VERIFYING ICE CREAM PLANT SANITATION AND HAZARD ANALYSIS CRITICAL CONTROL POINT PROGRAM (HACCP) BY MONITORING THE BACTERIOLOGICAL QUALITY OF THE PLANT

By

Mona H. Abd-Elgawad

Rhino Quality assurance Department, Missouri Clombia Nutrition and Food Science

ABSTRACT

Hazard analysis critical control point (HACCP) system in the dairy processing industry is used to control hazards and minimize food safety risks for consumers of dairy products. The first part of the study was conducted to measure the hygienic conditions of an ice cream plant by detection of microbiological hazards and to determine the points in the process where critical conditions must be mentioned to ensure safety. 420 environmental swabs were obtained for analysis by using two methods, the first was IDEXX Lightning ™ Cleaning Validation System to estimate the total surface contamination (Adenosine triphosphate ATP bioluminescence measurement), while the second method was used for bacteriological analysis. The results achieved allow to conclude that all samples were failed the ATP bioluminescenee assay because they scored 3.0 and above, a surface passed only if it seored less than 3.0. *Coliformis*, *E. coli* and *L. innocua* were found in production of floor, cooler floor and drains samples. In the second part of the study, 450 of produced food samples in the plant were examined hacteriologically to evaluate the quality of each product. The results revealed that, 3 and 2 out of 60 ice cream pellets were found to be positive for *Coliformis* and *L. innocua* respectively, and 3 out of 60 cookie dough samples were positive for *L. innocua*. The importance of HACCP system have been discussed.

INTRODUCTION

Food-borne diseases have re-emerged as a major public health concern in the developed and developing countries. The risk of food-borne disease is substantially heightened by biological and chemical contamination of areas

where food is produced, processed and consumed (**Kaerstein and Aduussalam, 1999**). The United State Food and Drug Administration identified frozen dairy products as being at risk for contamination. Since post pasteurization contamination most likely occurs during flavoring, freezing, ingredient addition, and packaging operations, efforts to minimize environmental contamination in different area of the plant should decrease the likelihood and level of product contamination.

Outbreaks and sporadic cases of listeriosis during the 1980's have implicated contaminated dairy products and it was stated that milk is not considered a likely source for contamination because pasteurization is effective in eliminating the organism and the contamination of dairy products was most likely a result of post processing contamination from environmental sources (USDA 1996). The FDA dairy food initiative program revealed that 2.9 % of the finished dairy products tested contain *Listeria spp.* and investigators were able to identify situations in processing plants, which suggested that the environment was a sole of product contamination (**Pritchard, *et al.*, 1994**).

The numbers of *Coliformis* bacterial have long been used by dairy industry to indicate fecal contamination and general sanitary conditions of dairy products (**Jay, 1992**) and a particular attention has been paid to *E. coli* that has been involved in recent outbreaks associated with consumption of pasteurized milk (**Upton and Coia, 1994, Dillon and Griffth, 1999**).

Several salmonellosis outbreaks were also identified and a cross connection between raw and pasteurized milk was identified as the most probable cause of those outbreaks. Contaminated ice cream with *Salmonella enteritidis* was associated with a 1994 multistate outbreak at the USA (**Vought and Tatini, 1998**). *Salmonella* also considered the most common food-borne pathogen in the world because for the last two decades, salmonellosis incidence has been constantly increasing (**Tauxe, 1991**).

Staphylococcal food poisoning followed the handling of food by persons who carry enterotoxgenic staphylococci in their noses or skin and employee practicing poor personal hygienic habits (**Tauxe and Hughes, 1996**). Poor refrigeration or inadequate heating also speeds up the growth of this bacterium in the food leading to production of the heat stable toxins. that food containing the toxins will still cause food poisoning.

As a consequence, the implementation of hazard analysis critical control point (HACCP) system in the dairy industry should be evaluated, monitored and enforced as an alternative to traditional inspection, rating/check system.

With respect to microbiological hazards, the National Advisory Committee on Microbiological Criteria for Foods recognizes that the microbiological sampling and testing can be important means to verify that a HACCP plan is under control (**NAMCF, 1998**).

