Internet Journal of Food Safety, Vol.9, 2007, p. 22-25

Critical Control Points on the Manufacturing Line of Otlu (Herby) Cheese

Bulent Ergonul*
Celal Bayar University Engineering Faculty Food Engineering Department, 45140, Muradiye, Manisa, Turkey

Implementation of Hazard Analysis and Critical Contol Points (HACCP) System to the cheese-making industry is very important in terms of obtaining safe products. Today, HACCP is one of the most important prerequisite program which has an international popularity and acceptance. In this study, HACCP system was established for the Otlu (Herby) cheese which is widely consumed in Eastern Region of Turkey. Milking and storage of raw milk, acceptance of raw milk, cleaning milk with filtration, storage of raw milk, pasteurization, adding starter culture into milk, adding herbs into cheese, ripening and storage of otlu cheese are determined as critical control points.

Cheese is the common name for a group of fermented milk-based products, produced in a wide range of flavors and forms all over the world (Arvanitoyannis and Mavropoulos, 2000). Cheese is historically among the safest foods known (Kosikowski and Mistry, 1997). Although it is properly produced and stored under hygienic conditions, because of its dynamic biologic and biochemical structure, cheese is unstable (Arvanitoyannis and Mavropoulos, 2000). Previously, cheese was classified under "safe foods", but after 1980s, infections and intoxications related to the consumption of contaminated cheese with pathogen microorganisms and their toxins at manufacturing steps have been reported (Temelli *et al*. 2006). So, implementation of HACCP system became important in terms of ensuring the safe and hygienic cheese production. HACCP is defined as "an effective system based on Good Manufacturing Practices (GMP) and Standard Sanitation Operation Procedures (SSOP), for providing safe and healthy foods" (Pierson and Corlett, 1992). HACCP can be adapted to plants that produce different kinds of foods, but industrial applications show differences because the flow diagrams of the products differ. Thus, all production lines have different critical control points and HACCP plans (Topal, 2001).

Otlu cheese is one of the most known traditional Turkish cheeses and widely consumed in southeastern Anatolia espacially in Van. Otlu cheese is produced from sheep, cow or goat milk. The mixture of these three milks can also be used (Coşkun, 2005). This type of cheese can be produced from high acidity milk. Notralizing agents should not be used before manufacturing. Typical form of otlu cheese is quadrangle. Its typical size is, 7 cm in width, 7 cm in height. It is white or yellowish in color and is known as semi-hard cheese. Otlu cheese has a salty flavor and thyme odor can be sensed. Little holes can be seen on the surfaces of the cheese. The annual consumption amount of otlu cheese in Van city is 14.74 kg per person. Average chemical composition of Otlu cheese is given as Table 1.

Table 1. Chemical composition of Otlu cheese (Coşkun, 2005)

Dry material (%)	46.78
Protein (%)	22.17
Fat (%)	17.29
Ash (%)	6.85
Salt (%)	5.73
Calcium (mg/100g)	678
Phosphore (mg/100g)	416
Sodium (mg/100g)	1103
Potassium (mg/100g)	180
Magnesium (mg/100g)	33.40

Since, otlu cheese is produced from raw milk, mainly in small primitive dairies under poor hygienic conditions (Tekinsen and Ozdemir, 2006) and many kinds of herbs are added, there are important chemical, physical and microbiological contamination sources (Akyüz and Tunçtürk, 1992). The aim of this study is to present the hazard analysis on a traditional Turkish Otlu (Herby) cheese, for determining the critical control points of the process and establishing the HACCP system.

