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Hazard Analysis and Critical Control Point (HACCP) in the Dairy Product: Cheese

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ABSTRACT

Food safety management systems in the food industry have been established over the last four decades. The dairy industries soon realized the need for proactive procedures hence implementing HACCP (Hazard Analysis and Critical Control Points) for ensuring that safe dairy products would reach the consumers. The implementation of the HACCP system, which is known as preventive methodology would remove the possibility of complaints because of the risk of a food product. HACCP is a control system and form of risk management in the effort to prevent problems that are based on the identification of critical points in the management and production stages. Cheese is one of the dairy products that are widely favored by the community. There are various potential hazards in terms of biological chemical, and physical through process of making cheese from the initial stage of quality control of raw materials until the ripening stage. Generally, processing stages such as receiving raw materials, quality inspection, cooling, incubating, separation of why with curd, ripening and packing are consider as CCPs, which require to be watched out.

Keywords: Food safety, HACCP, Cheese and dairy products

Introduction

Milk is one of important food for the health of the body, because it includes valuable nutrients, namely protein, fats, carbohydrates, vitamins and minerals. Milk and milk products play an important role in the food supply chain [1]. Due to the complex composition of milk and milk products, dairy products are good medium for spoilage growth and the production of pathogenic microorganisms. Therefore, in a short time the milk becomes unhealthy for consumption [2].

Cheese is recognized as a group of fermented milk-based products, produced widely in various flavors and shapes all over the world [3]. Cheese is produced generally from the milk of cows, sheep, camels, buffaloes or goats, and it is rich nutritious food in the healthy diet of American, Asian and European people [4]. It's considered as a good source of for essential nutrients including high level of amino acids, peptides, proteins, short-, medium and long- chain fatty acids, vitamins, and essential minerals containing calcium. Also, cheese has several bioactive properties, such as anti-carcinogenic, antimicrobial, anti-thrombotic activities. A large variety of cheeses has been made in all over the world and consumed by different groups of people. Among the varieties, Cheddar was known to be highly appreciated cheese in UK and Mozeralla in USA [5]. Production of Cheese is growing quickly from year to year; this can be resulted by the consumption of the community increasing. Several studies have shown the incidents or outbreaks of foodborne diseases associated with different dairy products: Brucellosis, Listeria, Salmonella, Clostridium botulinum [6-9]. In many industrialized countries, milk and dairy products contained about 2-6% of outbreaks of foodborne diseases [10]. Cheese was classified under "safe foods" in the past, but after 1980s, infections and intoxications associated with the consumption of contaminated product with pathogens and poisoning bacteria and their toxins at production steps have been observed [11]. Thus, it should be properly manufactured and stored under hygienic conditions, because of its dynamic biologic and biochemical structure, cheese is unstable [3]. It is proved that the microbiological quality of milk and the procedures adopted through milking and processing will be effective in cheese

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quality [12, 13]. As a result, the application of any measures to guarantee the quality of milk used for making veriety cheeses as well as hygienic conditions during its processing are required to obtain safe and high quality cheeses. Different types of quality/safety management systems such as ISO 22000, Total Quality Management, and HACCP were developed for the food industry. Food safety needs compliance with good manufacturing practices (GMP), good hygiene practices (GHP), sanitation standard operating procedure (SSOP), also operation prerequisite programs (OPRPs), and the principles of Hazard Analysis of Critical Control Points (HACCP) [14]. First time, the concept of critical control points mentioned in 1959, when the National Aeronautics and Space Administration (NASA), Pillsbury, and US Army laboratories cooperated to provide safe food for space expeditions. HACCP is based on the hazard assessment of food safety during a control system. This system is considered as a preventive method, which identified the biological, chemical, and physical hazards in whole food chain [15, 16]. Several reports showed the positive effects of implementing HACCP on the microbiological quality of food products [15, 17-18]. HACCP implementation is necessary for all small- and medium-sized food companies in the European Union (EU), and HACCP is well-known as a worldwide guideline for controlling safety of foodborne hazards in the international food safety community [19]. Dairy products traditionally have known as a main source of human nutrition. Nowadays, several dairy varieties are consumed all over the world either directly or as ingredients of other foods (e.g. pastries, pies, cake, etc.). Due to their importance, the safety of dairy products has received specific attention by many official bodies. The HACCP system has been implemented for all EU members by the 92/46 directive for dairy hygiene. Specifications of safety were further increased by regulations 852/2004 and 853/2004 [20].

