Hazard Analysis Critical Control Point (HACCP) (….continued)

Most large cheese manufacturing companies have implemented HACCP into their quality control systems in order to produce safe and good quality product. However, seldom do small-scale cheese plants implement their own HACCP plans. Moreover, HACCP is a plant-specific and product-specific quality system.

Research approach

Based on the principles and several existing generic models of HACCP, the recordkeeping forms of the model can be designed in the following manner:

1. Specific prerequisite program
2. Product description
3. List of product ingredients and incoming materials
4. Process flow diagram
5. Hazard identification
6. Critical control points determination
7. HACCP control chart

1. Specific prerequisite program

Prerequisite programs involve several steps and procedures to provide a safe environment and condition for the production of cheese. These programs are crucial to determine the critical control point. The prerequisite programs are based on the building design, pest control, storage and transportation, sanitation, water supply, equipment and personal hygiene.

1.1. Building design

It should be noted whether the paint on the walls and ceiling is or is not peeling; the ceiling is or is not leaking; the floor is sloped for liquid to drain and the door is self-closing.

1.2. Pest control

The pest control activities should be contracted to professional in food industries. The UV light could eliminate the flies and the mice trap could eradicate the mice.

1.3. Storage and transportation

The specific conditions of the store room need to provide appropriate temperature and humidity for the raw materials and the final products. Daily inspection of the conditions could ensure a consistent environment to prevent the hazards and produce quality products. Proper transportation equipment should be used and the proper environmental conditions should be monitored for each batch.

1.4. Sanitation

The sanitation facilities should be properly set up to eliminate possible hazards. The sanitation tube connected with the facilities should be long enough to reach all the areas that need to be sanitized. The strength of the chlorine solution should be 200ppm; daily check is required. The sanitation should be used on all the equipment, containers and tools in the process. Sanitation should be part of the personal hygiene too.

1.5. Water supply

Potable water (or drinking water, safe to drink) should be used in the process. The water potability testing should be verified and recorded every half year. The filter for the water needs to be checked monthly.

1.6. Equipment

All the equipments need to be checked routinely to ensure a smooth running system. The equipment should be operating properly and should be free of cracks, rust and dents.

1.7. Personal hygiene

The employee should be well-trained on the personal hygiene. The supervisor should conduct checks daily. The employee needs to wear a hat or a hair net while working and needs to wash and sanitize his/her hands before working. They have to use some plastic coverings for their shoes. They must also be free of disease.

2. Product description

This part of the model gives criteria on how to describe the product characteristics for the consumers (Table 1). It is important that the consumers know how to properly use and store the product. It helps the researcher to make the right decision on how to prevent the possible hazards. For example, the Cheddar cheese is a ready-to-eat product; therefore, the pasteurization process is a critical step in cheese making process.

Table 1: Product Description

1. Product Name	Cheddar Cheese
2. Important product characteristic (moisture,pH, salt, preservatives…)	Hard cheese Moisture%: 30-45% pH: 5.2-5.4 Salt: 1.5 -2.0%
3. How it is to be used	Ready to eat
4. Packaging	Cryovac, vacuum seal
5. Shelf life	1 or may be several years
6. Where it will be sold	Retail store
7. Labeling instruction	Keep refrigerated
8. Distribution condition	Refrigerated

3. List of ingredients and incoming materials

Hazards are seldom created by themselves in processing. Most of the hazards come from the ingredients and incoming materials. For example, the raw milk used in cheese making may contain harmful bacteria such as *E. coli*, *Staphylococcus aureus*, Salmonella that could contaminate the end product. All the ingredients and the possible microbiological (M), chemical (C) and physical (P) contamination or hazards are listed in table 2. The table also includes the preventative measures for the hazards in each raw material.

