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DEVELOPMENT AND DOCUMENTATION OF HAZARD IDENTIFICATION AND CONTROL PROCEDURES FOR RETAIL FOOD OPERATIONS

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Introduction

In order for the retail food industry to prosper and provide customer satisfaction, it is essential that there be a steady stream of new and improved processes for use by both commercial and home / non-commercial food preparers. It is not the responsibility of the FDA or the USDA to provide this technology for new processes and/or hazard and control technology. That is the responsibility of the food industry and food technology consultants from both the private sector and universities. To provide for the development of new technology, there must be funding for this type of research and development. Individual restaurants and small companies cannot support these types of studies on their own, but can participate and gain useful information from the development of new technologies by forming associations.

New technologies must be documented. The following is an example of a method for process documentation based on HACCP, so that new and improved food processes / preparation methods will be documented in a consistent manner.

Describing the retail food system

A retail food system can be graphically described, as shown in Figure 1. This is the first step. The following questions must also be answered in detail. Who are the customers? What is the input? What is the floor plan? What is the menu / products produced? What forms of service and catering are offered?

Flow diagram development

The retail food system is actually a group of processes that produce products (output) from a group of ingredients. Size of the system / volume is of secondary importance compared to the specification of how each process step is performed. A generic list of the processes and performance standards is shown in Figure 2.

At the beginning of any process development, the research chefs and food technologists must first develop a detailed flow chart that describes the process in detail so that output product specification will be met consistently.

There are two kinds of processes—those associated with prerequisite programs and those associated with food product production. The National Advisory Committee on Microbiological Criteria for Foods (NACMCF) offers a very simple flow diagram and two multi-column documents for documenting a food product HACCP (Figures 3 and 4). However, the columns on these forms are too narrow for easy documentation, and they duplicate each other.

Prerequisite programs (Figure 5) can be documented as pictographic HACCP flow diagrams. Examples of this type are shown for cleaning hands (Figure 6) and cleaning food contact surfaces (Figure 7). Each step is shown as a figure, and the analysis for each step is described beside each picture, on the right side of the page. These pictographic diagrams can be used to train personnel how to wash their hands correctly and adequately, and how to properly clean and sanitize food contact surfaces.

Retail HACCP food preparation / processes can be documented as shown in Figures 8 through 12 (preparation of chicken cacciatore). Figures 8 and 9 show the flow diagram in the strict NACMCF format. Figure 8 is the NACMCF-HACCP worksheet where hazards and controls are specified. The flow chart is shown on the left side of the worksheet. Figure 9, then, is the HACCP plan for the chicken cacciatore according to the NACMCF form. Figure 10 is a HITM (Hospitality Institute of Technology and Management) modification that combines the NACMCF worksheet and plan. Figure 11 is a simplified recipe flow chart that would evolve after a HACCP team / chef has made some flow charts such as those shown in Figures 8 and 9. A nutrition label may also be added to the recipe or production formulation. Figure 12 is the most important document of this group, because it shows a fully integrated recipe with hazard control information. When personnel become familiar with HACCP and the controls, this document can be used to provide sufficient control documentation that can be easily used by cooks / chefs to verify that hazards are controlled. The HACCP format shown in Figure 10 can also be used to document a validation of the safety of a procedure.

Validation

Figure 13 is a HACCP validation for Peking duck. Note that the research study information is shown in the right column. Similar flow documentation for Peking duck is shown in Figure 13. Figures 14 and 15 show a sushi flow and recipe HACCP.

Risk analysis

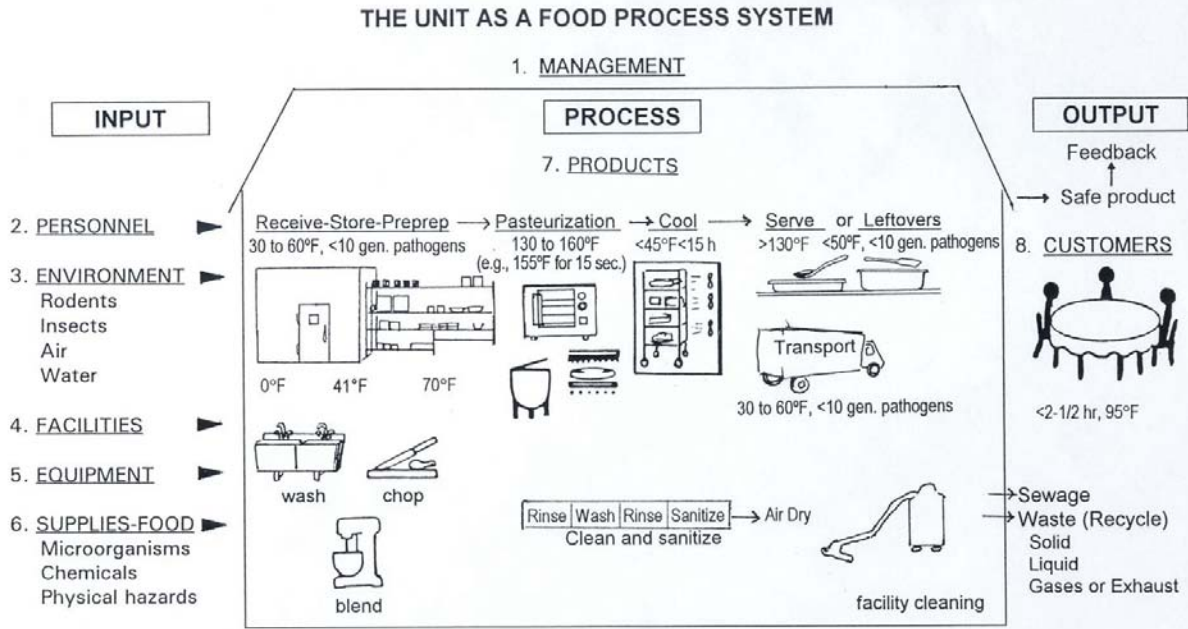
To do the risk analysis, the HACCP team should use forms shown in Figures 16 and 17. These forms can be used to assess risks and designate methods to minimize them.

Publishing a HACCP'd process

A HACCP process is not complete until it is peer reviewed and published. Figure 18 is an outline for the contents for such a paper. The paper should include HACCP worksheets, plans, and validation studies in a way that formally establishes a food preparation / production procedure as a useful method for producing safe food.

(Figures follow, beginning next page.)

FIGURE 1.



HAZARDS: Microorganisms [bacteria (vegetative cells and spores), viruses, parasites]; chemicals; hard foreign objects.

CONTROLS: Management involvement; hazard analysis and control; written procedures; employee training and empowerment; process measurement, control, and improvement; discipline and consequences.

FIGURE 2. RETAIL FOOD PROCESS CONTROLS THAT ASSURE HAZARDS ARE AT A TOLERABLE LEVEL

To validate refrigerated processes, use non-pathogenic *Listeria innocua* and control for <10 generations. To validate pasteurization and washing surfaces, use non-pathogenic *E. coli* ATCC 25922.

INPUT

- (HC)* Employee fingertip washing and drying for a 10⁻⁶ reduction, or <1 highly infective *E. coli* per ml finger rinse water.
- (HC) Water, supplier HACCP; the hazards are at safe levels.
- (QC)* Insects, rodents, and birds excluded through construction.

