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A Model HACCP Plan for Small-Scale, Fresh-Squeezed (Not Pasteurized) Citrus Juice Operations[1]

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It is the focus and intent of this document to provide assistance for management of small-scale citrus-juice processors to put in place and implement strategies that assure the safety and maximize the quality of non-pasteurized juice.

Background

Consumption of fresh-squeezed (not-pasteurized) citrus juices has increased nationwide. Fresh-squeezed juice--once produced and marketed primarily at roadside stands--is currently marketed throughout the United States and to some foreign countries.

The feature of fresh-squeezed (not-pasteurized) citrus juices that sets them apart from conventional juice products is the lack of heat pasteurization. The heat process used in pasteurization of conventional juices increases shelf life by inactivating certain enzymes and microorganisms (yeasts, molds, bacteria). However, heat processing also results in flavor loss and other changes which detract from the fresh, natural quality of the juice (Carter 1989).

It has long been recognized that shelf life and quality of fresh-squeezed juice products is directly related to the care and sanitation steps taken in processing. If processed and stored under appropriate conditions, good quality juice may achieve several days' shelf life prior to quality deterioration. Likewise, caution and care in manufacture are necessary to assure microbiological safety of the product.

From a safety standpoint, *Salmonella* and *E. Coli* 0157:H7 contamination are of highest concern. Traditionally, foods of animal origin are most commonly implicated in outbreaks involving these micro-organisms. More recently, large *Salmonellosis* outbreaks have been associated with contaminated fresh fruits and vegetables (Centers for Disease Control 1991, Hedberg et al. 1994, McFarland 1994). Of great concern to the fresh-squeezed juice industry is the *Salmonellosis* outbreak--in 1995 at a Florida theme park--which involved contaminated unpasteurized orange juice. More than 60 park visitors were affected in this outbreak (Centers for Disease Control 1995). Recently, an association of *E. Coli* 0157:H7 with outbreaks involving non-pasteurized apple cider and juice made headlines.

The Florida Department of Citrus had amended its rules and Grade A standards for packing Fresh-squeezed Florida Orange Juice (Florida Dept. of Citrus 1993). Gift fruit shippers, small scale retail processors, and roadside stand operators who squeezed less than 30,000 boxes

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annually are regulated by the Florida Department of Agriculture and Consumer Services (Fl. Dept Agric. & Cons. Serv. 1996). A significant number of operations--processing a significant volume of juice--are not, as yet, covered under existing regulations.

Overview of HACCP

The use of a highly structured **Hazard Analysis Critical Control Point (HACCP)** system in food-safety control is not new. The first food-industry HACCP application (in the 1960s) was by the Pillsbury Co. who had been contracted by National Aeronautics and Space Administration (NASA)--in conjunction with U.S. Army Natick Laboratories--to design and produce foods for space flights. The cooperative HACCP program which evolved had the goal of nearly 100% assurance that space foods produced would be free of microbial or viral pathogens. This systematic, preventative approach combines the principles of food microbiology, quality control, and risk assessment.

Various forms of HACCP have been applied in the food industry since the 1970s. The first regulatory application of HACCP was by U.S. Food & Drug Administration (FDA) in the 1970s where the approach was used in a regulatory/industry cooperative program for low-acid canned foods.

A working definition of HACCP

Simply stated, HACCP is a logical--and thorough--system designed to identify hazards and/or critical situations, and to produce a structured plan to control these situations. HACCP bases the food-safety program on sound scientific data: to increase training and awareness of employees at all levels, and to focus on prevention and control of food safety problems at highly specific (and controllable) points in the process chain. Implementing a well-designed HACCP program provides food manufacturers and handlers a high level of control over product safety.

The advantages

The primary advantages of HACCP is that it is a preventative--rather than a reactive-- approach to hazard identification and control in the food handling environment.

Additional benefits to be realized include:

- more efficient and directed use of resources,
- reduced need for expensive end product testing,
- improved product quality, and
- higher customer satisfaction.

Note: *A common fallacy is that HACCP is complicated. It is detailed, but logical. And, the outcome of an appropriately planned, disseminated, and executed HACCP program makes the jobs of all those involved in the food handling operation easier.*

What are winning characteristics?

An HACCP plan must be personalized and specific to the individual food handling operation; it must be user-friendly and dynamic. There is no such thing as a generic plan that can be applied to all food operations.

Of course, a specific, user-friendly and dynamic plan which is discussed, written, and shelved is totally useless.

Pre-HACCP Programs and Activities

Considerable will and energy must be put into the planning stages of implementing HACCP. Certain prerequisite programs and activities (Table 1) should be an integral part of this planning process. During this preliminary stage, it is important to spend sufficient time on organization and prioritization and to use the team approach.

Table 1. Prerequisite Programs and Steps.

Develop Commitment/Identify and Train Key Personnel
Assemble the HACCP Team
Develop Understanding of Food Products, Processing, and Distribution
Develop and Verify Process Design and Flow Diagram
Evaluate Effectiveness of Sanitation Programs

• **Develop Commitment/ Identify and Train Key Personnel.** HACCP is a management tool. As such, it requires the commitment of all personnel involved in processing--from top-level management to the line worker. It is desirable to have several meetings with all employees to brief and indoctrinate them on the useful features of HACCP. After these preliminary meetings, carefully select the key people who will participate in the program and will write the plan. They will require additional training on HACCP principles and implementation procedures.

• **Assemble the HACCP team.** HACCP is also a team activity. Therefore, spend sufficient time in discussing and assigning levels of employee responsibility. Use

care in choosing the HACCP planning team: it should include representatives of all phases of food processing or handling (including top management and clean-up crew). A team leader should be identified either by appointment or election. The leader should be committed to the concepts, have a record of responsible behavior, and possess leadership skills. The team should be prepared to develop a regular meeting schedule.

• **Develop understanding of food product(s), processing, and distribution.** HACCP is also a process review. Planning for HACCP is an opportunity to examine the processes involved and products being handled in the facility, as an in-depth understanding of the product(s) produced and processing steps involved is necessary for an effective HACCP plan. Encourage all HACCP team members to participate in this evaluation.