Table 2: Hazards in Ingredient and Incoming Material Analysis Chart

Ingredient & material	Hazards	Preventative measure
Milk	MCP	Store < 4 ºC Proper transfer equipments Sanitize equipment Proper personal hygiene and handling
Starter culture	M	Qualified product supply, store < -40 ºC
Rennet	M	Qualified product supply, store < 4 ºC
Salt	MP	Qualified product supply, store at Room temperature Proper personal hygiene and handling
Water	MCP	Supply quality water
Cryovac	MCP	Qualified product supply

Table 3: Hazard Analysis Chart

Process step	Hazards	Preventative measure
Adding milk	MCP	Proper equipment setting, Sanitize all the transfer equipment
Pasteurization	MCP	72ºC, 16 sec, Proper pasteurizer setting, Sanitize all the equipment
Filling	MCP	Heat to 32ºC, Sanitize the milk tank, the stirring tools and the thermometer, Proper personal hygiene & handling, Proper building setting (tank is without cover), Pest control
Adding starter culture	MP	Medium agitate Proper personal hygiene & handling
Adding rennet	MCP	pH 6.61, 30ºC Sanitize the container used for diluting rennet, Proper personal hygiene & handling
Coagulation	MP	30 min, Stop stirring and take tools out, Proper personal hygiene & handling
Cutting	MCP	pH 6.57 Correct knife size for optimum curd size, Sanitize the cutting tools and the cutter's hands and arms, Proper personal hygiene & handling
Scalding	M	38ºC, 30 min, Proper personal hygiene
Stirring	MCP	38ºC 20 min, Sanitize the stirring tool, Personal hygiene and handling

Table 3: Hazard Analysis Chart (continue)

Process step	Hazards	Preventative measure
Whey drainage	MCP	pH=6.4 Sanitize all the tools, Proper recycle whey setting, Proper personal hygiene and handling
Cheddaring	MCP	Consistently monitor pH during cheddaring Sanitize the knife, Proper personal hygiene and handling
Milling	MCP	pH=5.35 (5.2-5.4) Sanitize the milling machine, proper personal hygiene and handling
Salting	MCP	1.5-2.0% salt, Moisture content is optimum at 39%, Sanitize the salt container and the stirring tools, Supply quality water, Proper personal hygiene and handling
Moulding	MCP	Sanitize the moulding container and cloth, Proper personal hygiene and handling
Pressing	MP	Proper pressure at 75 kpa, Proper whey drainage setting, Proper personal hygiene and handling
Wrapping	MCP	Proper vacuum machine setting, Sanitize the container, scale and tools, Proper personal hygiene and handling
Ripening	MP	Proper building setting, Proper storage condition setting, Pest control

4. Process flow diagram

The process flow diagram is made of a sequence of steps through the whole process; a concise explanation of each step is given to describe how the final product is made. It is used to document the production and distribution processes and helps to identify hazards at each step. It includes the processes from the raw material to the production procedure to the distribution.

5. Hazard identification

Hazard identification is helpful to identify potential microbiological, chemical and physical hazards that may occur during each step of processing.

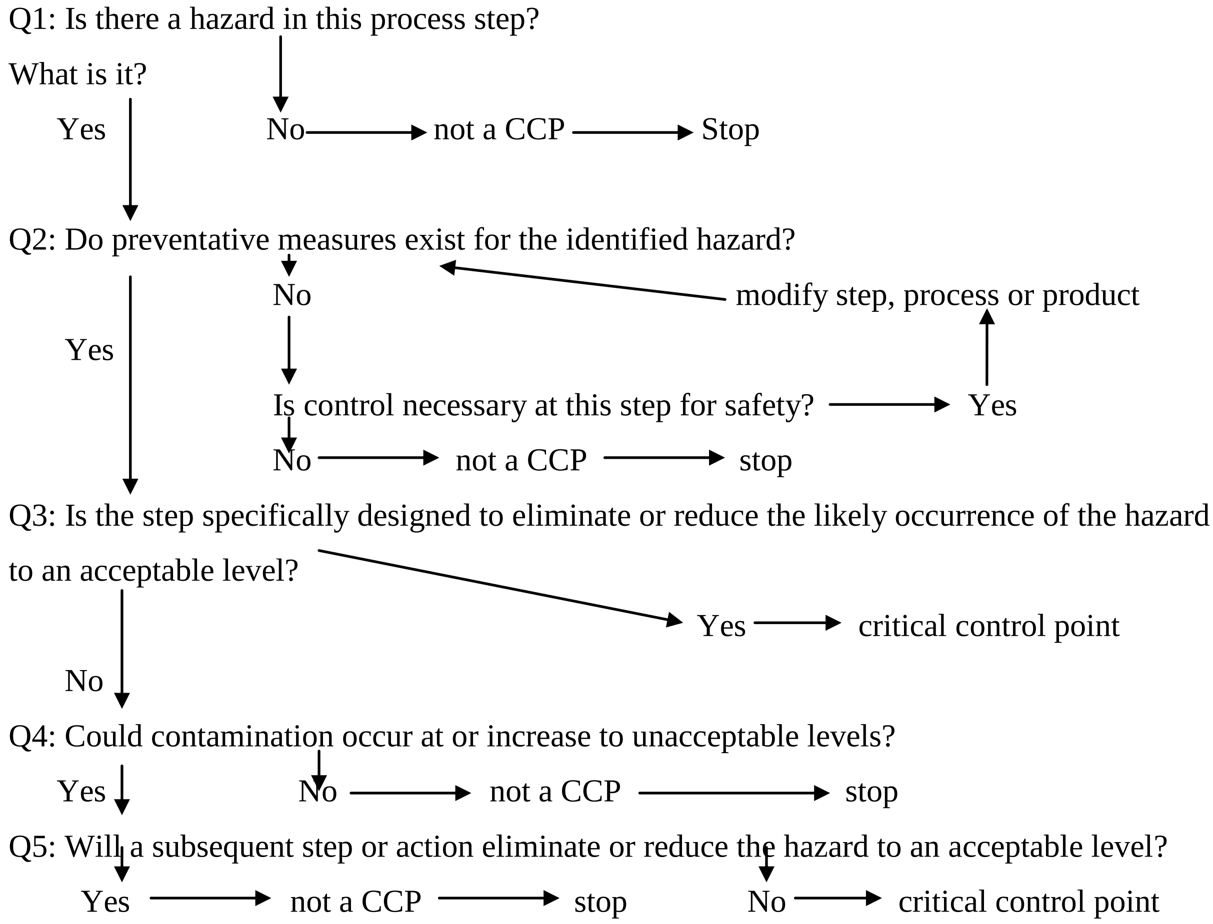
In Table 3, the preventative measures are provided for the hazards in each processing step. All the control situations are set up under the requirements in this plant to make safe and quality cheese. See details in the table 3.