Flow diagram of Otlu cheese. After milking, raw milk is chilled to 4°C. Milk is kept at this temperature during transportation to the cheese manufacturing unit. First, milk is filtered for the removal of rough dirts and stored in tanks at refrigerator temperature. Then, milk is pasteurized. Pasteurazation can be performed in three different ways: at 61-65°C for 20-40 minutes or, at 71-75°C for 15-40 seconds or, 75-95°C for 1 seconds (flash heating) (Scott, 1981). After pasteurization, milk is cooled down to 32-35°C. At

*Corresponding author, mailing address: Celal Bayar University, Muhendislik Fakultesi, Gida Muhendisligi Bolumu, Muradiye Kampusu, Muradiye, 45140, Manisa, Turkey. Phone: +90 236 241 2144 (283) Fax: +90 236 241 2143. E-mail: bulent.ergonul@bayar.edu.tr

this temperature %1.5 cheese culture of a mixture of *Lactococcus lactis* subsp. *lactis* and *Lactococcus lactis* subsp. *cremoris*, then rennet is also added into milk for coagualation. After approximately 1 hour, coagulation is completed. Coagulum is cut by a knife in 1-2 cm^3 dimensions. Whey is removed by sieving and stirring. Then herbs are added into soft cheese. Herbs can be added at amount of %0.5-2.0. Otlu cheese containing %1 herb is the most preferred and widely produced in Van region. 25 different types of herbs are used in Otlu cheese manufacturing in Turkey. Some of them are, cünk (*Ranunculus polyanthemos* L.), cress (*Nasturtium officinale* R. Br.) , polo mallet (*Gypsophila* L. spp.), siyabo (*Silene vulgaris* Garcke var. Vulgaris), mendi (*Anthriscus nemorosa*), teasel (*Carum carvi* L.), dill (*Anethum graveolens*), heliz (*Prangos ferulacea* L.), hitik (*Ferula* L. spp.), thyme (*Thymus kotschyanus*), pennyroyal (*Mentha spicata* L. subsp. spicata), partridge herb (*Ziziphora clinopodioides*), sweet basil (*Ocimum basilicum* L.), asphodel (*Eremurus spectabilis* Bieb.), sirmo (*Allium fuscoviolaceum*), sirim (*Allium aucheri* Boiss.), handuk (*Allium paniculatum* L. subsp.) and sheeps sorrel (*Allium akaka* S.G. Gmelin).

Herbs are kept into brine solution until adding into cheese. So before adding they should be washed at least two times to remove the salt. Herbs are spreaded on soft cheese and mixed well. Cheese should be turned upside down to mix the herbs homogenous. Then, cheese is covered by press cloth and set aside for removal of the water in mixture. After a while, cheese is pressed by adding gradated weights on to remove the remained water. After removal of water, cheese is cut into pieces. Cheese pieces are put into brine solution (16% w/v) for at least 6 hours for salting process. Dry salting also can be performed. Ripening is performed under 4°C in brine. Ripening period is approximately 1 month. After ripening, cheese is marketed in brine solution or in individual vacuum packages for each piece of cheese.

Critical Control Points of Otlu Cheese Production Milking and Storage of Raw Milk. Milk should be obtained from healthy goats, cows or sheeps under hygienic conditions. In case of a disesase of mastitis, milk can be contaminated by *Staphylococcus aureus* and *Staphylococcus epidermidis*. The udder of the animal should be clenaed by an antimicrobial agent to remove these pathogen microorganisms. If antibiotic medicines are given to animals, these animals shoud not be used for milking until recovery. Feeds of the animals are also determined as critical control points. Heavy metal levels of feeds must be analyzed before giving to animals. Also, mycotoxin like organic substances may be found in feed. Mycotoxin analysis should be performed before purchasing the feed. Milk should be stored in tanks at 4°C until processing. Hygienic conditions of the tanks are important in terms of preventing the cross-contamination. Transportation of the milk from farm to plant should be realized under hygienic conditions at 4°C (assuring the cold chain). In this manner, microbiological growth can be prevented. While transportation temperature of the milk should be kept under control and should not be exceed 5°C.

Milking equipments and milking area should be cleaned and sanitized before and after the milking process. Also automated systems like Clean In Place (CIP) might be established in the plant to increase the effectiveness.