The following are suggested activities:

- prepare a list of all juice products with appropriate name and identification;
- summarize the composition, formulation, and important quality and stability characteristics;
- examine raw materials, especially their source and unique properties;
- examine the characteristics of packages used;
- evaluate intended product distribution, special problems and potential for abuse;
- evaluate all steps in the process; and
- list all potential sources of contamination.

• **Develop and verify process design and flow diagram.** Examine all areas involved in the flow of product(s) through the processing/ handling system. Include raw materials/ ingredients, a sequence of processing steps, time and temperature considerations, and finished product handling, storage, and distribution. Flow diagrams should contain simple block diagrams. Walk-through the diagram to assure its accuracy.

• **Evaluate effectiveness of sanitation programs.** HACCP is a way to insure and document adequate sanitation. If your sanitation program is not current, this is a good time to update it, as most facilities include sanitation in their HACCP plan. Planning for HACCP is an opportunity to assess the effectiveness of existing sanitation programs and to evaluate where improvements are needed. Critically inspect and examine the following areas:

Premises and surroundings. Every attempt should be made to minimize contamination sources in the exterior surroundings of the facility. Is the drainage adequate to prevent pooling of water? Is sufficient effort being made to control rats, mice, frogs, toads, birds, and other contamination sources?

All buildings and facilities should be so constructed that they are easily cleanable. Floors, walls, and ceilings should be constructed of impervious materials and should be sealed as appropriate to prevent outside sources of contamination.

Clean rooms should be constructed separate from other areas for critical operations such as container filling, etc. Plant design should be of a flow-through nature from raw to finished product with little opportunity for cross-contamination of finished product with raw materials.

Sanitary facilities. Sanitary facilities, wash rooms, and toilets should be separated from process areas and should be clean and maintained. Employee **hand-washing sinks with hot water** should be provided and accessible to work areas.

Lighting and ventilation. Evaluate the adequacy of lighting in the facility. If employees do not have adequate lighting, they cannot effectively operate, maintain, and clean equipment. A poorly ventilated plant will have condensation problems which increase the risk of overhead contamination.

Water and ice supply. A food processing and handling facility should be provided with potable water. Water from private wells should be sampled and examined for potability through microbiological analysis on a regular frequency. Any ice used in the facility should also be potable and handled in such a manner to minimize contamination.

Waste handling and facilities. Waste facilities should be separated from processing/handling areas and be cleaned and maintained on a regular basis so as not to attract pests. Keep garbage and trash containers or bags covered and sealed.

Receiving and storage. Raw materials can be an important source of contamination. Critically evaluate procedures for raw material receiving and handling:

Are there specifications for these materials?

How are these products monitored for compliance to these specifications?

Evaluate storage requirements and conditions for raw materials, packaging materials, finished product, and non-food chemicals--including:

- requirements and effectiveness of rooms and equipment for temperature control and other environmental requirements (e.g., humidity) as appropriate;
- potential for overhead contamination and contamination from outside the facility, and effectiveness of preventative measures; and
- storage of non-food chemicals away from food products.

Processing/handling equipment construction, installation, and maintenance. Evaluate all for general sanitary design and construction. Are the food-contact surfaces manufactured of impervious material, free of crevices, and cleanable? Cleanable grade stainless steel surfaces are recommended wherever feasible.

Generally, wood surfaces (and many plastic surfaces which have a lot of wear) are not considered cleanable in design.

Care should also be used in evaluating aluminum surfaces. Aluminum can become corroded, cracked, and pitted with long term exposure to chemicals or corrosive food materials. **Corroded aluminum is not cleanable.**

Location and installation of equipment. Evaluate as follows:

Is the equipment installed to minimize the risk of overhead, splash contamination, or contamination from outdoors?

Is equipment crammed into small areas where there are unclean able nooks and crannies?

Personal hygiene habits. Planning for HACCP is an opportunity to evaluate the effectiveness of employee training programs with regard to personal hygiene and sanitary practices. An increasingly common source of contamination in food-processing and -handling is poor hygiene practices by employees. All employees should be instructed as to the importance of proper hygiene--reminders or signs in the restrooms can help.

Observe employees during operations. Assess employee traffic patterns: employees working with raw materials that may be contaminated with agricultural wastes should be restricted from finished product areas. Control access to critical areas for both visitors *and* employees.

Cleaning and sanitization programs. Planning for HACCP is an opportunity to upgrade/update cleaning/sanitization programs as **cleaning/ sanitization procedures are the most important tasks in a food processing/handling operation**. Consult a reputable chemical supply and sanitation company about setting up an effective cleaning and sanitizing program. Inspect and document the effectiveness of cleaning and sanitizing at regular intervals. Select and identify reliable personnel to be responsible for such operations.

Pest control programs. Planning for HACCP is an opportunity to upgrade/update your facility's pest-control programs, because a “clean” facility or “clean” equipment that allows for invasion by rats, mice, frogs, toads, insects, or other pests is no longer clean.

Consult with a reputable pest control company to assist in pest elimination in the processing environment. A designated, reliable employee should be charged with responsibility to monitor and document the effectiveness of such a program:

- keep all entrances closed,
- remove stagnant water,
- control weeds in the surroundings,
- check the perimeter of the facility for cracks or holes,
- be sure all food products and packaging materials are stored on pallets off the floor,
- dispose of trash and waste at the end of every work day, and
- monitor any other appropriate activities to control pests.

Recall program. If--before your facility’s HACCP plan is implemented--a food-borne contamination problem occurs, a product recall may be in order. Before this occurs, evaluate the potential for a product recall. Bear in mind that product recall may be as simple as having a traceable company address or a telephone number on a label. It could, alternatively, involve a highly systematic procedure.

HACCP Implementation

The seven principles of HACCP and stepped sequence for implementation are presented in Table 2. The HACCP principles and definitions presented are based upon the U.S. National Advisory Committee on Microbiological Criteria for Foods (NACMCF) HACCP System Guide (NACMCF 1989, Pierson and Corlett 1992, Anon. 1994, Bryan et al. 1991).

Table 2. HACCP Implementation Steps

1) Conduct a Hazard Analysis
2) Identify Critical Control Points
3) Establish Critical Limits
4) Establish Monitoring Requirements
5) Establish Corrective Actions
6) *Establish Record-Keeping Systems*
7) Establish Procedures for Verification and Validation

Principle 1: Conduct a Hazard Analysis.

