Food safety system application during production of ice cream

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ABSTRACT

Ice cream is one of the main dairy products and a nutritionally food. It is one of the favorite food items to a large segment of the population particularly by children. This study investigates to hygienic quality of ice cream through the application of Food Safety System. Ninety samples were collected during the production of ice cream. Thirty samples were collected before the application of the system; thirty samples were collected after the application of the system and thirty samples were collected from swabs. The samples were examined for the presence of, coliforms, fecal coliforms, Bacillus cereus, Staphylococcus aureus, mold, and yeast count. The obtained results indicated that the microbial count of samples before the application of the Food Safety System was higher than those after the application of the system. They ranged between 1.2 x 106 to 1.8 x 103, 8.0 x 101 to negative, 2 x 102 to negative, 7.0 x 102 to 1.9 x 102 and 2.4 x 105 to 2.3 x 103 / gm in the packaging stage at aerobic total count, coliforms, Bacillus cereus, Staphylococcus aureus, mold and yeast count respectively, while fecal coliforms were not detected in both before and after system application.

Keywords: *Food safety system- ice cream production*

INTRODUCTION:

The application of Food Safety System can aid in inspection by regulatory authorities through focusing on the matters of high health risk and promote domestic and international trade by increasing confidence. In addition to enhanced food safety, the benefits of applying HACCP include better use of resources and more timely response to production problems **Chen et al (2013)**.

Food safety has become a main thing in the world making public health agencies and governments of several countries look for more efficient ways to monitor production chains. Food Safety System is a means to ensure the safe production of food products. It is an assurance system based on the prevention of food safety problems and is accepted by the international authorities as the most effective means of controlling food-borne diseases. The implementation of food safety system will produce the safe food and suggest the control measures because it will improve the quality of ice cream **United Nations Codex Alimenterius, (2003).**

HACCP, as a food safety assurance program, requires continuous monitoring of established critical limits at ccp and the verification of evaluation compliance with the approved HACCP plan **(WHO, 1995).**

Ice cream is one of the main dairy products. It is one of the favorite food items to a large segment of the population. It is a nutritionally and an enriched frozen dairy product consumed by all age groups particularly by children and mostly during summer. Ice cream is sold in a package form (cups, cones, and cartons).

AIMS OF THE WORK

1. Assessment of hygienic quality of ice cream through the application of Food Safety System.
2. Finding the critical control point by observing each step of the production operation.

Materials and methods:

This study was carried out at a company in Cairo for 10 months. Visit intervals were once a week.

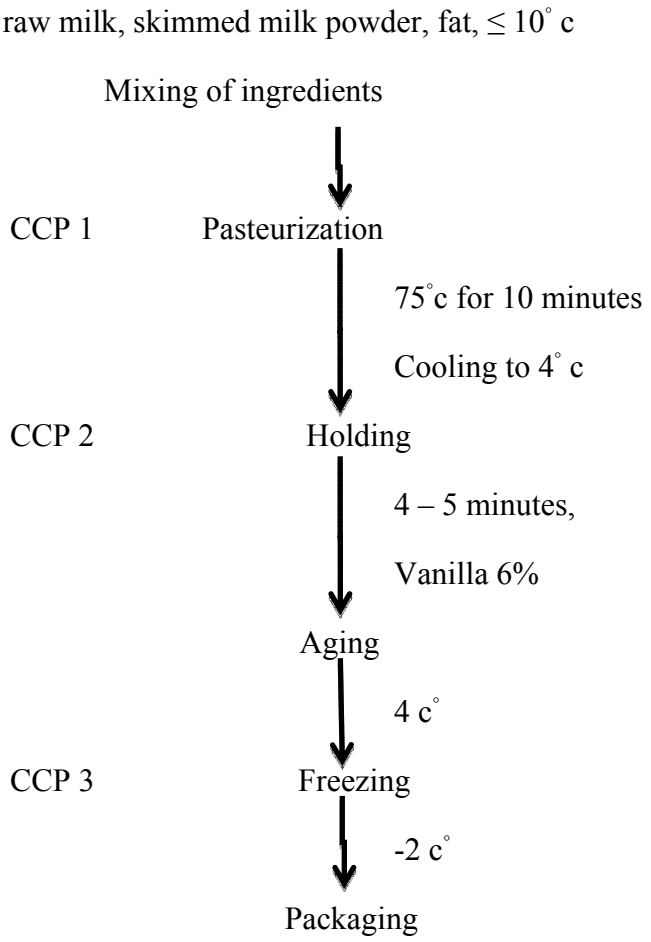
The total number of samples analyzed was: thirty samples that were collected before the application of Food Safety System; five samples were taken from each step, thirty samples were collected after the application of Food Safety System then 30 swab samples that were taken from tables, walls and food handlers.

