

Juice is organic and natural
Juice will have more of a cooked taste
Juice will have more of a fresh taste
Juice has less risk of pathogens
Juice may have more risk of pathogens
Don't know

12. Where do you get your information about food safety? (Select all that apply)

National television programs or news broadcasts (CNN, 60 Minutes, Food Channel, etc.)
National radio broadcast (National Public Radio, etc.)
National newspaper or magazine articles (USA Today, Prevention, etc.)
Internet – national websites
Internet – local websites
Local television programs or news broadcasts
Local radio broadcasts
Local newspaper articles
Family or friends
Physician
Other health professional

The last few questions are for statistical purposes only. We need this information to compare your opinions with the other households.

13. What is your gender? (Select one)

Female
Male
Prefer not to answer

14. Which of the following best describes your racial or ethnic group: (Select one)

Asian
American Indian or Alaskan native
Black or African American
Hispanic or Latino
Native Hawaiian or Other Pacific Islander
White or Caucasian
Other_____
Prefer not to answer

15. What is highest level of education you have attained? (Select one)

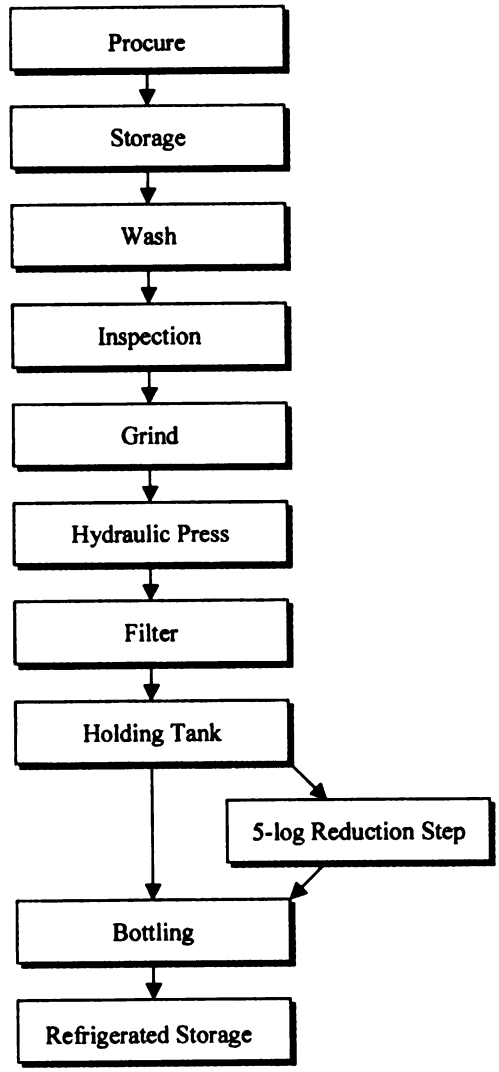
Less than high school graduate
High school graduate
Some college or technical school
College graduate
Post graduate
Prefer not to answer

This concludes the survey. Thank you for helping us with this research.

APPENDIX O

APPLE CIDER PROCESSING STEPS

Apple Cider Processing Steps



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