A ***food hazard*** is any unacceptable contamination by a biological, chemical, or physical agent at sufficient level to cause a food to be unsafe for human consumption. By far the most common agents are biological, mainly pathogenic bacteria, other microorganisms and parasites.

Microbiological hazards are the potential for pathogenic organisms to survive, grow, contaminate the product/raw materials and eventually cause food-borne illness.

Chemical hazards could result from a number of sources: agricultural chemicals, insecticides, fungicides, etc.; cleaning/sanitizing agents and chemicals, certain toxins, and misuse of food chemicals (preservatives, additives, etc.).

Physical hazards include: inadvertent field matter (stones, metal, insect fragments, etc.); inadvertent processing residues (glass, metal fragments, etc.); intentional materials (employee sabotage) and miscellaneous particulates and fragments.

The HACCP team should evaluate hazards of significance and preventative measures needed for each food product and process. They should use as many sources of information as possible in this evaluation phase: scientific literature, opinions of experts, laboratory records, and specifications.

The team should be as detailed and thorough as possible and spend sufficient time, effort, and discussion during this step.

Hazards should be categorized as to severity and/or risk. **Risk is an estimate of the occurrence of a hazard and is usually categorized as high, medium, low, or negligible.** Risks associated with certain pathogens have been categorized in Table 3.

During this evaluation process, specific factors which may contribute to contamination, survival, and/or growth (Table 4) in the specific food processing/handling system should also be assessed.

Table 3. Categorization of Food-related Microbiological Hazards *(NACMCF 1989)*

Severe Hazards	Moderate Hazards	
	Extensive Spread	Limited Spread
Clostridium botulium	*Listeria monocytogenes*	*Bacillus cereus*
Shigella dysenteriae	*Salmonella spp.*	*Campylobacter jejuni*
Salmonella typhi & paratyphi	*Shigella spp.*	*Clostridium perfringens*
Hepatitis A and B	Enterovirulent *E. coli*	*Staphylococcus aureus*
Brucella	*Streptococcus pyogenes*	*Aeromonas*
Escherichia coli 0157:H7	Norwalk virus	*Yersinia enterocolitica*
	Cryptosporidium parvum	Parasites

Table 4. Selected factors influencing growth of common food-borne pathogens (*Bryan et al. 1991)**

Organism	Minimum Growth Factors	
	Temp. C°/F°	pH
Bacillus cereus	5/42	4.4
Campylobacter jejuni	25/77	4.9
Clostridium perfringens	15/60	5
Listeria monocytogenes	0/32	4.5
Salmonella	6/43	3.8
Staphylococcus aureus	7/45	4.3
Yersinia enterocolitica	3/38	4.4

**Values may vary with different strains*

Principle 2: Identify Critical Control Points.

A ***Critical Control Point (CCP)*** is any operation (practice, procedure, process, location, or step) at which there is a high- to medium- risk that lack of control will result in human risk; and at which control can be applied.

Clearly defined examples of CCPs are: the pasteurization step for milk which is specifically done to eliminate pathogens, a metal detector which automatically removes metal fragments in ground beef or similarly processed products, or the cooking step in food service operations.

However, CCPs are not limited to those processes or operations which **eliminate** hazards. CCPs can also be identified where hazard **prevention** or **reduction** can occur (e.g., ingredient or raw material specifications, sanitation programs, etc.). Since, in fresh-squeezed juice operations there is no final heat process to totally eliminate pathogens, there are no CCPs where hazards can be totally eliminated. This fact does not preclude the application of effective HACCP programs.

Highly effective HACCP programs are in use in manufacturing facilities which do not have a terminal heat process (e.g., meat and poultry slaughtering and processing, raw vegetable/ salad operations, etc.). In such operations, CCPs are carefully identified at specific operations or steps aimed at hazard prevention or reduction.

Identification of CCPs is an important and painstaking process and provides the backbone of HACCP. In addition to the element of hazard control at a CCP, it is equally important that such control can be monitored and adequately verified (see Principles 4 and 7). It is a worthwhile exercise for each HACCP team member to follow the CCP decision tree which is presented in Table 5.

Table 5. CCP Decision Tree.

<table>
<tr><td colspan="3">Q1. Do preventative measures exist fo the identified hazard?</td></tr>
<tr><td>Yes</td><td colspan="2">No</td></tr>
<tr><td rowspan="2">Proceed to Q2</td><td colspan="2">Is control at this step necessary for safety?</td></tr>
<tr><td>Yes</td><td>No</td></tr>
<tr><td></td><td>Modify step, process or product</td><td>Not a CCP. Stop[1]</td></tr>
<tr><td colspan="3">Q2. Does this step eliminate or reduce the likely occurrence of a hazard to an acceptable level?</td></tr>
<tr><td>Yes</td><td colspan="2">No</td></tr>
<tr><td>Critical Control Point</td><td colspan="2">Proceed to Q3</td></tr>
<tr><td colspan="3">Q3. Could contamination with identified hazard(s) occur in excess of acceptable level(s) or could these increase to unacceptable level(s)?</td></tr>
<tr><td>Yes</td><td colspan="2">No</td></tr>
<tr><td>Proceed to Q4</td><td colspan="2">Not a CCP. Stop[1]</td></tr>
<tr><td colspan="3">Q4. Will a subsequent step eliminate identified hazard(s) or reduce the likely occurrence to an acceptable level?</td></tr>
<tr><td>Yes</td><td colspan="2">No</td></tr>
<tr><td>Not a CCP. Stop[1]</td><td colspan="2">Critical Control Point</td></tr>
<tr><td colspan="3">[1]Proceed to next step in the described process</td></tr>
</table>

Thoroughly discuss the selection of CCPs. Once identified, CCPs should be clearly labeled on product flow diagram(s) (see Figure 2).

Principle 3: Establish Critical Limits.

A ***Critical Limit (CL)*** is a safe limit or tolerance that must be met for each identified CCP. These are the boundaries of safety for the microbiological, chemical and physical hazards. Exceeding these boundaries indicates that a health hazard may exist or could develop.

The most obvious examples of such tolerances or limits are specific temperature/time relationships for either processing or storage which are necessary to prevent, eliminate or reduce microbial hazards. Food compositional information such as acidity may also be used.