All of these samples were tested for the identification microbial hazards included: aerobic total count, coliforms, fecal coliforms, *Bacillus* cereus, *Staphylococcus* aureus and mold and yeast count.

Samples were collected in sterile bags and kept inside an ice box until they reached the laboratory.

The microbial procedures were recommended in the International Commission on Microbiological Specifications for Foods **(ICMSF 1978, 1995).**

Ice cream consisted of packaged frozen mixture of raw milk, fat, skimmed milk, sugar and vanilla which was exposed to 75° c then suddenly cooled to 4° c before being frozen at -2° c. This product is consumed by all population.



Flow diagram of ice cream production process

RESULTS and DISCUSSION:

Table (1) illustrates the microbial counts of ice cream produced before food safety system application. It can be seen from the table that the aerobic count, mold and yeast were higher in both mixing ingredients and packaging steps than in the other steps. The table also shows that no growth of fecal coliforms was found in all the steps. *Staphylococcus* aureus was found in receiving of raw milk and transferred from hands to udder and milk during milking and from microbial contained in improperly cleaned equipment, microbial growth during storage and delivery **Giffe et al (1996) and Sharof et al (1989).**

Table (2) shows the hazard analysis chart of ice cream production. It can be seen from the table that the hazards in all the production steps of ice cream were microbial survival and growth, cross contamination and environmental contamination. The preventive measures included the use of safe ingredients, safe utensils and tanks, clean environment, control of time and temperature, the application of sanitary measures and personal hygiene of food handlers. **Yu-Ting Hung et al, 2015** noticed that the monitoring of CCP is essential to ensure that the specific criteria are being met. Monitoring procedures were implemented by the HACCP team to ensure that all CCPs were under control.

Table (3) shows the HACCP control chart of ice cream production. It can be seen from the table that the critical limit of the holding step was cool and hold at 4 c° for 5 minutes. The critical limit of step 2 was to heat at 75 c° for 10 minutes and the critical limit of step 5 was freezing at -2 c°. The procedure of monitoring in

all the steps of ice cream production was of time and temperature measurement. The corrective actions of step 2 was re-heating at 75 c° and then re-cooling suddenly at 4 c° for 5 minutes (pasteurization) **Kassem et al, (2010).**

Table (4) shows the microbial counts of a random sample during ice cream production taken after the application of HACCP. It can be seen from the table that after HACCP application both the aerobic total count and mold and yeast count were higher during mixing of ingredients than in the other steps. The aerobic total count during mixing of ingredients was 4.3 x 10^4, this decreased to 1.8 x 10^3 during packaging. On the other hand, mold and yeast decreased from 2.8 x 10^5 during the mixing of ingredients step to 2.3 x 10^3cfu/g during packaging. Also, the table shows that both *Bacillus* cereus (7.0 x 10^1) and coliforms (4.5 x 10^1) were identified only during the mixing of ingredients step. *Staphylococcus* aureus was detected in all the production steps. Mean counts ranged between 1.0 x 10^2 and 1.6 x 10^2 colony/g. **Kassem et al (2010)** reported that microorganisms were found to survive in the degree (≤10°C) and also could be attributed to poor hygienic conditions and lack of sanitation.

Table (5) shows a comparison between the microbial counts before and after HACCP application during ice cream production. It can be seen from the table that the microbial counts before HACCP application are higher in all the steps than after HACCP application, whereas, the growth of fecal coliforms was negative in all the steps of ice cream production both before and after HACCP application. *Bacillus* cereus

was not detected after HACCP application in all the production steps except during the mixing of ingredients step. On the other hand, *Staphylococcus* aureus decreased after HACCP application in all the production steps. **El Tawila (2001)** also reported that the decrease in the microbial count after HACCP system application indicated its successful application at food establishments.