PROCESS

Receiving

- (HC) Food to be eaten as received; must have supplier HACCP safety certification*.
- (QC) Just-in-time delivery acceptance <10°F or <45°F.
- (HC) Avoid biological, chemical, and physical contamination at receiving.
- (HC) Damaged packages, cans, and infested packages stored separately for return to supplier.

Storage

- (QC) Label food containers with receiving date.
- (QC) Short-term frozen storage <10°F; long-term 0 to -20°F.
- (HC) Aerobic, refrigerated, raw food spoils safe or is made safe by washing or pasteurization.
- (HC) Refrigerated, ready-to-eat food is used before there is time and temperature for 10 generations of *Listeria innocua* to multiply.

Pre-preparation

- (QC) Use oldest ingredients first.
- (HC) Thawing can be conducted at room temperature in an airflow of <50 feet / minute. It is critical to melt all ice in the center of the food before cooking or cook from the frozen.
- (HC) >10³ spoilage bacteria / gram initial counts inhibits *Staphylococcus aureus*, *Clostridium botulinum*, toxin production
- (HC) Food contact surfaces for ready-to-eat food cleaned for 10⁻⁵ reduction.
- (QC) Cut - chop 24 hours before use to moderate multiplication.
- (QC) Keep food temperature <40°F, except during preparation, <55°F. Chill raw food <4 inches deep.
- (HC) Double wash fruits and vegetables in cold water, 10⁻² reduction or use thermal pasteurization of surface, 10⁻⁵ reduction.
- (HC) Keep raw, unprocessed and ready-to-eat foods separate.

Preparation

- (HC) Ferment with controlled starter culture or validated HACCP procedures.
- (HC) Use additives according to CFR.

HC = Hazard Control
QC = Quality Control

Acid control:

- (HC) Control salmonellae in unpasteurized food with pH <4.1.
- (HC) Control *Clostridium botulinum* in pasteurized food with pH <4.6.
- (HC) Salt control *Staphylococcus aureus* toxin production, 12% in water phase or temperature control <50°F or >115°F.
- (HC) Heat 50 to >130°F, <6 hours to control *Clostridium perfringens*; <15 hours to control *S. aureus* toxin.
- (HC) Pasteurize raw, wet meat, fish, and poultry: 7D salmonellae, z = 10°F; D₁₄₀ = 1.73 minutes to achieve <1 *Salmonella* per 100 grams.
- (HC) Sterilize: 12D *C. botulinum*, z = 18°F; D₂₁₀ = 400 minutes.
- (HC) Hold surface and center >130°F with controlled Rh >90%
- (HC) Cool center 130 to 45°F with 38°F driving force, <15 hours.
- (HC) Mix cold salads with <50°F ingredients.
- (HC) Do not add any ingredients that are not on the label / recipe.

OUTPUT

Package -- transport -- serve

- (HC) Temperature >130°F, or pasteurized food <38°F, or at any time-temperature that limits vegetative forms of spore pathogens to multiply to <10 generations between production and consumption.
- (QC) To retain nutrients, hot hold 150°F, <30 minutes.
- (HC) Hot food serves <170°F to avoid burns to the mouth and skin.
- (HC) Avoid contamination of cold, ready-to-eat food with hazards.
- (HC) Package for the consumer <2 inches thick. Label, "Consume in 2 hours, or begin cooling in less than 2 hours. Do not cool food in a container in a bag. Remove the bag. Cool center to 45°F in less than 15 hours."
- (HC) Label allergic ingredients. Answer consumer allergy questions about food ingredients.

Leftovers

- (HC) Do not add fresh food to old food (allergen control);
- (QC) spoilage control.
- (QC) Note: Reheating is not used as a hazard control, because it will not control toxins, poisons, and physical hazards.

* Hazard certification: that hazards are at a tolerable level.

Without hazard certification, assume:

- Salmonella* spp.: <10 / gram
- Listeria monocytogenes*: <10 / gram
- Staphylococcus aureus*: <100 / gram
- Clostridium perfringens*: <100 / gram
- Bacillus cereus*: <100 / gram
- Clostridium botulinum*: <1 / gram
- Chemical: safe level
- Physical: <1/16 inch

FIGURE 3. HAZARD ANALYSIS WORKSHEET

(1) Ingredient/processing step	(2) Identify potential hazards introduced, controlled or enhanced at this step?	(3) Are any potential food-safety hazards significant? (Yes / No)	(4) Justify your decision for Column 3.	(5) What control measures can be applied to prevent the significant hazard?	(6) Is this step a critical control point? (Yes / No)

FIGURE 4. HACCP PLAN _____

(1) Critical Control Point (CCP)	(2) Significant Hazards	(3) Critical Limits for each Control Measure	(4) (5) (6) (7) Monitoring				(8) Corrective Action(s)	(9) Verification	(10) Records
			What	How	Frequency	Who			

FIGURE 5. RETAIL FOOD HACCP-TQM NACMCF PREREQUISITE PROGRAMS / GMPs PLUS HACCP

I. Management (Prereq.)

- Strong commitment
- Risk management
- Complaint investigation
- Traceability and recall

II. Organization and Personnel (Prereq.)

- HACCP Team
- Personnel, responsibilities, accountability and authority
- Policies, procedures, and standards
 - Personal hygiene
 - Personal safety
 - *Monitoring, records, verification*

III. Operation Description (Prereq.)

- Describe the food (menu, ingredients, and processing) and distribution.
- Describe the intended use and consumers of the food.
- Develop a flow diagram of the processes that are directly under the control of the establishment. Provide a schematic of the facility with food flow.
- Verify the flow diagram.
- Environment / facility
 - Adjacent properties
 - Building exterior
 - Traffic flow patterns to minimize cross-contamination from raw food to cooked food.
 - Ventilation
 - Waste disposal
 - Sanitary facilities / hand washing
 - Water, ice, culinary steam
 - Lighting

IV. Reserved for future use

V. Supplies (Prereq.)

- Policies, procedures, and standards
 - Assure that suppliers have GMPs and food safety programs / guarantees or supplier HACCP system verification
 - Ingredient specifications
 - Testing of ingredients
 - Receipt and storage temperatures
 - Chemical control, segregation of cleaning supplies, fumigants, and pesticides or baits
 - *Monitoring, records, verification*

VI. Production, Products, and Service (HACCP)

- Policies, procedures, and standards
 - Product zone control
 - Foreign material control, metal, glass
 - Allergen control
 - Packaging specifications
 - Product specifications
 - Product temperature control, labeling, shelf life
 - Product group HACCPs
 - Shelf-stable, safe, a_w , pH, additives, E_h
 - Shelf-stable, safe until open; low-acid packaged food
 - Shelf-stable, dry; unsafe when wet
 - Refrigerated / frozen, safe; supplier controlled until cooked/prepared
 - Refrigerated / frozen, unsafe; cook makes safe
 - Individual item flow chart / recipe HACCP
 - *Monitoring, records, verification*

VII. Cleaning and Sanitation (Prereq.)

- Policies, procedures, and standards
 - Sanitary design of facilities and equipment
 - Master sanitation schedule
 - Facility outside
 - Facility inside
 - Equipment
 - Chemicals and material safety data sheets
 - *Monitoring, records, verification*