Materials and Methods

Cheese processing involves following steps:

Receive raw milk

Milk is collected and transported from the farms to the dairy company refrigerated milk cans (churns). To control the microbiological hazards, milk should be cooled to 0-4°C after collection and stored at this temperature through transport and storage [21].

Centrifugal separation

The purpose of the centrifugal separation is to eliminate the foreign objects and dirty particles from the milk and separate the fat content of the milk using several types of milk separators. In the next processing step, the fat will be mixed with skimmed milk to standardize it to a desired fat level.

Pasteurization

The objectives of the Pasteurization are to remove foodborne pathogens, eliminate or reduce food spoilage micro-organisms. During this step, the milk is heated to 68°C for 10 min. This thermal treatment is adequate to inactivate alkaline phosphatase however, not superoxide dismutase. Temperature of pasteurization above 78-80°C would inactivate superoxide dismutase but this may lead to denaturation of milk proteins, during the formation of κ-casein and serum proteins complexes.

Addition of the starter culture

A suitable starter culture is vital for quality of product. The lactic acid bacteria used to make feta cheese are *Streptococcus thermophilus, Lactococcus lactis* subsp. lactis and *Lactobacillus delbrueckii* subsp. *bulgaricus*. Starter cultures must be of excellent quality. It is applied at 1% v/v and the inoculated milk is incubated for 30 min.

Addition of rennet and CaCl2

Cheese is made by coagulating through the action of chymosin that is the most important component of rennet. This step is primarily necessary for the creation of a uniform gel and finally Feta with firm texture. Factors that affect the clotting with rennet including temperature, milk acidity and the amount of rennet added. This amount is about 1.0-3.0 g rennet, of rennet strength 1: 100.000, for 100 liter of milk. The milk should be at rest over clotting for 30-60 min at 30-35°C.

Cutting of the coagulum and moulding

After the coagulation caused by the rennet has been carried out, the resulting curd/gel is cut into 23 cm cubes, poured into perforated metal molds in thin layers and left for 56 hours to allow syneresis to take place. A very important factor in this essential step of feta production is temperature. The temperature of the facilities where syneresis and salting take place must be 16°C. At this temperature a product with better texture and taste is obtained. When the curd is firm enough to remove the molds, it is cut into four sub-blocks measuring 23 x 12 x 6 cm.

Salting

Salting feta cheese is a two-step process. The first stage involves dry salting and is carried out on a salting table on which the blocks of curd are placed. Coarse salt is sprinkled on the surface of the cheese to allow it to slowly penetrate the curd. Dry salting is repeated two or three times every 12 hours. During the second stage of salting, the feta is kept immersed in a concentrated NaCl solution (brine). The final salt concentration in

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feta cheese should be 34%. Salt combined with acid (pH < 5.1) is essential for the quality and safety of the final product.

Ripening

This step occurs during about 15 days at 16°C and 85% relative humidity. Higher RH levels can encourage the growth of molds that produce mycotoxins. The ripening room must be separated and checked for hygienic conditions. At the end of ripening, the salinity in the moisture is 5±6%, the pH is not higher than 4.6 and the moisture content varies by 55%.

Storage and packaging

In the final stage of the feta cheese flow diagram, the feta cheese is packed in cans. Containers should be completely cleaned. After packaging, the containers should be filled with brine. The brine you add should cover the surface of the cheese in the container, but also leave a 2 cm space free. It is then held at 14-16°C until a pH of 4.6 is reached and a moisture content of less than 56% is achieved. At this point the containers are sealed and stored at 45°C. The relative humidity of the facility where the feta cheese is aged must be 95-100%. Care must be taken to ensure that the surface of the cheese is completely covered with brine [21, 22, 23].