Other examples of critical limits include: specifications on raw materials/ingredients (e.g., an ingredient shall be free of *Salmonella*) or simple checks on sanitation parameters (e.g., sanitizer level, inspection for cleaning, etc.).

Establishing CLs based on inspections or visual observations is more difficult. It involves setting an accept/reject decision based on subjective evaluation.

Examples: a food product contact surface is not clean; washed fruit is not clean; or acceptance/rejection of raw materials based upon sensory evaluation.

Care must be exercised; limits and tolerances must be identified for each CCP. Further, limits must be realistic and be measurable. It may be a good plan to set operational or warning limits in addition to establishing CLs to allow for operational variability.

Principle 4: Establish Monitoring/Inspection Requirements.

Monitoring is a scheduled observation or measurement of a CCP and its limits. The purpose of monitoring is two-fold: to assess whether a CCP is under control and to produce an accurate record for future verification and validation. Monitoring CCPs is of great importance and should be done by responsible individuals who are properly trained, have commitment to HACCP and are unbiased. Monitoring procedures should be accurate and done at appropriately

established frequency. Take time to assess and inventory monitoring equipment, tools, devices, and materials. Check that thermometers are accurate. Develop user-friendly inspection and reporting forms.

Monitoring may be continuous (temperature/ time recorders, metal detectors, and other recording devices) or it may be done on an established frequency involving *hands-on* determinations: objective (using instruments and measuring devices) or subjective (observations and inspections).

Examples of the latter: visual observation, chemical testing, physical measurements, sensory evaluation, and microbiological testing.

Visual observations are usually based upon a predetermined inspection checklist which usually involves observing temperatures, or cleanliness of equipment. Chemical testing may include measuring pH or acidity, cleaner and sanitizer levels, chlorine levels in chill water or wash water, and sugar content.

Examples of physical monitoring methods include: temperature/time measurement devices, and detectors for extraneous matter such as metal, plastic, etc.

Sensory monitoring involves examining raw materials for "off" odors, presence of molds, or other defects.

Microbiological testing has a limited but important role due to the time delay involved for results. While it is not possible to use microbial data to stop a process on the spot or to bring a CCP under control, microbial testing is used to set/maintain acceptance standards or tolerances on raw materials and ingredients in hazard analysis.

Microbial data may also be used in HACCP verification (see Principle 7). The following are important in establishing monitoring procedures:

- CCPs must be clearly identified *prior* to setting up the monitoring program. Decisions are based on whether a hazard exists and procedures are established to measure if a CCP is *in* or *out* of control. Procedures must be *written* in a clear and concise manner.
- Frequency of monitoring for each CCP will vary with degree of risk.

Principle 5: Establish Corrective Actions.

A ***Corrective Action*** is a procedure followed when a deviation occurs. Corrective action must be taken whenever monitoring indicates that limits or tolerances are not met. Such action must be immediate to assure that the situation is rectified. Action will vary with the process being monitored and the type of monitoring indicated. Based upon the severity of hazard and the individually defined situation, corrective action may involve: notifying a supervisor, process line shut down, reprocessing, adjusting process temperature and times, rejecting raw materials or ingredients, and holding or recalling product in distribution. Corrective actions must be identified and documented in the HACCP plan and should specifically address each CCP. It is fundamentally important to specifically delineate responsibility and authority with regard to corrective action.

Principle 6: Establish Record Keeping System.

An ***adequate record keeping system*** is the heart of a HACCP program. Records are the documentation needed to verify effectiveness. Develop summary charts or an HACCP Description Chart as shown in Table 6 for every product processed. (See Table 10 for an HACCP Description Chart for Fresh-Squeezed Orange Juice.)

Other types of information to record include:
- a detailed listing of the HACCP team and assigned responsibilities;
- adequate and appropriate product, processing, packaging, raw materials information;
- adequate and appropriate storage and distribution records;
- the process flow diagram indicating CCPs (as in Figure 1 and Figure 2);
- adequate information for critical limit identification, monitoring system, and corrective actions.
- It is important that the format of the records be simple and user-friendly.

- These recording forms should be kept accessible to facilitate immediate record entry. Checks and balances avoid false entries in these records. Records which relate to critical inspection points must be reviewed, initialed, and dated on a daily basis by a designated, responsible person. Any deviation must be noted and problems addressed. HACCP records should be kept for at least one year. It is important to individualize record forms to specific operations. Examples of monitoring records are presented in Table 7 and Table 8.

Table 6. HACCP Description Chart *(adapted from Bryan et. al. 1991)*

Product:					**Plant:**			
Operational/ Process Step	**Hazard/ Concern**	**CCP/Type**	**Critical Limit/Criteria**	**Monitoring/ Frequency**	**Records/ Location**	**Responsibility**	**Corrective Action**	**Verification Procedures**

Table 7. Sanitation Log Sheet *(Adapted from Pierson and Corlett, 1992)*

S = Satisfactory

Date: N = Needs improvement

A = Alert

Process Step or Activity	Time			Comments
	Start	Break 1	Break 2	

Insp. by: _____Prod. Supvr.: _____QA mgr: _____

Table 8. Temperature Data Sheet *(adapted from Pierson and Corlett, 1992)*

Storage Box Refrig.: #1		Critical Limit = 40°F
Product Line:		Critical Limit = _____
Time	**Temperature (°F)**	**Comments or Actions**
0800	39	
0830	38	
0900	37	
0930	36	
1000	36	
1030	36	
Notes:		
Operator:		Date:

Principle 7: Establish Verification and Validation Procedures.

A working HACCP system is dynamic and flexible, and allows for change. It should have provisions for verification and validation of its effectiveness. The verification team should be clearly identified and empowered. Verification should be on a well-defined and established frequency (at least semi-annually). Larger facilities may want to consider third-party verification. Essential elements for HACCP verification are presented in Table 9.

Table 9. Essential elements for HACCP verification
HACCP plan review
Compliance with CCPs
Confirmation of adequacy of procedures
A walk-through, visual inspection
A written verification report

Review of the HACCP plan. Are any changes needed in the overall HACCP plan? Are CCPs, CLs and other procedures adequate and up to date with the operation?