VIII. Maintenance (Prereq.)

- Policies, procedures, and standards
 - Preventive maintenance
 - Master maintenance schedule
 - Facility outside procedures
 - Facility inside procedures
 - Calibration procedures
 - *Monitoring, records, verification*

IX. Pest Control (Prereq.)

- Policies, procedures, and standards
 - Pest control practices
 - Master pest control schedule
 - *Monitoring, records, verification*

X. Training (Prereq.)

- Policies, procedures, and standards
 - New employee
 - Continuing education
 - Personal hygiene, personal safety
 - GMPs
 - Cleaning, maintenance
 - HACCP and food handling

XI. QA/QC (Prereq.)

- Policies, procedures, and standards
 - Pathogens vs. spoilers
 - Management verification
 - Laboratory testing
 - Supplier ingredients
 - Our environment
 - Our products
 - Shelf-life testing
 - Process and equipment validation testing

XII. HACCP Verification Audit (Prereq.)

- Verification of capability to produce and serve safe food

References

- National Advisory Committee on Microbial Criteria for Food. 1998. Hazard analysis and critical control point principles and application guidelines. *J. Food Protect.* 61(9):1246-1259.
- National Advisory Committee on Microbial Criteria for Food. 1998. Principles of risk assessment for illness caused by foodborne biological agents. *J. Food Protect.* 61(8):1071-1074.
- Sperber, W.H., Stevenson, K. E., Bernard, D. T., Deible, K. E., Moberg, L.J., Hontz, L.R., and Scott, V.N. 1998. The role of prerequisite programs in managing a HACCP system. *Dairy Food Environ. Sanitation.* 18(7):418-423.

FIGURE 6. DOUBLE HAND WASHING WITH A FINGERNAIL BRUSH HACCP

Dept.: _____ Person responsible: _____ Effective date: _____

Process: To wash fingertips and hands to reduce by 10^{-5} pathogens from feces and vomit on fingertips and underneath fingernails and reduce 10^{-2} pathogens from food when preparing food in the kitchen.

The Hazard: When an employee arrives from home, or after using the toilet, the employee must be assumed to have $\leq 10^6$ pathogens on his or her fingertips and underneath fingernails. This concentration must be reduced to ≤ 10 to assure that the transfer of pathogens to the food that the employee handles is at a safe level. When working in the kitchen, an employee might touch contaminated food such as raw poultry and then, must reduce pathogens by 10^{-2} to reduce the pathogens to a safe level.

Standards and Operating Procedure

Get ready. Check to see that there is an adequate supply of unscented, non-antibacterial hand detergent, an Anchor Surgeon's Scrub nail brush, and disposable paper towels at the hand sink.



Wet hands. Turn on the water. Let it flow rapidly at 2 gallons per minute until warm (110 to 120°F). It is the water that removes the pathogens.

Apply detergent to the fingernail brush. Place enough detergent (1/2 teaspoon or 3 to 5 ml) to build a good lather on the fingers.



Brush and lather, particularly fingertips and fingernails. Hold the brush with the bristles up, and touch the tips of the fingers of the hand that held the toilet paper to the tips of the bristles. Gently brush the tips of the fingers, without bending the bristles, while water runs over the fingers and washes the pathogens down the drain. Continue until the brush and the fingers have no lather (about 12 to 15 seconds). This will give about a 1,000-to-1 reduction.

If this is the first fingertip wash when coming from home, put more detergent on the nail brush and brush the fingertips on the other hand, because all fingertips could be contaminated (for example, cleaning up after animals at home).

Lay the nail brush down with bristles up. This allows the water to run off so that the brush dries, and bacteria cannot multiply.



Second wash for additional toilet/food pathogen reduction or first wash for reduction of food pathogens to a safe level. Add 1/2 teaspoon or 3 to 5 ml of hand detergent to the palm of one hand. This wash without the nail brush reduces pathogens another 100 to 1. If it follows use of the nail brush, it gives a total of >100,000-to-1 reduction of pathogens on fingertips. When working with food, there are only moderately low levels of pathogens on fingertips, and this 100-to-1 reduction is sufficient to make the fingers safe from food pathogens.



Lather and wash hands (and arms if you will be mixing salad or dough). Massage the hands together and between the fingers. Wash the arms up to the tips of the shirt sleeves, if appropriate. Thoroughly rinse all of the lather from the fingertips, hands, and arms in flowing warm water. When the detergent and lather are gone from the skin, the pathogens are reduced to a safe level.



Dry hands using paper towel(s). Use clean, disposable paper towel(s) to thoroughly dry hands and arms. This reduces the microorganisms an estimated, additional 100 to 1.

FIGURE 7.

CUTTING BOARDS AND OTHER FOOD CONTACT EQUIPMENT AND UTENSILS (Immersion Cleaning and Sanitizing Process in a 3-Compartment Sink)

Hazard Control Policies, Procedures, and Standards

Dept.: _____ Person responsible: _____ Effective date: _____

Process and Output Specifications: To wash and sanitize cutting boards and other food contact equipment and utensils in a 3-compartment sink to prevent cross-contamination of foods and maintain a safe level of microorganisms of ≤ 100 microorganisms per 8 square inches (50 square centimeters) on the surface.

The Hazard: To prevent cross-contamination, cutting boards, large bowls, pans, kettles and knives must be washed and sanitized between preparation of different food items, particularly between raw and cooked foods, and any time after these items have been used or emptied.

Standards and Operating Procedure



Get ready: Check to be sure that supplies are adequate: scrub brush or pad, detergent, sanitizer, hot water. Clean and rinse all compartments of the 3-compartment sink with hot water and detergent solution before start-up each morning and at any other time during the day, if the compartments are dirty. The wash water and rinse water are critical control points. The wash water should be changed often enough to keep microbial counts $< 1,000$ APC/ml. If the sink will not be used for an hour or more, drain the wash and rinse compartments and leave them empty until time for use.

Fill sinks.

Fill wash compartment with detergent solution. Use ____ oz. of _____ (detergent) per gallon of water at 110°F to 120°F. Fill the second compartment of the sink with water at a temperature of 110°F to 120°F. Fill the third compartment with sanitizer solution containing ____ oz. of _____ (sanitizer) in ____ gallons of water (75°F to 100°F).



1. Remove gross soil.

Scrape, rinse and remove gross soil from the surface of items to be washed with hot (110°F to 120°F) water before putting any utensil, cutting board, pot or pan into the wash sink. This critical step controls the rate at which food soil (debris and grease) gets into the wash water. Food soil in the wash water decreases the effectiveness of the detergent and hampers the adequate removal of surface contaminants (microorganisms, chemicals and hard foreign objects).



2. Wash and scrub surface.

In the first compartment of the sink, wash and scrub surface(s) with the scrub brush / pad. Loosen and remove all soil. Use the brush / pad to get into the cracks of cutting boards. Regularly check the wash water. When it will no longer produce suds and is dirty, it must be changed. (Do not put knives or objects with sharp edges in the bottom of the sink. These items should be washed immediately after use.) If a metal scrub pad must be used, check carefully for metal pieces that break off and stick to the item, which could get transferred to the customers' food and cause injury.

FIGURE 7 (cont'd).



3. Rinse.

Rinse equipment, cutting boards, utensils, etc. by immersion in hot rinse water. Change the rinse water as it cools or shows the presence of detergent suds. If the detergent and dirty water from the first sink are not rinsed off thoroughly, the sanitizer will be neutralized by the soap and soil.