6. Critical control points determination

There are two parts in this section. The first part is the critical control point (CCP) decision tree (Figure 1); the second part is the CCP decision matrix (Table 3).

The CCP decision tree for the processing phase will help to identify appropriate CCPs in the process. It is a flow of five questions that focus on analyzing the hazards in the process and determining whether or not each hazard is a critical control point.

Figure 1: CCP Process Decision Tree



The five following questions are in the decision tree:

Question 1 identifies the hazards in a specific process step. To answer this question, the researcher needs to think about the entire potential hazard in this step. No one hazard should be neglected in this part. If there is a hazard then go to the question 2.

Question 2 is to find out whether or not there is a preventative measure for the identified hazard. The researcher should use the information in the hazard identification section. If there are no preventative measures, the researcher should ask if control is necessary at this step. If yes, the step, process or the product needs to be modified. If this is a preventative measure, the process moves to the question 3.

Question 3 is made for some special process steps, which are set up for controlling the hazards; for example, pasteurization for the raw milk. If this process step is designed to deal with the hazards, this process is a CCP. If not, go on question 4.

Question 4 identifies the contamination involved in the process. The researcher must combine the condition of the process and the possible hazards. For example, does the environment of the process include hazards? Does the personal action in this process include hazards? If the contamination could occur at or increase to an unacceptable level, move to question 5.

Question 5 identifies a subsequent action that can eliminate the hazards. If there is an action, this process step is not a CCP. If there is not one, it should be a critical control point.

The CCP decision matrix lists all the answers (Yes/No) for every question based on each hazard. The matrix provides space for the researcher to expand why the hazard is a critical control point or not.

Table 3: Process Decision Matrix Form

Process step and hazard	Q1	Q2	Q3	Q4	Q5	CCP
	Y	Y	N	Y	Y	N

7. HACCP control chart

The HACCP control chart (Table 4) is based on the CCPs in the processing. For each CCP, the identified hazards and preventative measures are listed in this chart. In addition, the critical limits, monitoring, corrective action and responsibility are summarized in this chart. The HACCP control chart shows all the potential critical hazards that can occur during processing. It is the most essential part of the whole HACCP plan, which is the organization analysis and documentation of the CCPs. The column of the responsible will be filled out by the operator or the supervisor who is responsible for the control. It helps the company easily manage all the information.