Compliance with CCPs. Thoroughly review all records including monitoring records/inspection records, customer complaint records, etc. to assess that CCP compliance over the evaluation period had been adequate. Make appropriate adjustments.

Confirmation of adequacy of procedures. Assess whether procedures used have been adequate? Check calibration of instruments, and thermometers as appropriate. Make appropriate adjustments.

Walk-through inspection. A verification inspection of the facility should be performed during operation. Assess whether critical areas or steps in the operation have been missed.

Written verification report. A brief, concise verification report should be written each time the HACCP plan is verified.

Fresh-squeezed (Not-pasteurized) Citrus Juice Operations

General Process Characteristics

A general flow diagram is shown in Figure 1.

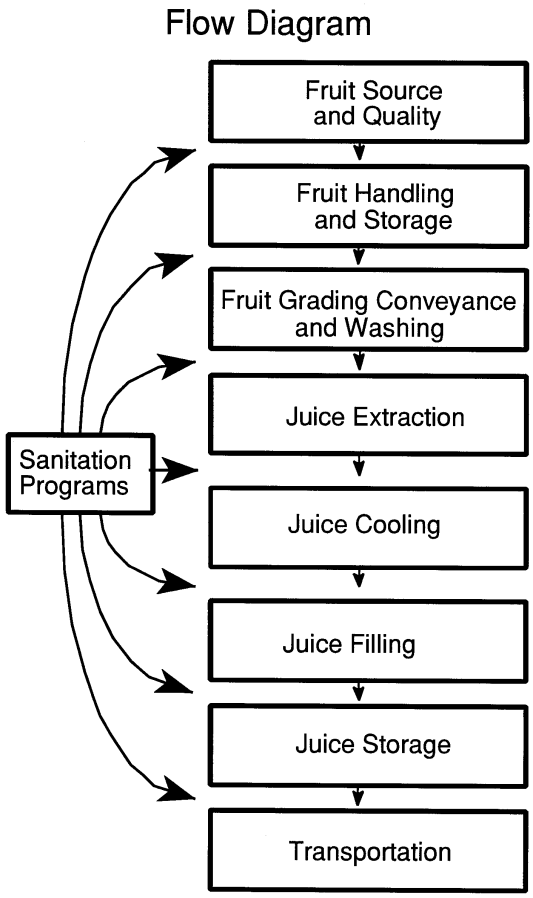

Figure 1. Flow diagram for fresh-squeezed (not pasteurized) citrus juice.

Raw Fruit Source and Quality

Fruit Source. To produce juice of consistent quality and safety, it is necessary to establish and maintain a dependable supply of good quality fruit. With this in mind, it is extremely important that care be exercised in examination and grading the fruit just prior to juice extraction.

Table 10. HACCP DESCRIPTION CHART

Product: ***FRESH- SQUEEZED ORANGE JUICE*** **Plant:**

Operational/ Process Step	Hazard/ Concern	CCP/Type	Critical Limit/Criteria	Monitoring/ Frequency	Records	Responsibility	Corrective Actions	Verification Procedures
Sanitation Programs	Microbiological pathogenic/ spoilage Chemical improper storage & use	CCP1/ Prevention	Clean, sanitized, properly stored equipment Prevention from overhead & environmental contamination Hygienic Personnel Practices Proper use & storage of chemicals 200 ppm chlorine or equivalent	Observe cleaning/sanitizing procedures/ daily Critically inspect all areas/weekly Critically inspect all areas/monthly Check chemical levels/every 3 hrs	Sanitation logs	Supervisors	Stop production & correct	Semi-annual inspection
Fruit Source & Quality	Microbiological pathogenic/ spoilage Chemical Agr. chemicals		Use only high quality fruit Appropriate fertilizers Proper use of Agr. chemical	Inspect & observe production & handling practices/daily	Inspection forms	Graders/ Supervisors	Reject poor quality fruit	Semi-annual inspection
Raw Fruit Handling & Storage	Microbiological pathogenic/ spoilage		Clean/sanitized storage boxes Refrigerate at 40°F or below	Observe & inspect operations/daily Check storage room temperature /hourly	Sanitation log sheet Temperature log sheet	Supervisor Supervisor	Replace uncleanable equipment Correct & maintain temp control	Semi-annual inspection
Fruit grading, Conveyance & Washing	Microbiological Pathogenic/ Spoilage Chemical Improper use	CCP2/ Prevention	Grading - Fruit rejection standards Conveyance - Minimum environmental contamination Washing/Rinsing - Proper procedures	Observe operations/hourly Critical inspection/ daily 200 ppm Chlorine or equivalent rinse/each use	Checksheets Inspection log sheets Log sheets	Supervisor	Re-grade or reject Re-wash	
Juice Extraction	Microbiological Pathogenic/ Spoilage		Clean/Sanitized equipment Prevent overhead contamination	Visual inspection &/ observation of equipment/daily	Sanitation log sheet	Supervisor	Stop production and clean properly	

Table 10. HACCP DESCRIPTION CHART

Product: ***FRESH- SQUEEZED ORANGE JUICE***				**Plant:**				
Operational/ Process Step	**Hazard/ Concern**	**CCP/Type**	**Critical Limit/Criteria**	**Monitoring/ Frequency**	**Records**	**Responsibility**	**Corrective Actions**	**Verification Procedures**
Juice cooling & filling	Microbiological Pathogenic Spoilage	CCP3/ Prevention	Cool to 40°F No overhead contam. of fillers Clean/Sanitized equipment	Temperature recording/hourly Visual Inspection/daily	Temperature Sanitation log sheet	Supervisor	Cool to 40°F	
Juice storage	Microbiological Pathogenic Spoilage		Maintain at 40°F or below	Temperature recording/hourly	Temperature log sheet	Supervisor	Cool to 40°F	

Avoid the use of dropped fruit. The risk of fruit contamination increases if manure is used as a fertilizer in groves--especially if the manure is insufficiently composted--or if uncontrolled vermin or wild animals (deer, etc.) inhabit the groves. Not only is there the risk of contaminated fruit's producing contaminated juice, but the long-term risk that such fruit will contaminate all subsequently handled product.