4. Sanitize surface.

When the surface is clean, immerse the item for 1 minute in the third compartment of the sink containing the sanitizer solution. If there is no third compartment, items can be sanitized by flooding the surface with sanitizer solution (75°F) from a squirt bottle and wiping the sanitizer solution across the surface with a clean disposable paper towel. After use, throw away the paper towel.

As an alternative to using chemical sanitizers, items can also be sanitized in the third sink by immersion in hot water at 170°F to 180°F for 30 seconds.



5. Air dry.

Allow surfaces to air dry thoroughly. This is another critical control. Since there is still a small but safe amount of soil and microorganisms on the surface, microorganisms will multiply perhaps 100 to 1,000 times in 6 to 8 hours on a wet surface. Microorganisms do not multiply on dry surfaces.

6. Clean sink.

At the end of daily operations, drain the sinks. Clean sink compartments with brush and hot detergent solution. Rinse sinks with hot water. Allow sinks to air dry, and keep dry until used again. Dispose of water. Clean the area. Get more chemicals and other cleaning aids. Do not refill containers. Replace with new containers, because microorganisms can grow in many chemicals, or oil chemicals will react with and reduce the effectiveness of fresh chemicals, if mixed with new.

FIGURE 8. HAZARD ANALYSIS WORKSHEET—CHICKEN CACCIATORE

(1) Ingredient/processing step Ti = temperature of the food into the step To = temperature of the food out of the step t = time to do the step	(2) Identify potential hazards introduced, controlled or enhanced at this step? *	(3) Are potential hazards significant? (Yes / No)	(4) Justify the decision for Column 3.	(5) What control measures can be applied to prevent the significant hazard?	(6) Is this step a critical control point? (Yes / No)
1. O Prepare sauce. Get chopped onions, mushrooms, green peppers, minced garlic. Sauté in oil. Add crushed tomatoes, juice, wine and seasoning. Bring to simmering temperature. Ti 40°F To 205°F t 20 min.	B veg. cells, spores C none P none	No	Not likely to occur. All ingredients are from approved sources. Time and temperature kill the vegetative cells.		
↓ 1a. D Hold in bain marie. ↓ Ti 205°F To 165°F t 20 min.	B spores C none P none	No	Spore outgrowth not possible.		
2. O CCP Get chicken quarters from refrigerator. Remove rib bones. Place quarters, one layer deep in shallow roasting pan. Bake (brown) in convection oven at 350°F. Ti 40°F To >160°F t 30 min.	B veg. cells, spores C none P none	Yes	Chicken is contaminated.	Temperature inactivates vegetative cells. Spores survive.	Yes
3. O Remove pan(s) of chicken from oven. Ti >150°F To 145°F t 15 min.	B spore outgrowth C none P none e	No	Time too short. Temperature >130°F		
↓ 3a. D Pour off liquid. Chill. Refrigerate liquid. (Save for chicken stock.) ↓ Ti 150°F To 40°F t <4 hours.	B spore outgrowth C none P none	No	Time and temperature too short		
4. O Cover chicken quarters with sauce. Ti 145°F To 145°F t <10 min.	B spore outgrowth C none P none	No	Temperature >130°F		
5. O Bake at 300°F in convection oven until chicken reaches a temperature of 175°F. Ti 145°F To >175°F t 45 min.	B spore outgrowth C none P none	No	Temperature >130°F.		
6. I Check. Is the temperature >175°F? If not, continue to cook. Yes No ↓	B spore outgrowth C none P none	No	Not likely to occur. Temperature inactivates vegetative cells		
7. T Cover and transfer to 150°F holding unit. Ti 175°F To 170°F t 5 min.	B spore outgrowth C none P none	No	Not likely to occur. Temperature >130°F.		
8. D Hold. Serve 1/4 chicken and 3 oz. sauce. Use within 2 hours. Ti 170°F To 150°F t 120 min.	B spore outgrowth C none P none	No	Not likely to occur. Temperature >130°F.		
9. S CCP Cool to <45°F within 15 hours. Ti 150°F To 45°F t <15 hours	B spore outgrowth C none P none	Yes	If food cools too slowly, <i>C. perfringens</i> can multiply.	Time and temperature during cooling control <i>C. perfringens</i> multiplication to < 1 log increase	Yes

* B=Biological hazard; C=Chemical hazard; P=Physical hazard

FIGURE 9. HACCP PLAN FOR CHICKEN CACCIATORE

(1) Critical Control Point (CCP)	(2) Significant Hazards	(3) Critical Limits for each Control Measure	(4) (5) (6) (7) Monitoring				(8) Corrective Action(s)	(9) Verification	(10) Records
			What	How	Frequency	Who			
2. Baking chicken	Bacterial cells and spores.	160°F, >7.2 seconds for a 7D <i>Salmonella</i> kill.	Internal temperature of chicken pieces.	Measure temperature.	At end of baking period.	Cook.	Heat until chicken reaches 160°F.	Owner.	Recipe worksheet.
9. Cooling	Outgrowth of <i>C. perfringens</i> spores.	<1 log increase in <i>C. perfringens</i> .	Internal temperature of chicken pieces.	Measure temperature.	Near end of the allotted cooling period.	Cook.	Use recommended methods of cooling: shallow pan, low refrigerator temperature, blast cooler or fans in cooling unit.	Owner.	Refrigerator log sheet.