Raw milk
↓
Storage of milk in farm at 4°C
↓
Transportation of milk to the plants
↓
Incoming of raw milk into plant
↓
Filtration
↓
Storage in tanks at 4°C until processing
↓
Pasteurization
↓
Coooling down to 32°
↓
Starter culture addition
↓
Rennet addition
↓
Colagulation
↓
Coagulum cutting
↓
Removal of whey
↓
Adding herbs
↓
Mixing
↓
Pressing and straining
↓
Salting and ripening
↓
Packaging and storage

Figure 1. Sample flow diagram for otlu cheese manufacturing

Acceptance of Raw Milk. While transportation, breaking down of the cold chain may cause rapid microbiological growth in milk. Therefore, before acceptance microbiological and chemical analysis should be performed on milk. Antibioic residue tests, acidity and pH measurement should be done.

Cleaning the Milk by Filtration. Removal of the extraneous materials which are known as physical contaminants will be possible by an effective filtration

process. Therefore, this step should be taken into consideration as critical control point.

Storage of Raw Milk. Milk should be kept under refrigerator temperature at 4-5°C until processing into cheese. At this temperature, several psychrotrophic microorganisms can grow and multiply. So, proteolytic and lypolitic enzymes can be formed. Since, by pasteurization these microorganisms can be eliminated, only the enzymes will cause problems in terms of flavour and odor. *Bacillus cereus* which can form spores, can grow at low temperatures like 5°C. Its toxin may cause food poisoning. To eliminate the risk of the growth of these pathogens, milk should be kept at 4°C but no longer than 72 hours. Raw milk storage tanks should be well cleaned and sanitized to avoid the contaminations.

Pasteurization. The aim of the pasteurization is to kill the pathogen microorganisms present in milk. In otlu cheese manufacturing, criteria used for the pasteurization process are generally 71-75°C and 15-40 seconds. Heating has important effects on the chemical structure of the milk. Extended pasteurization process over than 40 seconds may cause denaturation of serum proteins (beta-lactoglobuline, alfa-lactoglobline, serum albumine and immunoglobuline). These denaturated proteins covers the casein misella and reduces the effect of rennet on k-casein. If high temperature is preferred, $CaCl_2$ (maximum 20g/100L) can be added into milk. Because, serum proteins in mil kare heat sensitive and least sensitive to calcium when compared to casein.
Insufficient pasteurization causes survival of pathogen microorganisms in milk. Thus, pasteurization temperature should be controlled during the process.
Pasteurizators should be cleaned and sanitized before and after every pasteurization process. Caustic (NaOH) solutions can be used fort he claning the equipments. After pasteurization, microbiological analysis of pathogen microrganisms can be performed to verify the effectiveness of the process.

Adding starter culture into milk. After pasteurization process milk is cooled down to 32-35°C. At this temperature, starter culture of the mixture of *Lactoccous lactis* subsp. lactis and *Lactococcus lactis* subsp. cremoris is added into milk. The percentage of the added culture is about 1.5% (v/v). After adding starter culture, milk is set aside for a while (30 minutes) at 32-35°C fort he growth of the starter microorganisms. Then rennet enzyme is added to colagulate the milk. Starter culture added into milk should be the pure culture of the microorganisms mentioned above. Thus, cross-contamination can be prevented. Starter culture addition should be realized under hygienic conditions by the experienced personnel.

Adding herbs into cheese. Herbs are waited in brine solution until used, to prevent spoilage. Before adding into cheese, herbs are washed well at least 2-3 times to remove the salt. Salt used for brining should be chemically pure, because it can be a possible chemical contaminate in this step. Salt should be purchased with an analysis certificate indicating its chemical purity. 1-2% (w/v) herbs can be added into cheese. Herbs are spreaded on the soft cheese and mixed well to obtain homogenous mixture of herbs and cheese. Microbiological and chemical analysis of herbs should be performed before using for preventing the contamination of pathogens. Since, herbs added into cheese are raw, possible chemical, physical and microbiological contaminations can be hindered only by well washing. Chlorine solutions can be used for washing the herbs. If chlorine solutions are used, after washing, herbs should be rinsed well with a potable water to remove the remained chlorine.
Also, pesticide, heavy metal and mycotoxine analysis should be performed on the herbs. Pesticides and heavy metals are the main chemical contaminations seen in herbs.