Fruit Quality. Develop specifications for quality parameters such as color, Brix/acid ratio, and flavor. Care should be exercised when using late season (May, June) fruit. Fruit harvested late in the season may have low acidity (above pH 4.0), creating a better environment for microbial growth or survival (including pathogens).

Raw Fruit Handling/Storage.

Refrigerated Storage. It is beneficial to cool and refrigerate raw fruit to protect against surface yeast and mold contamination as well as microbial growth. Ideal storage conditions are at 32° to 34°F (0° to 1°C) and 80% to 85% relative humidity (Carter 1989).

Higher product quality and lower microbial counts are achieved if the fruit is cool when extracted. This is especially important for operations which do not have a heat exchanger or other system to cool juice after extraction. *Remember: a) not to store fruit for extended periods prior to extraction, b)label and inventory fruit in storage, and c)use a first in-first out philosophy*.

Sanitation. Containers used to move raw fruit are often a contamination source. Unfortunately, the bulk-pack pallet boxes commonly used are not easily cleaned. Where sanitizers are used as a preventative for these fruit boxes, a common practice is to rinse chlorine solutions. Unfortunately, chlorine sanitizers are relatively ineffective on these fruit boxes and could be replaced with more effective foaming sanitizers or other agents. It may be beneficial to discuss the cleanability of these boxes with a reputable chemical supplier. Safely dispose of those boxes in poor repair and no longer cleanable.

Grading, Conveyance and Washing

Grading. The fruit should be thoroughly graded before washing and extraction. All fruit needs to be graded and washed even if it was previously done at the packing house. **Do not short-cut the grading operation: This is your final assurance that the fruit going to the extractor is of acceptable quality.** Remove all rots and other defective fruit such as fruits with cuts, splits, punctures, black heart, and other defects that may allow microbial contamination. Use sufficient labor for the grading operation with final inspection and verification by supervisors. Fruit which is not extracted within a reasonable time should be graded again.

Washing. Fruit shall be acid-washed using roller brushes or equivalent cleaning procedure to remove soil, debris, etc., and rinsed with sanitizer solution using--at a minimum--chlorinated water (200 ppm) or equivalent for a minimum contact time of two minutes. Follow chemical supplier recommendations.
Visual inspection of the washed fruit should be done routinely. Chlorine levels should be checked periodically. Rewash fruit as necessary. A final rinse with potable water is recommended. Fruit which is not extracted within a reasonable time period should be rewashed.

Sanitation. Thoroughly inspect washing, and grading facilities. Evaluate the potential for overhead contamination. Where feasible, install shields or other means to provide adequate protection from environmental contamination from birds, frogs, vermin, and other sources to all grading, washing, and conveyance equipment. While it is a common practice to conduct grading and washing activities out-of-doors, it is nearly impossible to avoid contamination of equipment under these conditions. After feasibility is studied, plans should be made to move all operations indoors into appropriately constructed and sealed facilities.

Review appropriate cleaning and sanitizing procedures with all appropriate employees. Inspect equipment (especially conveyor rollers, belts, brushes, sorting tables, etc.) for cracks, crevices, and evidence of wear. Such equipment can harbor microorganisms and contaminate the fruit in which it comes in contact. **Don't underestimate the importance of cleaning and sanitizing.** A common misconception with regard to chemical use is that if a little is good, more is better. Use of chemical agents at higher concentrations than needed is detrimental-- besides costing more in supplies, it may result in corrosion of equipment. Consult a reputable chemical supplier for assistance and develop a protocol which is effective at reasonable concentrations.

Final Inspection. A final visual inspection should be done prior to the extraction step. Transfer of washed

fruit to the extractor or sizer must be done in properly cleaned conveyors or containers. Fruit should be extracted promptly after washing and handling of fruit should be minimal. Fruit which has warmed up in the washing process, should be cooled down prior to extraction.

Juice Extraction

Extractors. There are several types of extractors in common use including hand- operated and mechanical extractors. Hand-operated extractors (if in use) should be closely examined for cleanability and routinely disassembled for cleaning and sanitizing. Mechanical extractors are in more common use for both small-scale operators--e.g., Food Machinery Corp. (FMC), Fresh-n-Squeeze, Automatic Machinery & Electronics, Inc. (AMC), and Juice True extraction--and for larger scale operations (FMC, AMC, and Electronics Corp.) Detailed cleaning and sanitizing instructions recommended by these manufacturers should be followed.

Sanitation. Extraction and container filling operations **must be conducted indoors in a separate room from** raw fruit handling facilities. Such a room should be constructed of impervious materials to facilitate cleaning and with adequate lighting and ventilation.

Extraction equipment and sizing equipment should be of impervious and cleanable construction, in good repair, and cleaned and sanitized at a regular frequency. As many of the working parts of this equipment are of intricate design and are fabricated from aluminum, careful routine inspection of condition and cleanliness is recommended on a regular frequency.

Carefully follow the recommended cleaning procedures from the equipment manufacturer or chemical supplier. Cleaned and sanitized parts should be stored in a sanitary manner on a drain table or similar device to allow for drying.

Juice Cooling

Cooling. **It is recommended that the extracted juice be cooled as rapidly as is practical to below 30°F.** Again, this cooling step is more efficient if the oranges have been chilled prior to the extraction process. If your procedure is to fill containers and place these containers in refrigerated storage boxes, it is imperative that oranges be chilled prior to extraction since most refrigerated storage boxes cannot efficiently cool juice at ambient temperature in an acceptable time period.

A more efficient alternative is to chill the juice bottles in an ice bath prior to placing in refrigerated boxes--avoid overloading the refrigerated storage boxes; allow sufficient air space between containers. Some processors cool the juice in agitated, cold wall storage tanks prior to filling operations. Still, the most efficient and recommended cooling practice is to circulate the juice through a tubular or plate-type heat exchanger supplied with a circulating refrigerant.

Note: if such equipment is used, it should be properly cleaned and sanitized prior to each use so as not to contaminate the juice.

Sanitation. Evaluate the cleanability of pumps, tanks, piping, and all juice contact surfaces including containers used to transport juice (e.g., pails, buckets, etc.). Replace worn, uncleanable plastic pails with stainless steel pails.