Table (6) shows the microbial count of swab samples taken from tables, walls and food handlers. It can be seen that the swabs from the tables had aerobic bacteria, mold and yeast and coliforms of 5.0 x 10^2, 1.7 x 10^4 and 2.0 organisms, 30 cm^2, while no growth of other microorganisms was found. The aerobic bacteria and mold and yeast were 3.1 x 10^3 and $3.0x10^3$cfu/cm^2 respectively in walls, while no growth of other microorganisms was found on the walls. Also, the aerobic bacteria, coliforms, *Staphylococcus* aureus and mold and yeast were 3.0 x 10^2, 3.0, 4.0 x 10^2 and 1.0 x 10^2 respectively from food handlers, while no growth of other microorganisms was found. Food handlers, walls, tables and utensils which were used during the production of ice cream were unclean and unsafe. The satisfactory cleaning of equipment, utensils, walls and tables is very important **(Bryan 1981)** and **(Bryan 1991).** Poorly cleaned utensils, equipment and tables' surfaces are known to harbor and promote the spread of microorganisms **(Aureliet al 1996).**

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Table (1): The microbial counts of ice cream produced before Food safety system application

Microbial test	Mixing of ingredients	Pasteurization	Holding	Aging	Freezing	packaging
Aerobic total count	2.3×10^6	1.2×10^3	1.6×10^3	2.0×10^3	3.7×10^3	1.2×10^6
Coliforms	7.0×10^1	5.0×10^1	7.0×10^1	7.8×10^1	7.8×10^1	8.0×10^1
Fecal coliforms	- ve	- ve	- ve	- ve	- ve	- ve
*Bacillus*cereus	78.0×10^1	3.0×10^1	3.0×10^1	1.0×10^2	1.0×10^2	1.2×10^2
*Staph.*aureus	1.6×10^2	1.3×10^2	1.3×10^2	1.5×10^2	1.5×10^2	7.0×10^2
Mold & yeast	3.4×10^5	3.7×10^3	4.0×10^3	4.0×10^3	4.2×10^3	2.4×10^5

Mean number of samples = 6 from each step

Table (2): Hazard analysis chart of ice cream production

Process Step	Hazard	Preventive Measures
1- Mixing of ingredients	▪ High load of microorganisms ▪ Cross contamination from utensils and food handlers ▪ Environmental contamination	▪ Use of safe ingredients ▪ Use clean and safe utensils (GMP) ▪ Personal hygiene during mixing (GMP) ▪ Clean environment (GMP)
2- Pasteurization	▪ Microbial survival	▪ Time and temperature control
3- Holding	▪ Spores germination ▪ Cross contamination during holding in the storage tank	▪ Time and temperature control ▪ Clean tank (GMP)
4- Aging	▪ Multiplication of microorganisms ▪ Microbial cross contamination from utensils and the tank	▪ Time and temperature control ▪ Use clean tank and utensils (GMP)
5- Freezing	▪ Growth multiplication of microorganisms	▪ Time and temperature control
6- Packaging	▪ Multiplication of microorganisms ▪ Cross contamination from wrapping materials, food handlers and the environment	▪ Time and temperature control ▪ Clean wrapping materials ▪ Cleaning and disinfecting of the packaging line ▪ Application of sanitary measures and personal hygiene of food handlers

Table (3): HACCP control of ice cream production

Process step	CCP	Hazard	Preventive measures	Critical limits	Monitoring		Corrective action
					Procedures	frequency	
2- Pasteurization	1	Microbial survival	Time and temperature control	Heating at 75 c° then cooling at 4 °c	Time and temperature measurement	At each pasteurization step	Re-heating at 75 c° for 10 minutes then cooling at 4 c°
3- Holding	2	Cross contamination during holing in the storage tank	Time and temperature control	Time of temperature 4 c° for not more than 5 minutes	Time and temperature measurement	At each holding step	Repeat step 2 if contamination was evident
5- Freezing	3	Growth multiplication of microorganisms	Time and temperature control	Freezing at -2 c°	Time and temperature measurement	At each freezing step	Discard the product if contamination was evident

Table (4): The microbial counts of a random sample during ice cream production taken after the application of HACCP

Microbial test	Mixing of ingredients	Pasteurization	Holding	Aging	Freezing	Packaging
Aerobic total count	4.3×10^4	2.1×10^1	2.3×10^2	3.2×10^2	1.2×10^3	1.8×10^3
Coliforms	4.5×10^1	- ve	- ve	- ve	- ve	- ve
Fecal coliform	- ve	- ve	- ve	- ve	- ve	- ve
*Bacillus*cereus	7.0×10^1	- ve	- ve	- ve	- ve	- ve
*Staphylococcus*aureus	1.6×10^2	1.0×10^2	1.0×10^2	1.0×10^2	1.0×10^2	1.0×10^2
Mold & yeast	2.8×10^5	4.1×10^2	2.1×10^3	2.1×10^3	2.1×10^3	2.1×10^3