The purpose of this study was to measure the hygienic conditions of an ice cream plant by detection of the bacteriological hazards. A hazard analysis which included watching operations, measuring temperature of dairy products throughout receiving, preparation and storage, and bacteriological testing (TBC, *Coliformis, E. coli, Listeria, Staphylococcus aureus and Salmonella*), swabbing critical and non-critical environment were conducted to verify hygienic adequacy of final product and HACCP plan.

MATERIAL AND METHODS

A large ice cream and frozen dessert plant was used in this study, which operated two shifts production and the third shift for sanitation. A formal HACCP plan was being created by plant management. This plan includes a prerequisite program and standard operation procedures (Fig. 1). Some critical control points (CCPs) were identified. The CCPs plan included CCP # 1 cooler temperature maintained at < 40° F for all dairy ingredients storage, CCP # 2 microbiological assessments of each product (every shift) of < 40/gm *Coliformis* (all products including received ingredient must be free from fecal contamination), must contain < 10000/gm total bacterial count, must be negative for *Listeria, Salmonella, Staphylococcus aureus and E. coli* and CCP # 3 is metal detector check for the finished products (control of foreign materials). All products must be put on hold until determined that all the outlined CCPs criteria are met, then release paper is checked for a completed HACCP review for the finished product lot being reported.

ATP bioluminescence assay of environmental swabs:

Because Adenosine triphosphate (ATP) is widely found in organic debris and microorganisms, ATP bioluminescence measurements provides a real time estimate of total surface contamination. Consequently, this method provides a measure of overall cleaning efficacy, and the ability to provide this information within minutes has prompted some authors to recommend ATP testing for use in HACCP plan (**Griffth, 1993; Chen, 2000; Illsley *et al.*, 2000 and Moore, 2001**).

IDEXX Lightning [TM] Cleaning Validation System (IDEXX laboratories, inc, Westbrook, ME) was used. The illuminometer was calibrated according manufacturer's instructions before use. The reading was taken immediately after swabbing. Control assays were conducted using unused swabs. Readings were recorded. A surface passes if it scored less than 3 and failed if the score is 3.0 and above.

Bacteriological analysis of environmental swabs:

450 samples were obtained via the sponge method (**Silliker and Gabis, 1975**). Surfaces identified as potential areas of concern were sampled after cleaning and sanitation and areas were divided into two categories, critical

(direct contact surfaces as conveyors, belts, mixing vats, equipments, gloved hands, tables and pails) and non-critical swabs (floor, freezers, coolers, drains, entrances and exits for the production and storage areas and foot bathes).
The sponges were placed back in the whirl pack ™ bags, stored at refrigeration temperature and processed within 24 hours of collection, then subjected to bacteriological analysis.

Bacteriological analysis of food samples:

A total of 450 samples (from the beginning and the end of each shift) of ice cream novelties, cookie dough, cookies, cheese cake and ice cream pellets, ice cream mixes, pasteurized whole egg and pasteurized white egg were examined for the total bacterial count (TBC), *Coliformis*, *E. coli* by using 3M petrifilm standard method (SM, 3M, Company, st. Paul MN), Listeria monocytogenes (**Cunniff, 1995**), *Staphylococcus aureus* and *Salmonella* (**Hitchins, 1995**).

Fig. (1): Common flow diagram of dairy products produced by the plant

Receiving critical materials (Ingredients)

Attribute	Specification	Sampling plan	Action
Temperature Integrity TBC *Coliformis* *E. coli* CP *Staphylococci* *Samonella* *Listeria*	Must be less than 40° F No holes or leaks > 10000 Not more than 10/g. Negative Negative Negative Negative	Representative samples were randomly collected for baeteriological tests.	Lot is accepted if all physical and bacteriological specifications are satisfied. (COAs) or FDA guarantee.

↓

In process controls

Attribute	Specification	Sampling plan	Action
Weight, overrun, density Product evaluation form Code certification Metal detector * Temperature * Micro and retention *	Compliance with regulation and standard specification set for each product (QA)	Once every hour Once every hour Must be done Once every hour Once every hour Once every hour	Adjust any deviation with the appropriate department (QA maintenance, production, sanitation).

↓

Sanitation control

Objective	Procedure	Frequeney	Specification	Action
Production line	Inspect (ATP) swabbing (critical and non-critical).	Daily inspection Weekly inspection	Compliance with GMPs.	Stop production and investigate problem. sanitize and resample.