Be sure that cleaning and sanitizing procedures are adequate. Heat exchangers are designed to be cleaned by a clean-in-place (CIP) procedure. Simply circulating cleaning agents and rinse water through these units usually is not sufficient for adequate cleaning. In addition, many couplings, fittings, and other parts associated with these units must be disassembled for cleaning. Consult a reputable chemical supplier for assistance and assure that CIP equipment is of appropriate size and pressure, and that it is operating properly. Disassemble and inspect plate heat exchangers on a regular basis, and replace worn plates or gaskets. Pump heads, tank valves, piping, and other removable equipment should be disassembled for cleaning and sanitizing. Store all clean equipment under clean, dry, sanitary conditions.

It is a common practice to blend juices. Such practice should be done in a sanitary manner with appropriately cleaned and sanitized containers and equipment.

Juice Filling

Juice filling should be done in a sanitary manner. Juice containers and packages (usually plastic bottles) should be of approved materials for food use and stored in a clean, dry facility. Bulk packs usually are sealed in plastic. Do not remove the plastic until just prior to filling. Handle the bottles with care not to

contaminate them during filling. Avoid putting fingers into the neck or inside of the bottles during handling. Avoid overhead contamination during filling operations. Remove excess juice from outside of containers and avoid contamination during transfer to storage box. Mechanical fillers--if used--should be disassembled, cleaned and sanitized prior to each use. Inspect filler heads and parts for wear. Replace worn, uncleanable parts.

Juice Storage

Inspect the maintenance sanitary conditions of all refrigerated storage cases. Provide thermometers to all refrigerated storage boxes and routinely check the temperature. **Store juice as cold as possible (at 30°F or below).** Properly label juice bottles with name and address of processor. It is also recommended that the date of manufacture be placed on the label. Use logical stock rotation in refrigerated cases. Consumer instructions regarding home storage conditions are also recommended for label consideration.

Transportation

If packaged juice is transported to another facility (e.g., retail store), it should be done in clean, sanitary, refrigerated trucks.

HACCP Plan

Principle 1. Hazard Analysis

The primary hazard in fresh-squeezed juice are pathogenic microorganisms which have the ability to survive and/or grow under the acidity conditions of the juice. The most important pathogen in this regard is *Salmonella* because of the ability of some strains to grow under refrigeration condition and survive at low pH (see Table 4). The recent association of *E. Coli* 0157:H7 with apple juice also raises concern about this pathogen.

Again, the lack of terminal heat pasteurization underscores the importance of selecting CCPs where microbial contamination risk is possible and can be reduced or prevented.

Risks of chemical hazards-- including cleaners, sanitizers, and pesticides--can be effectively eliminated by following appropriate practices for chemical usage. Further, locate the storage of these nonfood chemicals away from juice or raw fruit storage. Control of these hazards is part of an effective sanitation program. The risk of physical hazard is minimal.

Prevention of physical hazards consists of:
- good housekeeping procedures,
- prevention of overhead contamination, and
- equipment maintenance inspection programs.

Principle 2. Critical Control Points (CCPs)

Suggestions for CCPs have been identified in the flow diagram (Figure 3).

It is important that the HACCP team follow through with the suggested procedure above to assure that these are appropriate to their operation and to, perhaps, identify additional CCPs. In this model plan, three CCPs have been suggested. It should be emphasized that in an individualized plan, other CCPs may be appropriate.

The CCP selections are:

CCP 1: Sanitation Programs

The primary purpose of sanitation programs is to prevent and reduce hazards. Sanitation operations, especially cleaning and sanitizing, are appropriate to identify as CCPs in a HACCP plan. The most important criteria for a sanitation CCP is that it can be sufficiently monitored and that control decisions can be made. The goal in identifying sanitation as a CCP is to document program effectiveness.

If identifying sanitation as a CCP, the HACCP team must ask the questions:
- What must be done to assure that it is effective and that it reduced any potential for contamination?
- What type of monitoring procedures?
- What monitoring frequency is going to be involved?

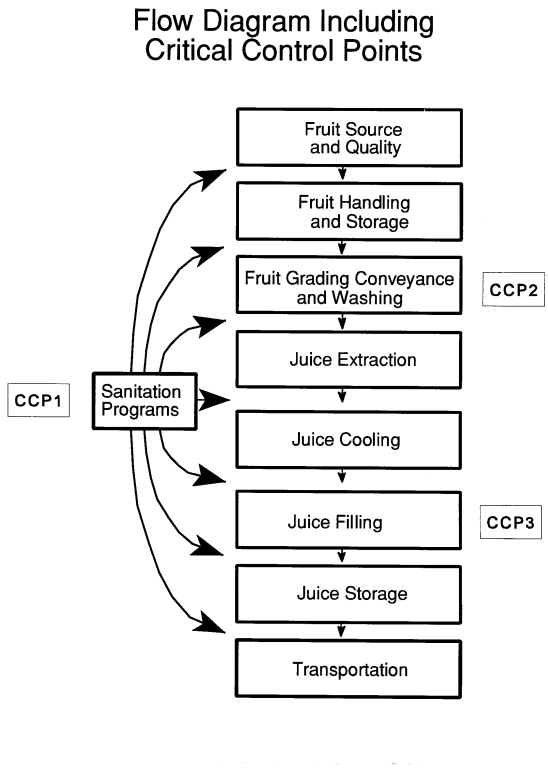

Figure 2. Flow diagram with CCPs.

CCP 2: Grading, Conveyance and Washing

Because of their interrelatedness, fruit grading, conveyance, and washing steps have been lumped into a single CCP in the generic plan (see Figure 2). Individual facilities may choose to separate these into two or more CCPs.

Poorly supervised, poorly monitored, inadequately controlled fruit grading and washing operations could be a major source of microbial contamination as bad fruit or inadequately washed contaminated fruit can seed the entire processing line with pathogenic microorganisms. Thus, effective control and monitoring procedures need to be developed.

CCP 3: Juice Filling

Properly processed and handled juice can be contaminated during sloppy filling operations. Since this may be a major source of contamination in some facilities, selection as a CCP is justified. Again, effective monitoring procedures must be developed.