Ripening. Otlu cheese is waited in brine (16% w/v) for salting for at least 6 hours. Then otlu cheese pieces are put into open tins of 17 kg. Brine added on cheese and cheese is ripened in brine at 4°C for at least 1 month. During ripening, at higher temperatures and relative humidity, moulds can grow and multiply in cheese. So, temperature and the relative humidity of the ripening room should be under control.
An alternative ripening method is dry salting. Salt is spreaded on otlu cheese and cheese pieces are put into tins. Cheese is covered by salt to prevent the contact with air and tin is veiled with a piece of cloth. In this method otlu is ripened at 7-8°C for 3 months.

Storage of otlu cheese. Storage of otlu cheese should be realized under refrigerator temperature (4°C). During transportation, cold chain should be assured to prevent the microbiological spoilage. Stores used for storage of otlu should be cleaned and sanitized periodically to avoid cross-contaminations. Also FIFO (first in first out) system should be established for the removal of the cheese from stores. Tins used as packaging material should be purchased from reputable supplier and kept at stores under controlled relative humidity to avoid rusting. Before using, tins should be washed well with potable water to remove the dust and dirts in it. Microbiological analysis like swab technique can be used to determine the hygienic condition of tins.

CONCLUSION

Establishing of HACCP system to the production line of Otlu cheese is of great importance to assure the food safety and hygienic conditions during manufacturing.
HACCP should be considered as a system based on Good Manufacturing Practices (GMP) and Standard Sanitation

Operation Procedures (SSOP). GMP applications include building, environment arrangements and personnel hygiene and behaviors. Sanitary and hygienic conditions of the plant can be improved by SSOP applications.

Not only the HACCP also, an integrated Total Quality Management system, ISO-9002 and ISO-14001 for environmental management should be established for further improvements. Periodically trainings for the personnel should be given to assure the continuity of the system.

REFERENCES

Akyüz, N., Tunçtürk, Y. (1992). Van ilinin genel sütçülük durumu üzerinde bir araştırma. *Yüzüncü Yıl Üniversitesi Ziraat Fakültesi Dergisi, 2*(2), 1-12

Arvanitoyannis, I.S., Mavropoulos, A.A. (2000). Implementation of the hazard analysis critical control point (HACCP) systm to Kasseri/Kefalotiri and Anevato cheese production lines. *Food Control*, 11, 31-40.

Coşkun, H. (2005) Otlu Peynir. Gıda Teknolojisi Derneği Yayınları No:31. Bizim Büro Basımevi, Ankara.

Jay, J.M. (1992). Modern Food Microbiology. Chapman and Hall, New York. p. 701.

Pierson, M.D., Corlett, D.A. (1992). HACCP: Principples and applications. New York, Van Nostrand Reinhold, p. 212.

Scott, R. (1981). Cheesemaking practice. Applied Science Publishers Ltd., London, UK.

Tekinsen, K.K., Ozdemir, Z. (2006). Prevalence of foodborne pathogens in Turkish Van otlu (Herb) cheese. *Food Control*, 17, 707-711.

Temelli, S., Anar, S., Sen, C., Akyuva, P. (2006). Determination of microbiological contamination sources during Turkish white cheese production. *Food Control*, 17, 856-861.

Topal, Ş. (2001). Gıda Endüstrisinde Risk Yönetim Sistemi: HACCP ve Uygulamaları. Taç Ofset Matbaacılık, İstanbul. p. 172.