Packing

(product, containers, cleanliness, net weight, code, metal detector, label)

Storage

Operation	Specification	Monitoring	Action
Palletizing Storage temperature	All products are to be stored on pellet above floor with pallets placed at least 12" from wall. Maintain area storage in a matter not to contaminate food.	Daily inspection by warehouse manger is required. Temperature ranges must be prominently shown at area entrances. QA must monitor temperature recorders and alarm systems twice a shift or more frequently.	Corrections must be made id needed If temperature is not met product condition must be checked. If quality has been impaired. remove, micro testing. dispose of as necessary.

RESULTS AND DISCUSSION

Measuring the bacterial counts of final products verifies the adequacy or inadequacy of the hygienic control for all proceeding process. ICMSF regulations call for a temperature of less than 40 ° F (< 4° C) for ingredients received as ice cream mixes, pasteurized egg and final temperature of finished ice cream and frozen dessert is -18 to -20 ° F. It was shown that this plant met this requirement (all temperature chart was checked, temperatures of received ingredients were checked and recorded) and no deviation was noticed.

Table (1) shows that all of the products examined seemed to have relatively low total bacterial counts except the pasteurized white egg, which has a relatively higher TBC, which ranged from 10^3-$8x10^3$ CFU/gm. However, all counts were less than the specification (10.000 CFU/gm) set by the FDA. 3 out of the 60 ice cream pellets were found to be positive for *Coliforms* but they did not contain any countable level of *E. coli*. Also, 2 out of ice cream pellet samples examined were found to be positive for *L. innocua*. 3 out of 60 cookie dough samples examined were found to be positive for for *L. innocua*. Baking the cookie dough will be enough to destroy *Listeria* and *Coliforms*.

Pellets were of a great concern because it is containing eggs, sugar, chocolate, etc. All kinds of ingredients that support growth of pathogen will not be subjected to any further heat treatment but it will be added to the ice cream as an adding.

Inconsistent use of cleaning and sanitizers allows food debris to be accumulated, then this soon become support for microbial growth and contamination. As seen in the environmental survey results in (Table 2)

showed that 3/30, 2/30, 5/30, 9/30, 10/30, 1/30, 5/30, 30/30, 19/30, 3/30, 2/30, 9/30, 20/30, 4/30, 1/30 of conveyers, belts, mixing vats, gloved hands, production floor, freezer floor, cooler floor, drains, entrances, plastic strips, dry storage area, maintenance tools, foot bathes, and tables, respectively failed the ATP bioluminescence assay because they scored 3.0 and above. The same surfaces, which did not pass the ATP test, were found to have a high total bacterial count. ATP gave only an indication of bacterial numbers. Also, ATP method only provides a primary measure of overall cleaning efficacy.

The production floor was found to be harboring *Coliforms*, *E. coli* and *L. innocua* 5/30, 2/30 and 10/30, respectively. Cooler floor and drains were also found to have *Coliforms*, and *L. innocua* in 6 out of 30 and 10 out of 30 sites examined, respectively. Our result is inagreement with results of (**Richard *et al.*, 1991 and Pritchard *et al.*, 1994**).

This should increased awareness that floor and drain cultures can be used as a reflection of overall environmental contamination status in the plant and this may results in improving treatment of drains and floors with very strong disinfectants to eliminate *Listeria* and other pathogenic microorganisms.

All other sites especially the direct contact surfaces were found to be pathogen free. Only pails used for frozen, reworked, or premixed ingredients were found to contain *Coliforms* in high numbers. *Coliforms* bacteria are susceptible to hot water and sanitizers, therefore their presence indicates poor sanitation control of these potential pathogens (**Jay, 1992**). The pails were found to be stored after its sanitation beside the washroom uncovered and consequently recontamination took place from the other soiled objects.

On the basis of these potential hazards, it was recommended that the pails must be washed thoroughly and sanitized before every use. Non-food contact surfaces (e.g. floors, walls, drains) should be cleaned regularly with very strong powerful disinfectant, use of practices which will help dry, or lessen the amount of wet areas/pooled water within the cooler, freezer and production floor in addition to maintain their integrity (no cracks or cervices) will help in the control of pathogens. Finished product should be cooled/frozen and stored in an area physically separated from the production floor to avoid cross contamination.