FIGURE 10. CHICKEN CACCIATORE QA RECIPE FLOW

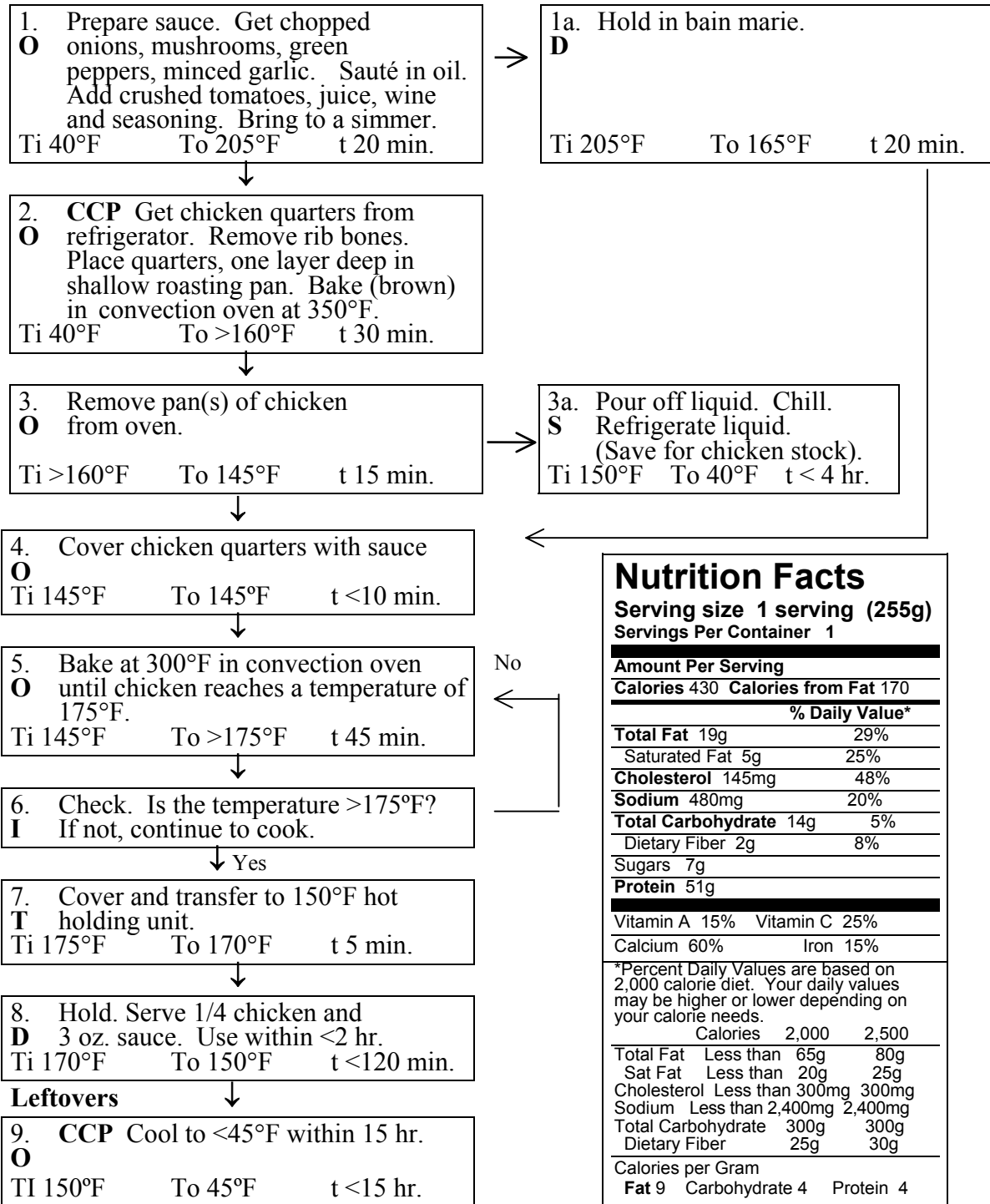
Product Specification: A fully cooked product of chicken and sauce.

Assumptions: Prerequisite programs are in place, effective and control ingredients, supplies, environment, personal hygiene, and equipment.

Process Step, Procedure, and Control	Hazard and Control Analysis: a. hazard identification, expected level / size, tolerable limit; b. control effectiveness; c. monitoring procedure / frequency and person, data recording; d. verification-who, when, how
<p>1. O Prepare sauce. Get chopped onions, mushrooms, green peppers, minced garlic. Sauté in oil. Add crushed tomatoes, juice, wine and seasoning. Bring to a simmer. Ti 40°F To 205°F t 20 m.</p>	<p>Ingredients are obtained from approved sources. There is no problem of chemical or particle contamination. Sautéing vegetables and heating after remaining ingredients are added is sufficient to kill vegetative cells of microorganisms. Spores survive.</p>
<p>1a. D Hold in bain marie. Ti 205°F To 165°F t 20 m.</p>	<p>Holding sauce at 165°F prevents spore outgrowth</p>
<p>2. CCP O Get chicken quarters from refrigerator. Remove rib bones. Place quarters, one layer deep, in shallow roasting pan. Bake (brown) in convection oven at 350°F. Ti 40°F To >160°F t 30 m.</p>	<p>Raw chicken pieces are contaminated. Baking chicken to an internal temperature of 160°F, >7.2 seconds provides a >7D reduction of <i>Salmonella</i>. Spores survive</p>
<p>3. O Remove pan(s) of chicken from oven. Ti >150°F To 145°F t 15 m.</p>	<p>Temperature is above 130°F. There is no spore outgrowth.</p>
<p>3a. S Pour off liquid. Chill. Refrigerate liquid. (Save for chicken stock.) Ti 150°F To 40°F t < 4 h.</p>	<p>Cooling time is short. Spore outgrowth is minimized.</p>
<p>4. O Cover chicken quarters with sauce. Ti 145°F To 145°F t <10 m.</p>	<p>Temperature is above 130°F. There is no spore outgrowth.</p>
<p>5. O Bake at 300°F in convection oven until chicken reaches a temperature of 175°F. Ti 145°F To >175°F t 45 m.</p>	<p>Temperature inactivates any remaining vegetative cells. There is no spore outgrowth.</p>
<p>6. I Check. Is the temperature >175°F? If not, continue to cook. No</p>	<p>Temperature is above 130°F. There is no spore outgrowth.</p>
<p>7. T Cover and transfer to 150°F hot holding unit. Ti 175°F To 170°F t 5 m.</p>	<p>Temperature is above 130°F. There is no spore outgrowth.</p>
<p>8. D Hold. Serve 1/4 chicken and 3 oz. sauce. Use within 2 hours. Ti 170°F To 150°F t <120 m.</p>	<p>Temperature is above 130°F. There is no spore outgrowth.</p>
<p>9. CCP O Cool to <45°F within 15 hours. Ti 150°F To 45°F t <15 hr.</p>	<p>Time and temperature during cooling chicken and sauce control <i>C. perfringens</i> multiplication to <1 log increase.</p>

FIGURE 11. CHICKEN CACCIATORE QA RECIPE FLOW

Preparation



Nutrition Facts	
Serving size 1 serving (255g)	
Servings Per Container 1	
Amount Per Serving	
Calories 430	Calories from Fat 170
% Daily Value*	
Total Fat 19g	29%
Saturated Fat 5g	25%
Cholesterol 145mg	48%
Sodium 480mg	20%
Total Carbohydrate 14g	5%
Dietary Fiber 2g	8%
Sugars 7g	
Protein 51g	
Vitamin A 15%	Vitamin C 25%
Calcium 60%	Iron 15%
*Percent Daily Values are based on 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.	
	Calories 2,000 2,500
Total Fat	Less than 65g 80g
Sat Fat	Less than 20g 25g
Cholesterol	Less than 300mg 300mg
Sodium	Less than 2,400mg 2,400mg
Total Carbohydrate	300g 300g
Dietary Fiber	25g 30g
Calories per Gram	
Fat 9	Carbohydrate 4 Protein 4

Ingredients: Chicken, tomatoes, onion, mushrooms, green peppers, Marsala wine, garlic, vegetable oil, salt, oregano, pepper

FIGURE 12. QUALITY-ASSURED HACCP RECIPE PROCEDURES

Recipe Name: Chicken Cacciatore	Portion size (vol./wt.): 1/4 (6 oz.) chicken + 3 oz. sauce	Preparation time: 2 hours
Production style: Combination	Number of portions: 100	Prepared by: S. P.
Written by: O. P. S. Date: 10/95	Final yield (AS): 100	Supervisor:
SA/QA by: J. Bell Date: 12/95	Final yield:	