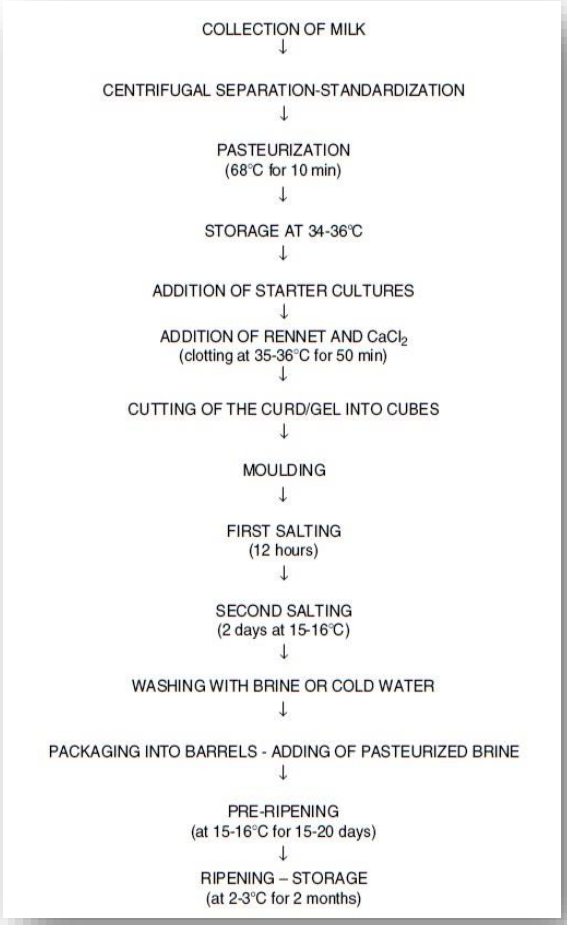


Figure 1. Flow chart

Implementation of HACCP Plan

Based on ISO 22000 and Codex Alimentarius, 12 steps for developing an HACCP plan in technical process of cheese production was drawn.
step1. Assemble HACCP team.
Step2. Describe product
Step3. Identify intended use
Step 4. Flow diagram of cheese production (Figure 1)
Step 5. On-site confirmation of flow diagram
Step 6. (Principle 1) Hazard analyses determination.
Step 7. (Principle 2) Determination of control points = CCPs
Step 8. (Principle 3) Establish critical limits for each CCPs to put the hazard under control.
Step 9. (Principle 4) CCP monitoring

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Step 10. (Principle 5) Establish corrective actions
Step 11. (Principle 6) Establish verification procedures. To assure the validity of the system.
Step 12. (Principle 7) Establish record-keeping procedures.

Results and Discusion

Hazard analyses determination

Food-safety hazard usually discusses about any biological, chemical or physical agent in a food, or condition of food that cause adverse health consequences for consumers [24].

Determination of critical control points and critical limits

Thus, all production lines have different critical control points and HACCP plans [25]. Critical control point in the line production of cheese was identified through the use of decision tree (Figure 2). Critical limit is a maximum and/or minimum measurement to which a biological, chemical or physical hazard must be controlled at CCPs to prevent, remove or drop to an acceptable level.
Three critical control points has been reported including:
CCP_1: Cutting and mincing step
CCP_2: Cooking the mixture
CCP_3: Storage of cheese… Critical limits: Storage at 4±2°C [26].
CCPs including milk, cream and salt addition, whey, pH adjustment (5.8), heat treatment of curd (88-90 °C for 15 min), packaging, and storage 4±2°c.during 10-14 days) reported. All the ingredients used like whey, cream, milk and salt found potential hazards. Therefore they should be of controlled quality and bought only from trustable suppliers. Additionally, in study of reception of raw milk, collection and transportation, filtration, pasteurization, addition of starter culture (1%), salting, ripening, packaging, and storage are recognized as CCPs of cheese production [27].

Monitoring, Corrective actions, and Verification procedures

To ensure that the critical limit established at every CCP can be successfuly fullfiled, monitoring must be established in the HACCP method. In order to avoide unsafe products from reaching consumers, a corrective action is performed when there is a deviation from any CCP. through this procedure, problems can be corrected and production will under control. Any unqualified product will be tested to determine its safety. A perfect HACCP plan also needs a verification procedure, like random sampling and testing, to examine whether HACCP can successfully control food safety [28].