All employees should be trained in Good Manufacturing Practices (GMPs) and sanitation control. GMPs are guidelines established by Federal and States agencies to assure that food are manufactured and stored under safe and sanitary conditions, this includes personal practices (disease control, personal hygiene, uniforms, footwater and hand washing).

In conclusion, microbiological assessment of food and monitoring the surrounding environment is recognized as a critical control points in validation of the HACCP system. If the environmental surfaces are not

washed properly and sanitized, they may be source for microbiological hazards. Because no ideal method exists for determining the cleanliness of surfaces we recommended regular microbiological evaluation beside ATP bioluminescence testing and visual-inspection for monitoring surfaces hygiene of dairy processing plant. This will help correlate food safety hazards during the inspection with the inspected area and responsible personnel. The potential scope of application of HACCP is immense, as are the potential benefits and a systemic stepwise evaluation of a process from start to finish will highlight certain areas that may improve not only product safety, but also product quality and efficiency of production.

REFERENCES

Chen, J. (2000): ATP bioluminescence: A rapid indicator for environmental hygiene and microbial quality of meats.
Dairy Food Environ. Sanit. 20: 617-620.

Cunniff, P. (ed.) (1995): Official methods of analysis of AOAC International, 16th ed. AOAC International, Gaithersburg, MD.

Dillon, M. and Griffth, C. (1999): How to clean: A management guide. M. D. Associates, Grimsby, UK.

Griffth, M. W. (1993): Applications of bioluminescence in the dairy industry. J. Dairy Science. 76: 3118-3125.

Hitchins, A. D. (1995): Chapter 10 . Listeria monocytogenes. In G. J. Jackson (Coordinator) FDA bacteriological analytical manual. 8 th ed. AOAC International, Gaithersburg, MD.

ICMSF, (1998): HACCP in microbiological safety and quality: International Commission on Microbiological Specification for Foods. Blackwell, Oxford.

Illsley, R. A.; Jackson, E. D. and Feirtag, J. M. (2000): Evaluation of the sanitation program at a baking facility for production of a low acid, fruit-based, shelf stable product.
Dairy Food Environ. Sanit. 20: 338-342.

Jay, J. M. (1992): Modern Food Microbiology. 4th ed. Chapman and Hall, New York.

Kaerstein, F. and Abdussalam, M. (1999): Food safety in the 21st Century. Dairy Food and Environmental Sanitation. 19 (11): 760-763.

Moore, G.; Griffth, C. and Fielding, L. (2001): A comparison of traditional and recently developed methods for monitoring surface hygiene within the food industry: Laboratory study.
Dairy Food and Environ. Sanit. 21: 478-488.

NACMCF, (1998): Hazard analysis and critical control point principles and application guidelines.
J. Food Prot. 61: 762-775.

Prtichard, T. J.; Beliveau, C. M.; Flanders, K. J. and Donnelly, C. W.

(1994): Increased incidences of *Listeria* species in dairy processing plants having adjacent farm facilities.
J. of Food Prot. 57: 770-775.

Silliker, J. H. and Gabls, D. A. (1975): A cellulose sponge sampling technique for surfaces.
J. Milk food techno. 38: 504.

Sun-Young Beak, Soon-Yong Lim, Dong-Ha and others (2000): Incidence and characterization of Listeria monocytogenes from domestic and imported foods in Korea.
J. Food Prot. 63 (2). P. 186-189.

Tauxe, R. V. (1991): Salmonella: a postmodern pathogen.
J. Food Prot. 54: 563-568.

Tauxe, R. V. and Hughes, J. M. (1996): International investigation of outbreaks of food-borne disease: public health responds to the globalization of food.
Br. Med. J. 313: 1093-1094.

Upton, P. and Coia, J. E. (1994): Outbreak of *Eschericia coli* O157: H7 infection associated with pasteurized milk supply.
Lancet, 344: 1015.

U. S. Department of Agriculture Food Safety and Inspection (1996): pathogen reduction; hazard analysis and critical control point (HACCP) systems. Final rule.
Fed. Regist. 61: 38806-38989.

Vought, K. J. and Tatini, S. R. (1998): *Salmonella enteritidis* contamination of ice cream associated with a 1994 multistate outbreak.
J. Food Prot. 61: 5-10.