Gp. #	Ingr. #	Ingredients and Specifications	EP Weight %	Edible Portion (EP) (weight or volume)		As served (weight)	Nutrition Ref. #
I	1	Onions, chopped (1/2" x 1")	13.26	3.0 lb	1,360.00 g		633
	2	Mushrooms, cut (1/2", both caps and stems)	13.26	3.0 lb	1,360.00 g		630
	3	Peppers, green, cut (1/2" x 1")	8.84	2.0 lb	907.20 g		643
	4	Garlic, chopped	0.83	6 Tbsp.	85.05 g		1,067
	5	Tomatoes, canned, crushed (2 - #10 cans)	58.58	13.25 lb	6,010.00 g		12,320
	6	Oil, vegetable	0.53	1/4 cup	54.00 g		122
	7	Wine, Marsala or Madeira	4.60	2 cups	472.00 g		1,481
	8	Oregano, crushed	0.03	2 tsp.	3.00 g		815
	9	Salt	0.05	1 tsp.	5.50 g		822
	10	Pepper	0.02	1 tsp.	2.10 g		818
		Total	100.00	22.6 lb	10,258.85 g		
		Approx. gallons		2.5 gal.			
II	11	Chickens, whole (25 - 2 1/4 to 2 1/2 lb.)		62 lb		40 lb	

Preparation

1. **Prepare sauce.** Get chopped onions, mushrooms, green peppers and garlic (40°F) from refrigerator. Sauté the vegetables in vegetable oil for about 10 minutes. Add crushed tomatoes with juice, wine, and seasonings (72°F). Bring sauce to a simmering temperature (205°F, 10 min.). Hold sauce in bain marie (165°F, 20 min.).
2. **Prepare chicken.** Get chicken quarters (40°F) from meat and poultry refrigerated storage area. Remove rib bones. (45°F, 10 min.)
3. **CCP** Place quarters, one layer deep in shallow roasting pans. Brown chicken by baking it in a convection oven at 350°F for 30 min. (>160°F)
3. Remove pans of chicken from oven (145°F, 15 min.). Pour off excess liquid. Chill liquid. Save for chicken stock. (40°F, <4 hours).
4. Cover the chicken quarters with sauce (145°F, <10 min.).
5. Return the pans of chicken and sauce to convection ovens at 300°F and continue baking until all parts of the chicken reach a temperature of 175°F (about 45 minutes).
6. Check temperature of chicken. If temperature is not 175°F, continue baking.
7. Cover chicken, transfer to 150°F hot holding unit and serve within <2 hours.

Hold/Serve

8. Hold / serve chicken >150°F, <2 hours. For each portion, use either 1/4 quarter white or dark meat. Chicken should be accompanied by 3 ounces of sauce (about 3 tablespoons) (>140°F).

Leftovers

9. **CCP** Cool to <45°F in <15 hours.

Ingredients that could produce possible allergic reactions: Tomatoes, wine

Process step #	Start food ctr. temp., °F	Thickest food dimension (in.)	Container size HxWxL (in.)	Cover Yes/No	Temp. on/around food	End food ctr. temp., °F	Process step time, hr./min.

FIGURE 13. PEKING DUCK HACCP VALIDATION

Person Responsible: _____ **Process Authority:** O. Peter Snyder, Jr., Ph.D. **Date:** May 12, 1999

Product specification: That the duck, after it is fried to >160°F, put on the buffet line, and kept at >140°F, will have a tolerable level of pathogenic microorganisms.

Assumptions: The raw duck will have moderate levels of *Salmonella*, perhaps 10 per gram, with a D-value and z value at 140°F 1.73 minutes and 10°F respectively. *Campylobacter* will be at higher levels, but is very easy to kill. *Clostridium perfringens* may be at 100 CFU per gram and will survive cooking to grow out. However, it does not multiply below 59°F or above 127.5°F. The duck, after cooking, will be safe if cooled in 15 hours, which is the case with loose pieces of duck in a pan. [Juneja, V.K., Snyder, O.P., and Cygnarowicz-Provost, M. 1994. Influence of cooling rate on outgrowth of *Clostridium perfringens* spores in cooked ground beef. J. Food Protect. 57(12):1063-1067.]

Process Step, Procedure, and Control	Hazard and Control Analysis: a. hazard identification, expected level / size, tolerable limit; b. control effectiveness; c. monitoring procedure / frequency and person, data recording; d. verification-who, when, how
1. Raw duck, frozen Thaw in refrigerator (24 hr.) or in running water (1 hr.) Ti 0°F To <40°F t 1 or 24 hr. ↓	There might be less than 1 generation of <i>Listeria monocytogenes</i> or <i>Yersinia enterocolitica</i> , but this is a tolerable increase and will be killed during cooking.
2. Stuff with spices and marinade. CCP Put the ducks on the hangers used to hold the ducks in the oven Ti <40°F To <50°F t <1 hr. ↓	They were stuffed at about 9:00 PM. Temperatures ranged from 57, 46, 56, 51, 29°F (soft ice). This was measured about 1 to 2 inches down with an Atkins 33040 thermocouple. There was a total of 12 ducks. APC was done on one duck, and it was about 28,000 CFU / gram.
3. Blanch in boiling liquid of water, honey, duck sauce, cornstarch, and red color. Ti <50°F To ~60°F t 3 min. ↓	The sauce, about 3 gallons, was made in the wok. It contained about 2T red tomato (yellow #6 & red #40), 3 T honey, 2 T yellow #5 & 6A. Cornstarch slurry was added, and the liquid in the wok was brought to a boil and thickened. The ducks were blanched for 3 minutes, one at a time. A duck was put into the hot liquid, which was spooned over the top. Three ducks were measured. After blanch, temperatures were: #1 duck: 66, 75, 71, 55°F; surface ~110 to 118°F #2 duck: 52, 64, 76, 72°F; surface ~115°F #3 duck: 51, 70, 56°F; surface ~131°F (Inside temperatures were measured about 1 inch down.) After blanching, the APC count was about 3,200 CFU / gram
4. Hang in smoking oven 12 hr. to let skin crisp. Hung ~9:45 PM. Temperature of kitchen ~74°F. Ti 66°F To 66°F t 12 hr. ↓	Fig. 1 shows the ducks hanging in the smoking oven. At about 10:00 AM the next morning, the temperature of the ducks was 66°F (evaporative cooling kept them a littler cooler than kitchen all night). The APC was about 90,000 CFU / gram. This is about 5 multiplications of bacteria in 12 hours. If we look at extrapolated FDA growth data (7 days at 41°F, 4 hours at 110°F), at 70°F, we would expect a generation time of 1.7 hours. Using HITM growth prediction over 30 to 127.5°F, one would predict 7 generations--very close agreement. [Snyder, O.P. 1998. Updated guidelines for use of time and temperature specifications for holding and storing food in retail food operations. Dairy Food Environ. Sanit. 18(9):574-579.]
5. CCP Cook duck to >165°F in steam / smoking oven at 350°F ~1 hr. 30 min. It actually steamed. Ti 68°F To >165°F t 1 hr. 30 min. ↓	Started cooking at 10:30 AM. Duck temperature ~68°F. The oven thermostat was set at 350°F, but the actual temperature was less, because the burner boiled a pan of water in the bottom of the oven, creating steam. 10:45: Duck thigh 90-110°F 11:00: Duck center 77-80°F; thigh 105-110°F 11:15: Duck center 110-115°F; thigh 135°F 11:30: Duck center 130-138°F; thigh 145-155°F 11:50: Duck center 161°F; thigh 160-165°F; 2nd row duck 175°F in the oven 12:00: All duck temperatures >165°F The microbiological count was about 30 CFU / gram on the cooked duck. These would be surviving spore formers.

FIGURE 13 (cont'd).