Additional CCPs

Raw Fruit. Depending upon the nature of the operation and the degree of control over raw fruit production, source, and handling, these steps could easily be justified as a CCP. By definition, contaminated raw fruit can contaminate the facility and result in contaminated juice. If chosen as a CCP, it is important that effective tolerances be set, and monitoring procedures be established. If the facility has a high degree of confidence in their raw fruit production and sources, the HACCP team may opt to not include these procedures as a CCP.

Cooling and Storage. Bacteria and yeast can be directly controlled by effective cooling. Fortunately, growth of most pathogens can be controlled by simply avoiding prolonged exposure to the "danger temperature zone" from 40° to 140°F. Lower temperature recommendations (30°F or below) where practical have been suggested to control the spoilage organisms which will rapidly degrade juice quality. Temperature monitoring can be done with relative ease.

Principle 3. Critical Limits

CCP 1: Sanitation Programs

In setting up the HACCP plan, establish and list acceptance criteria for all phases of sanitation included in the program. This may be difficult for general sanitation aspects. However, detailed requirements can be established which must be met. Examples might include: requirements of appropriate and sanitary clothing by employees, restriction of employee traffic into certain critical areas, oversight and monitoring of pest control operations, etc. For cleaning and sanitizing of equipment, it may be appropriate to provide oversight on chemical usage; to test and record sanitizer strength; **and to assure, through inspection, that equipment is effectively cleaned and sanitized after each use, and that it is stored properly.**

CCP 2: Fruit Grading, Conveyance and Washing

Establishing critical limits for these operations is highly individualized. It is essential that the HACCP team identify a specified decision point in which regrading and rewashing is deemed necessary and that all employees are aware of these specified tolerances.

CCP 3: Juice Filling

The HACCP team should discuss and evaluate the type of potential contamination violations which can occur in their specific filling operations. In setting critical limits, the team should decide as to the severity of violation which would necessitate stopping the operation for corrective action.

Principles 4, 5 and 6. Monitoring, Corrective Action, and Record Keeping

CCP 1: Sanitation Programs

The most important exercise is the identification of responsible individuals and empowering them to be able to stop the operation to allow for correction of sanitation violations deemed important. **The primary monitoring procedure for sanitation is visual inspection and observation.** In addition to identifying responsible employees, care should be taken to establish an inspection frequency and to develop a workable inspection form.

A sample inspection form for use with a HACCP program is shown as Table 7. The HACCP team should individualize the form as much as appropriate. The inspection frequency on cleaning and sanitizing equipment should be after each use. The designated individual should check that equipment is clean and properly stored by making an appropriate notation on the form. It is also suggested that forms be cross-checked and initialed by supervisors regularly.

CCP 2: Grading, Conveyance and Washing

It is vital to identify responsible individuals to supervise the operations and to empower these individuals to stop the process lines if inspection reveals the need to rewash and regrade fruit. These individuals should be provided with appropriately designed forms which are checked on a regular frequency to document that these operations are effective. An example of a simple check form is presented in Table 9. Corrective action would be simply stopping the line and rewashing and/or regrading when necessary.

CCP 3: Juice Filling

Designated employees should be provided with check forms (see Table 8) to record product temperatures at an established frequency. As with other forms, these notations need to be cross-checked by a supervisor. If appropriate temperature reduction is not achieved within the specified time period, the corrective action is to discard the juice.

With filling operations, a designated individual should oversee and inspect the filling operations with a critical eye and record observations on an appropriate form. Serious sanitation violations should result in the corrective action of shutting down the operation and discarding the potentially contaminated juice.

Principle 7: Verification/validation

A regular frequency for re-examination of the effectiveness of the plan should be established. Involve management in the verification process. Allow all team members to provide opinions as to what is working, what is not. Be challenging in the verification approach. Appropriate questions to ask include:

Should forms be modified?

Are inspection frequencies established adequate?

Summary and Conclusions

Improperly handled, fruit juices can harbor pathogenic microorganisms and have been associated with food-borne illness outbreaks. Since heat pasteurization is not used in the manufacture of fresh-squeezed fruit juices, it is imperative that strict attention be paid to sanitation principles in all processing operations.

A well-designed and implemented HACCP plan will provide additional protection that these products are safe from potential microbiological, chemical, and physical hazards.

In planning for HACCP, a special commitment to employee training, to assigning a responsible employee team, and to developing a thorough understanding of all food products and operations is imperative.

Implementing a HACCP plan includes a detailed analysis and risk assessment of potential hazards, identification of areas in processing which are at most risk of contamination, establishing monitoring and inspection requirements and procedures to evaluate compliance, establishing measurable parameters which maintain process control, identifying process control limits, establishing corrective actions to be taken, establishing and implementing a thorough record-keeping system, and providing for update verification or validation that the plan is working.

Glossary

Cleaning - complete removal of soil on surfaces of food equipment through the use of acceptable detergents at proper concentrations dissolved in water of acceptable microbiological and chemical quality.

Corrective Action - a prescribed procedure to follow when a deviation or lack of control occurs at a critical control point indicating a food safety risk.

Critical Limit (CL) - a safe tolerance that must be met at a critical control point to assure that a food hazard is prevented, reduced, or eliminated.

Critical Control Point (CCP) - any operation, practice, procedure, process, location, or step in a food-handling operation where there is a risk that a lack of control will result in a risk of a food hazard, and at which a control procedure can be applied to eliminate, reduce, or prevent the hazard.

Food Hazard - any contamination by a microbiological, chemical, or physical agent at a level sufficient to cause a food product to be considered unsafe for human consumption.

Food- borne pathogen - a microorganism associated with food products which is capable of producing illness or disease in humans.

Hazard Analysis Critical Control Point (HACCP) - a highly structured, systematic plan emphasizing evaluation, prevention, and control of potential hazards through concentrating on critical areas in a food-handling facility.

Monitoring - a scheduled observation or measurement of operational parameters at a CCP to assess if an operation is in control and to produce an accurate record or documentation.

Record-keeping system - a thorough and conscientiously applied record implementation and filing system to document operational control in an **HACCP** system.

Risk - an estimate of the severity or occurrence of a food hazard.

Sanitizing - use of an accepted procedure through steam, hot water, or chemical solutions at appropriate concentrations and contact times to reduce microbial contaminants on inanimate surfaces to a safe level from a public health standpoint (99.999% reduction).

Verification/validation - a scheduled procedure to assure that the HACCP plan is effective.

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