Table (1): Prevalence of food-borne pathogen in the examined product.

Type	Size	TBC Range	*Coliforms*	*E. coli*	*Listeria*	*Sal.*	*Sta.*
Ice cream novelties	60	70-450	-ve	-ve	-ve	-ve	-ve
Cookie dough	60	20-1700	-ve	-ve	3/60 were +ve *L.innocua*	-ve	-ve
Cookies	60	0-20	-ve	-ve	-ve	-ve	-ve
Minis	60	50-300	-ve	-ve	-ve	-ve	-ve
Ice cream pellets	60	400-4000	3/60 were + ve	-ve	2/60 were +ve *L.innocua*	-ve	-ve
Ice cream mixes	50	10-460	-ve	-ve	-ve	-ve	-ve
Past. Whole egg	50	160-780	-ve	-ve	-ve	-ve	-ve
Past. White egg	50	10^3-$8x10^3$	-ve	-ve	-ve	-ve	-ve

Table (2): Bacteriological evaluation of the environmental samples.

Site	Size	ATP	TBC Range	*Coliforms*	*E. coli*	*Listeria*	*Sal.*	*Sta.*
Conveyors	30	3/30	10^2-10^3	< 10	-ve	-ve	-ve	-ve
Belts	30	2/30	10-10^5	< 10	-ve	-ve	-ve	-ve
Mixing vats	30	5/30	10-10^3	< 10	-ve	-ve	-ve	-ve
Gloved hands	30	9/30	10-10^4	< 10	-ve	-ve	-ve	-ve
Production floor	30	10/30	10^5-10^7	5/30 were +ve	2/30 were + ve	10/30 were + ve *L. innocua*	-ve	ve
Freezer floor	30	1/30	10-10^3	< 10	-ve	-ve	-ve	-ve
Cooler floor	30	5/30	10^2-10^6	6/30 were +ve	-ve	6/30 were + ve *L. innocua*	-ve	-ve
Drains	30	30/30	10^5-10^7	10/30 were + ve	-ve	10/30 were + ve *L. innocua*	-ve	-ve
Entrances	30	19/30	10-10^5	< 10	-ve	-ve	-ve	-ve
Plastic strips	30	3/30	10-10^4	< 10	-ve	-ve	-ve	-ve
Dry storage area	30	2/30	10-10^2	< 10	-ve	-ve	-ve	-ve
Maintenance tools	30	9/30	10-10^3	< 10	-ve	-ve	-ve	-ve
Pails	30	20/30	10-10^4	9/30	-ve	-ve	-ve	-ve
Foot bathes	30	4/30	10-10^2	< 10	-ve	-ve	-ve	-ve
Tables	30	1/30	10-10^4	< 10	-ve	-ve	-ve	-ve

الملخص العربي

التحقق من الأشتراطات الصحية لمصنع آيس كريم وتحديد نقاط الخطر باستخدام الطرق البكتريولوجية

مني هاشم عبد الجواد

قسم مراقبة الجودة للأغذية بولاية ميزوري - كلومبيا

يستخدم برنامج مراقبة الجودة أثناء تصنيع منتجات الألبان في تحديد نقاط الخطر والسيطرة عليها لجعل المنتج أكثر أمانا للمستهلك. وقد أجري هذا البحث لقياس الجوانب الصحية لمصنع الآيس كريم ومعرفة الجودة البكتريولوجية للمنتج النهائي باستخدام طريقتين ، أولا طريقة قياس التألق الحيوي لثلاثي فوسفات الأدينوسين **ATP** لمعرفة التلوث السطحي وثانيا طريقة التحليل البكتريولوجي. وقد أظهرت نتائج أنه باستخدام الطريقة الأولي لم يتم الحصول علي نتائج ايجابية. وبالتحليل البكتريولوجي لعدد ٤٥٠ عينة من منتجات المصنع وجد أن ٣ و ٢ من ٦٠ عينة فقط من الآيس كريم كانت ايجابية بالنسبة للكوليفورم و الليستريا أنوكوا ، أما باقي العينات فكانت سلبية وتم مناقشة أهمية تطبيق الأشتراطات الصحية وبرنامج مراقبة الجودة في المصنع.