Table (5): A comparison between the microbial counts before and after HACCP Application during ice cream production

Microbial test	Mixing of ingredients		Pasteurization		Holding	
	Before HACCP	After HACCP	Before HACCP	After HACCP	Before HACCP	After HACCP
Aerobic total count	2.3×10^6	4.3×10^4	1.2×10^3	2.1×10^1	1.6×10^3	2.3×10^2
Coliforms	7.0×10^1	4.5×10^1	5.0×10^1	- ve	7.0×10^1	- ve
Fecal coliforms	- ve	- ve	- ve	- ve	- ve	- ve
*Bacillus*cereus	8.0×10^1	7.0×10^1	3.0×10^1	- ve	3.0×10^1	- ve
Staphylococcus aureus	1.6×10^2	1.6×10^2	1.3×10^2	1.0×10^2	1.3×10^2	1.0×10^2
Mold & yeast	3.4×10^5	2.8×10^5	3.7×10^3	4.1×10^2	4.0×10^3	2.1×10^3

Con. table (5)

Microbial test	Aging		Freezing		packaging	
	Before HACCP	**After HACCP**	**Before HACCP**	**After HACCP**	**Before HACCP**	**After HACCP**
Aerobic total count	2.0×10^3	3.2×10^2	3.7×10^3	1.2×10^3	1.2×10^6	1.8×10^3
Coliforms	7.8×10^1	- ve	7.8×10^1	- ve	8.0×10^1	- ve
Fecal coliforms	- ve	- ve	- ve	- ve	- ve	- ve
*Bacillus*cereus	1.0×10^2	- ve	1.0×10^2	- ve	1.0×10^2	- ve
Staphylococcus aureus	1.5×10^2	1.0×10^2	1.5×10^2	1.4×10^2	7.0×10^2	1.5×10^2
Mold & yeast	4.0×10^3	2.3×10^3	4.2×10^3	2.3×10^3	2.4×10^5	2.3×10^3

Table (6): The microbial count of the swab samples taken from table, wall, and food handlers.

Microbial test	Tables	Walls	Food handlers
Aerobic total count	5.0×10^2	3.1×10^3	3.0×10^2
Coliforms	2.0	- ve	3.0
Fecal coliforms	- ve	- ve	- ve
*Bacillus*cereus	- ve	- ve	- ve
*Staphylococcus*aureus	- ve	- ve	4.0×10^2
Mold & yeast	1.7×10^4	3.0×10^3	1.0×10^2

Mean number of samples = 10 swabs

تطبيق نظام سلامة الغذاء أثناء إنتاج الآيس كريم

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الآيس كريم من المنتجات ذات القيمة الغذائية العالية والمفضلة خاصة لدى الأطفال في فصل الصيف. وقد أجريت هذه الدراسة على 90 عينة من الآيس كريم أثناء وبعد تطبيق نظام سلامة الغذاء وتم أخذ مسحات من أماكن مختلفة وبينت النتائج أن المحتوى الميكروبي بالتطبيق النظام كان عالياً وأصبح أقل أو منعدم بعد تطبيق هذا النظام الآمن. حيث تراوح العد البكتيري الهوائي بين 1.2 x 10^6مستعمرة ميكروبية إلى 1.8 x 10^3 مستعمرة ميكروبية لكل جرام في مرحلة التعبئة. وتراوحت مجموعة القولون من 8 مستعمرات/ جرام إلى عدم تواجدها في مرحلة التعبئة.وتراوح ميكروب باسيليس بريسمن 2 x 10^2/ جرام إلى عدم تواجده وتراوح ميكروب المكورات العنقودية من 7 x 10^2إلى 1.9 x 10^2مستعمرة / جرام.وتراوحت مجموعة الخمائر والفطريات بين 2.4 x 10^5 إلى 2.3 x 10^3 مستعمرة / جرام. في حين أن مجموعة القولون المعوي لم تتواجد قبل وبعد تطبيق نظام سلامة الغذاء.

الكلمات المفتاحية: *نظام سلامة الغذاء- إنتاج الأيس كريم*