Table 1
CCPs and critical limits, corrective actions, verification

CCPs and critical limits	Corrective actions	Verification
Pasteurize 72-73 °C for 15 seconds	Perform cleaning tools every time it used	Review form the condition of pasteurizer
Cooling up to 4 °C with the addition of 5% starter	Re-cooking	Review the cooling tool condition form every time it used and do maintenance every month
Incubating 43 °C for 1-2 hours with rannet enzyme	Complaints to suppliers/Contact the QC manager and determine whether to agree or not.	Review form Receipt every month
Separation of why with curd at 40 °C	Perform cleaning tools every time it used	Review form the condition of the separation tool for each use
Soaking for 2 hours with salt	Re-cooking or down grade	Review the salt addition form Review form
Packaging	The product is destroyed	Packaging testing and checking

Record-keeping procedures

Documentation of this approach contains List of the HACCP members and their responsibilities, thorough description of the final product and its intend use, flow diagram, hazards associated to each CCP and preventing measures, determination of CCP and critical limits, monitoring, corrective action for deviation from critical limits, HACCP plan, maintenance of records, actions for verification of HACCP system [16].

Table 2
Feta cheese composition (%)

Moisture	Fat(in-dry-matter)	Protein	Lactose	Ash	Salt	Acidity(as lactic acid)
54.3	49.8	17.6	0.5	4.1	4.4	1.9

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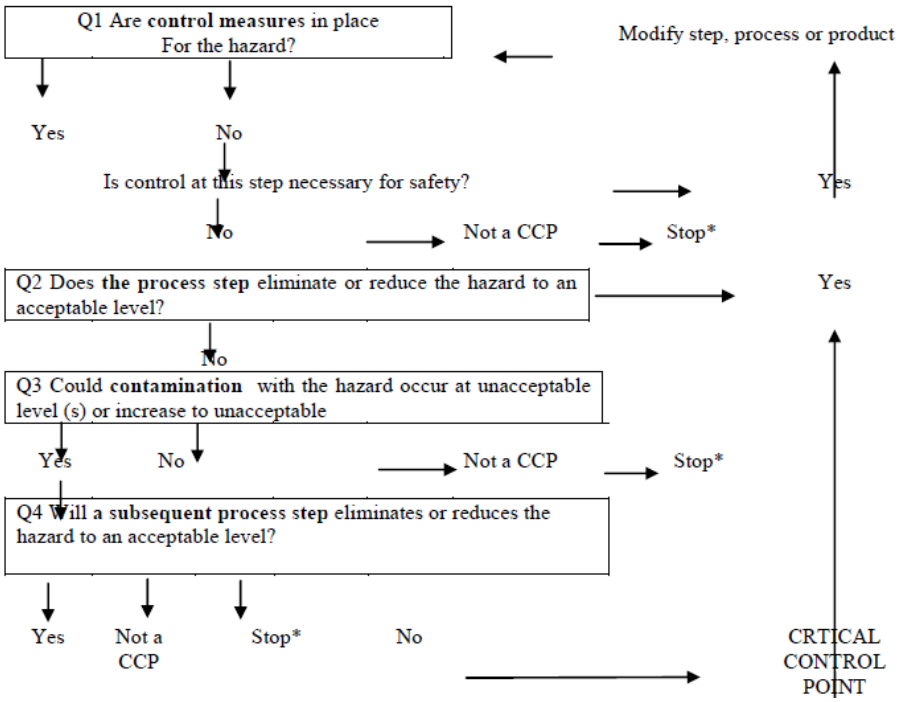


Figure 2. Decision tree for identifying CCPs

Conclusion

The most nutritionally complete food in the diet represented by cheese. Implementation of the HACCP system to the manufacture of cheese proved to be a valuable approach for improving the safety and quality of these dairy products. In fact, the percentage of defective food items indicated a substantial fall because of the identification and effective control of critical control points. Establishing of HACCP system to the processing line of cheese can ensure the food safety and hygienic conditions during production.

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