Table 4: HACCP control chart

Process step	Hazards	Preventative measure	Critical limits	Monitoring procedure	Monitoring frequency	Corrective action	Responsibility
Raw & packaging material CCP # 1	Microbiological chemical & physical contamination	Qualified starter & rennet supply Qualified cryvoac supply	No unqualified material be used	Apply supply quality assurance	Each supply	Change supplier Operator training	
Pasteurization CCP #2	Survival of pathogens such as *E.coli*, *Staphylococcus aureus*, *Bacillus cereus*, etc.	Pasteurizer checks: -check the heat plate -check the temperature controller	Temperature set at 72ºC Time set at 16 sec	Check thermometer and time check equipment is properly running Record keeping	Each batch Routinely Each batch	Adjust the temperature and time by setting the equipment well Call the engineer to repair	
Filling	Microbiolog	Proper	Temperat	Check	Each	Adjust the	

CCP #3	ical contamination	temperature setting	ure set at 32ºC	thermometer Record keeping	batch Each batch	heater to change temperature	
Adding starter & rennet CCP #4	Microbiological contamination Physical contamination	Proper additional rate Agitate properly	Starter: 2cans, Rennet: 40 mL per 400 L milk pH is measured at 6.6 before adding rennet Agitator set at medium	Check the additional rate of the starter and rennet & Check pH check the rate of the agitator Record keeping	Each batch Each batch	Applying more testing on pH Use active starter culture Adjust agitate rate Operator training	
Coagulation CCP #5	Microbiological contamination Physical contamination	Proper time setting and recording Take the stirring tools out of the tank	Time is set at 30min Tools prevent coagulation	Check the time and the stirring tools Record keeping	Each batch Each batch	Reject product Operator training	
Cutting, scalding & stirring CCP #6	Microbiological contamination	Proper time & temperature setting	Temperature is set at 38ºC, scalding for 30 min and stirring for 20 min	Check the temperature and the time Record keeping	Each batch Each batch	Adjust the heater to change temperature Operator training	
Milling CCP #7	Microbiological contamination	More cheddaring time control the pH Use of an	pH is measured at 5.2-5.4	Consistently monitor pH during cheddarin	Each batch	Reject product Applying more testing on pH	

		active starter culture at the correct addition		g Supervisor's managing and record keeping		Operator training	
Salting CCP #8	Microbiological contamination	Correct level of salt Correct mixing during salting	Salt%=1.5-2.0%	Records and testing	Each batch	Incorrectly salted curd must not be allowed to progress	

Some factors that are commonly used as critical limits include temperature, time, pH, moisture or salt concentration.

When a deviation from a critical limit occurs at a CCP, a corrective action needs to take place.

The responsibility should be considered both in monitoring and corrective action. The most important issue with responsibility is ensuring it is properly assigned. An operator in processing needs to know the necessary procedures and the correct way to follow them. It is also important to define which individuals are responsible for documenting and certifying the corrective action procedures. This information will be crucial in verifying that the required action has been taken.

Hazards identification, Critical control points determination

Based on the process decision tree, there are seven CCPs as determined, based on the following requirements in the plant.

1. The time and temperature of the pasteurizer is the most critical control point in the cheese making. Most of the pathogens are eliminated or reduced to the safety level.

2. The filling temperature is critical because it can provide the best situation for the starter culture to grow and at the same time, restrain the growth of the pathogens.

3. The supply and the amount of starter culture used in the production is the most guarded secret for a plant. Starter culture is used to produce acid before adding rennet. The rate of adding starter and rennet is very critical for the safety and also the flavor and aroma for the cheese. It can be controlled by pH before adding rennet. The rate of agitation is very critical in the plant according to the producer. If the rate is too high, the air in the milk will interrupt the coagulation; if the rate is too low, the starter cannot be mixed well in the milk.

4. The time of coagulation controls how well the gel forms before cutting. If the gel is cut early, some proteins will be lost. According to the producer, if the stirring tools are kept in the vat during coagulation, the proteins will not be formed into a gel network. It is very critical for the production in this plant.

5. The final pH is critical to control the growth of the pathogens. The low value of the pH inhibits pathogen growth and guarantees safe cheese.

6. The scalding and stirring time and temperature could influence the cheese to get the desired pH and moisture.
7. The rate of salt is very critical because salting affects the growth of the pathogenic bacteria.

Recommendations

As a HACCP system, the verification procedures which are the seventh principle must be included. This principle can be effective by using an audit method to ensure the HACCP plan is properly practiced in the production. Improvement should be continues.