<p>6. Cut in half. Dressing removed.</p> <p>Ti 160°F To 140°F t 20 min.</p> <p style="text-align: center;">↓</p>	<p>This time is too short to be a problem.</p>
<p>7. CCP Pan <3" deep, cover cool in walk-in.</p> <p>Ti 140°F To <40°F t 6 hr. (140 to 70°F 2 hr. 70 to <40°F 4 hr.)</p> <p style="text-align: center;">↓</p>	<p>The density is low, and the duck will cool safely. The microbiology of the finished duck (next step) shows that cooling is safe. [Juneja, <i>et al.</i>, 1994]</p>
<p>8. Hold <2 days, <41°F. Temperature of walk-in will fluctuate.</p> <p>Ti <40°F To <40°F t 2 days</p> <p style="text-align: center;">↓</p>	<p>I did a count on this. Even with the walk-in fluctuating from 33°F at night to 55°F in the middle of the day, the count was 3,300 CFU / gram after more than 2 days--very safe.</p>
<p>9. Deep fry, 350°F. Serve >150°F.</p> <p>Ti <50°F To >150°F t 4 min.</p>	<p>This would again reduce any microorganisms to essentially zero. There is no chance for toxin production in this process. The overall conclusion is that New Buffet Peking Duck is absolutely safe, with very great tolerance for possible human deviations in process operation.</p>

Regulatory Authority

Date



FIGURE 14. QUALITY-ASSURED HACCP RECIPE PROCEDURES (SUSHI RICE)

Recipe Name: **Sushi Rice**
 Recipe #:
 Production style:

Portion size (vol.):
 Number of portions:
 Final yield (AS):
 Final Yield:
 SA/QA by: P. Snyder Date:3/99

Number of casings:
 Preparation time:
 To be prepared by:
 Supervisor:

Written by: Date:2/99

Gp. #	Ingred. #	Ingredients and Specifications	Weight %	Weight	
I	1	Rice, short grain 3 1/2 Cups	38.14	682.5 g.	24.1 oz.
	2	Water, 4 Cups	52.53	940.0 g.	33.2 oz.
II	2	Rice vinegar*, 5 tablespoons plus 1 teaspoon	4.47	80.0 g.	2.8 oz.
	3	Sugar, 5 tablespoons	3.63	65.0 g.	2.3 oz.
	4	Salt, 4 teaspoons	1.23	22.0 g.	0.8 oz.
Total weight			100.00	1789.5 g.	63.2 oz.

* Nakano Rice Vinegar (4.2% acetic acid)

Pre-preparation

1. Assemble all ingredients and equipment
2. Wash rice in colander until water runs clean. Drain thoroughly. (If enriched rice is used, do not wash the rice because washing removes enrichment B-vitamin and mineral mixture.)

Preparation

3. Place drained rice in pan or rice cooker. Add water. Cover container with close fitting lid and bring the water containing the rice to boil (212°F).
4. Reduce heat to a simmering temperature (190°F) and continue to cook for 15 to 20 minutes (until all the water has been absorbed).
5. Remove from heat. Take off the lid and spread a clean, white cloth or paper towel over the top of the pot. Replace the lid and let stand for 10 to 15 minutes. (The towel absorbs any excess moisture in the rice.)
6. While the rice is cooking, combine the vinegar, sugar and salt in a small stainless steel bowl or pan. Heat the mixture until the sugar has dissolved (150°F), stirring constantly. Remove from heat. Set aside.
7. Empty the rice into a *hangiri* (nonmetallic shallow container) and spread the rice evenly over the bottom with a *shamoji* or large wooden spoon (or stainless steel spoon). Let cool at room temperature. (As an alternative, the rice can be spread on a stainless steel pan and cooled to 80°F in about 30 minutes.)
8. **CCP** Run a spatula through the rice (~80°F) using right and left slicing motions to separate the grains. At the same time, slowly add the vinegar mixture (~80°F). (You may not need all of it. Avoid using too much or the rice will become mushy.)
9. The rice should be fanned as the vinegar mixture is added. A helper may be required for this step.
10. Check the pH of the rice mixture. It must be less than 4.6. The expected pH is about 4.3.
11. The fanning and mixing take about 10 minutes [until the rice reaches room temperature (75°F)].
12. Do not refrigerate the rice, but keep it covered with a clean, white cloth or paper towel, at room temperature (75°F) until it is ready to be used.
13. Sushi lasts just one day. It should not be used as a leftover. (There is no hazard, but the sushi rice will spoil due to yeast and mold growth.)

Process step #	Start food ctr. temp., °F	Thickest food dimension (in.)	Container size H x W x L (in.)	Cover Yes/No	Temp. on/around food	End food ctr. temp., °F	Process step time, hr./min.
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FIGURE 15. SUSHI RICE HACCP

Process: Preparation of the acidified rice that is used as the core ingredient of sushi menu items.

Assumption: Good manufacturing practices are effective in the operation.

Hazard: Traditionally, the sushi is not refrigerated. If the tuna species is chosen carefully, it will be free of parasites. If the fish is prepared carefully it will have a low number of spoilage bacteria and will not develop a hazardous amount of histamine in 24 hours. The risk that remains is the possible multiplication of *Bacillus cereus* multiplication in the rice. Lowering the pH of the rice to a level at which there is no *B. cereus* multiplication (< 5.0 pH) can control this possible hazard in sushi rice as it "sits out" at room temperature for 24 hours. (If the rice is refrigerated, and the tuna is kept below 40°F, *B. cereus* will not multiply and pH control is not necessary. However, this is not sushi.) The actual pH of the rice in most recipes is 3.8 to 4.0.

Hazard and Control Analysis: a. hazard identification; b. critical limit; c. employee monitoring procedure / frequency and person; d. verification-who, when, how

Process Step, Procedure, and Control	Hazard and Control Analysis: a. hazard identification; b. critical limit; c. employee monitoring procedure / frequency and person; d. verification-who, when, how
Pre-preparation	
1. Assemble all ingredients and utensils. I Check that everything is ready.	Check that the tuna or other fish is fresh and has a very low APC count (for example < 10,000 CFU / g) to control the possible production of histamine. Use frozen fish to control the risk of parasites since it is very difficult to buy parasite-free fish. If appropriate, check for ciguatoxin. Check that the correct amount of acid (rice vinegar) has been measured (4.47% of the recipe total weight).
2. Wash rice in colander until water runs clean. Drain rice. I (If rice is enriched, do not wash it since that will remove the added B vitamins.)	Inspect the rice for rocks and remove if any are present..
Preparation	
3. Place drained rice in pan or rice cooker. Add water (70°F). Cover container and bring rice and water to a boil (212°F). O Ti 70°F To >200°F t 10 m.	This pasteurization-cook will reduce all vegetative pathogens to a safe level. Spores of <i>C. botulinum</i> , <i>B. cereus</i> and <i>C. perfringens</i> will be activated.
4. Reduce heat to simmering temperature (190°F). Continue to cook until rice is done. O Ti >200°F To 190°F t 20 m.	The <i>Clostridia</i> and <i>Bacillus</i> spores survive.
5. While rice is cooking, combine the vinegar, sugar, and salt in small stainless steel bowl or pan. Heat the vinegar mixture until sugar has dissolved. Set aside O Ti 70°F To 150°F t 5 m.	This must be done in a stainless steel container, or other type of container that does not react with the acid.
6. After rice is done, empty the pan of rice into a <i>hangiri</i> (small shallow container). Spread rice evenly over bottom of the pan with a <i>shamoji</i> (a large wooden or stainless steel spoon). Let cool O Ti 200°F To <120°F t 5 m.	The time is too short for any risk.
7. Run spatula through the rice (~80°F) using right and left slicing motions to separate grains of rice. At the same time, slowly add the vinegar mixture (~80°F). Fan the rice as the vinegar mixture is being added. O Ti 120°F To <80°F t 10 m.	CCP The vinegar, sugar, and salt mixture will reduce the pH of the rice to <4.4 pH. This controls the outgrowth of <i>B. cereus</i> which will not multiply at <5.0 pH. At pH of <4.6, the risk (if there is one) for <i>C. botulinum</i> is controlled.
8. Check the pH of the rice. It must be <4.6. The target pH is 4.3 (± 0.3pH) I	No This is the monitoring step to assure that the hazard control standard has been met.
Storage	
9. Store at room temperature (70 to 80°F). Use within 24 hours. S Ti 80°F To 80°F t <24 h.	The rice will spoil safe, because of airborne yeast and mold that get into the rice during mixing. The foodborne illness hazards are controlled.
Leftovers - >24 hour none. Discard any leftover sushi rice.	

FIGURE 16. UNIT OPERATION PROCESS RISK MANAGEMENT

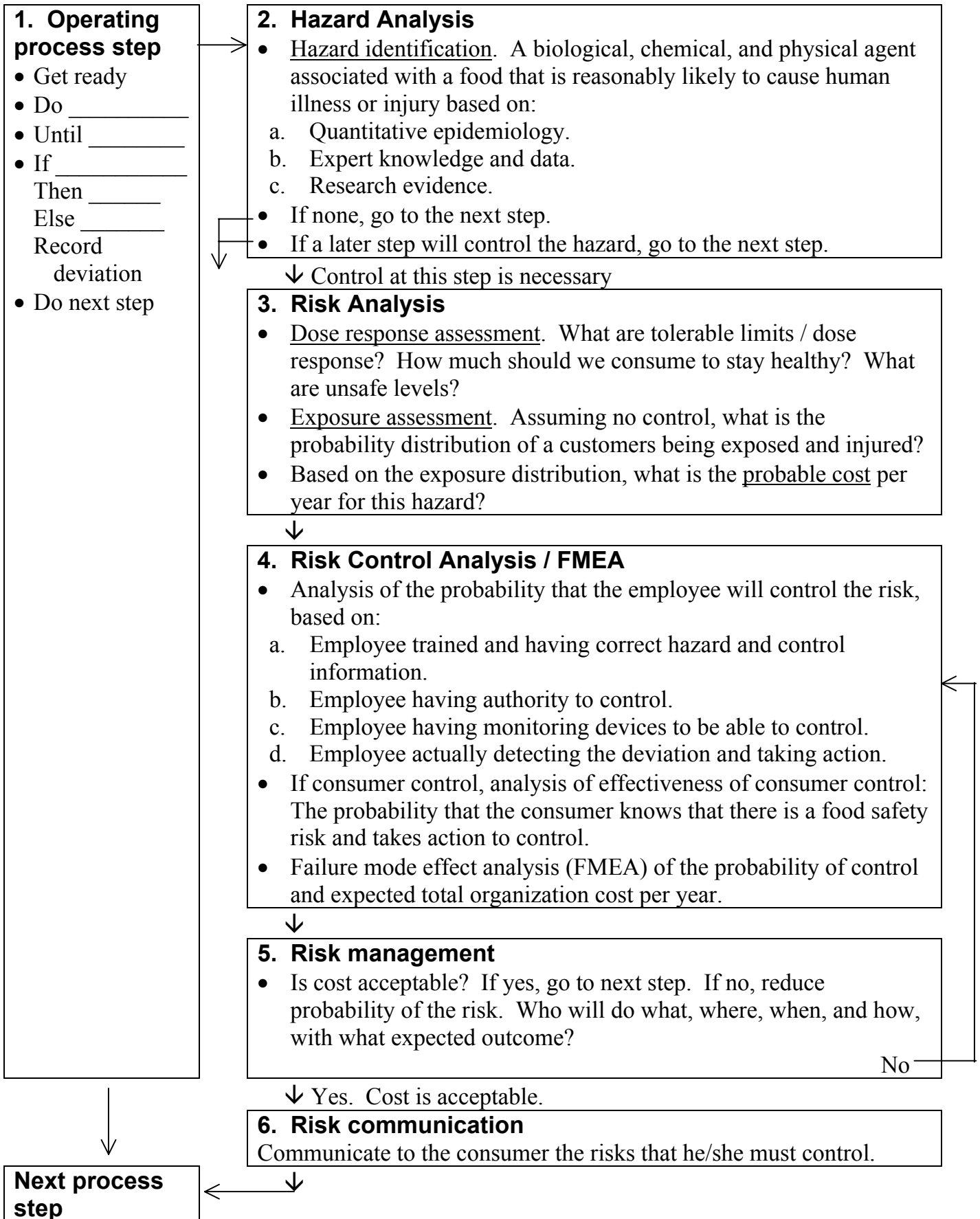


FIGURE 17. RETAIL FOOD HAZARD CONTROL DEVELOPMENT AND IMPROVEMENT PROCESS

Process	Comments
1. Identify the system. ↓	
2. Identify the step in the process in which you are interested. ↓	
3. Identify biological, chemical, and physical hazards reasonably likely to cause human illness or injury based on: a. Quantitative epidemiology b. Expert knowledge and data c. Research evidence. If none, go to next recipe step. → ↓	
4. What are the levels and sizes of the biological, chemical, and physical hazards coming in / increasing in the step. What are the tolerable levels and levels to maintain immunity? What is the expected cost if a person is injured? ↓	
5. Will a subsequent step reduce the hazards to an acceptable level? If yes, go to next recipe step. → No ↓	
6. Do a risk analysis. How many people per year can be affected? What is the cost? Is the cost significant? Are the hazards of significant likelihood and occurrence to warrant control? If no, go to next recipe step. → Yes ↓	
7. What is the current control? Is it adequate? Is it robust? What is the chance of failure? If not acceptable, improve the control until risk of failure is acceptable. Validate that the control gives the desired control with desired reliability. ↓	
8. Document the process. Develop employee self-monitoring. How does the employee check that he/she did the control correctly? What do they do, how, how often, and who does it, if not the employee? ↓	
9. What is recorded by the employee in order to determine the stability of the control? ↓	
10. HACCP team meeting. Review process CCP data logs. Determine which CCPs need improvement. Do R&D. Revise process with improved procedures.	

FIGURE 18. OUTLINE FOR PUBLISHING, IN AN IAFP PUBLICATION, RESULTS OF A HACCP STUDY FOR RETAIL FOOD OPERATIONS

Introduction

This document describes the HACCP process to produce _____ (product).

The consumer of this product is _____.

Consumers prepared the product by "_____."

The specifications for the product are: _____.

The process flow diagram is shown in Fig. 1.

The hazards in this process are _____.

The hazard control points in this process are: _____.

This paper describes the development and validation of the controls at the hazard control points that assure a safe product will be produced.

Procedure for the study

Results of the study

Discussion

Conclusion and recommended HACCP procedure