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Contamination in Dairy Chains and Approaches to Quality Control in Egypt

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Abstract

In Egypt dairy industry plays important role in Egyptian agriculture. The dairy industry is dominated by a large informal sector. About 50% of the produced milk is used for cheese making; 80% of the cheeses are made from raw milk without prior heat treatment by unlicensed factories, which use harmful raw materials and chemicals to produce cheese that may cause severe health problems. The safety of milk and milk products has been under discussion for many years. This study was aimed at getting a better understanding of the milk value chain as well as identifying the critical points for quality insurance of cheese produced in Egypt . All microbiological quality parameters indicated low milk quality just before the milk is transferred into cheese factories. These results suggest that milk is heavily contaminated right from the farm level, Analysis of the raw milk quality through the informal sub sector in Egypt revealed two main issues: (I) Poor hygiene conditions from the production location all the way to the cheese factories. (II) Lack of an efficient preservation system to limit bacteria proliferation during storage and transportation. An analysis of cheese production practices indicated that the majority of producers did not employ good hygiene practices to minimize contamination of cheese. For instance, most cheese producers did not test the bacteriological quality of the received milk. Traditional cheese processors have not focused much attention on milk bacteriological quality In addition, milk- handling equipment and cheese making facilities was not sufficiently cleaned. Lack of potable water and use of detergents was a major constrain to hygienic practices on cheese factory. Such bad practices led to heavy contamination prior, during and after pasteurization process during cheese making.

Raising the hygienic quality of milk is critical for the local supply chains, which face greater challenges in this respect than those in temperate climates. Worldwide, there are two alternative models to ensuring dairy product safety: in the U.S.A., the focus is on regulatory control and sterilization, while in Europe the focus is on managing quality and safety along the chain, from the cow to the consumer. This latter approach would seem more appropriate in the developing country context, where regulatory systems are weak and where contamination problems occur all along the chain. Examples of the chain approach to hazard analysis are given for milk and cheese in Egypt.

Key words: milk, cheese, sources of contamination, critical points, safety.

Introduction

In Egypt dairy industry plays important role in Egyptian agriculture. Milk production yields for approximately one third of the total agricultural gross income. In 2010 the total milk production amounted to 3.8 million metric tons which cover only 50% of total consumption, which is based mainly on cheese. The dairy industry is dominated by a large informal sector. The dairy industry stakeholders and consumer protection officials are joining forces to fight backstreet factories. If the informal sector is organized, it can supply a further expansion of the industry. The number of modern dairy has increased over the past few years. About 50% of the produced milk is used for cheese making; 80% of the cheeses are made from raw milk without prior heat treatment. The most popular soft cheese among Egyptians is produced by unlicensed entities that use harmful raw materials and chemicals to produce cheese that may cause severe health problems.

The dairy supply chain, as all other agri-businesses, is complex. Technically the dairy chain starts at raw milk

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production and ends when other processors, institutions and consumers utilize products that were created in the value chain. Raw milk as well as processed milk and by-products are also ingredients in other processing chains. Processors of confectionary, for instance, used as raw material. Tension exists between the real environment which is subjected to pollution, in many instances because of change, demands from the people in the chain to minimize the contamination of, on the one hand, the environment, and on the other hand, of the production process.

Cheese quality is influenced by raw milk quality. The microbial count and somatic cell count determine the load of heat-resistant enzymes in milk. Generally, high levels of psychrotrophic bacteria in raw milk are required to contribute sufficient quantities of heat-stable proteases and lipases to cause breakdown of protein and fat after pasteurization. Therefore any improvement in the quality of milk could contribute to the insurance of public health safety while at the same time having positive economic consequences.

As is the case in many countries, raw milk cheese safety is a major public health concern in Egypt, During the last decades, several investigators have isolated and identified different bacterial species from Domiatti cheese, including coliforms (Aly,., and. Galal. 2002)., Micrococcus spp. (Fahmy, and Youssef. 1978), Arthrobacter spp. (El-Gendy et al.1980) Propionibacterium jensenii, Microbacterium lacticum, Brevibacterium linens (El-Zayat, et al. 1995). Staphylococcus aureus (El-Baradei, 1999),and Aeromonas spp. (de los Reyes-Gavilán.1992). Average percentages of fungal contamination of hard, fresh kareish, pickled kareish, and Damiette were 56.7, 48, 36 and 54, respectively. Aspergillus, Penicillium and Yeast were the most prevalent mycoflora. Aflatoxins B1, B2, G1 and G2 were existed in 13.3% of the examined hard cheese samples in a concentration of 4.33, 4.33, 2.58 and 2.58 µg/kg hard cheeses respectively, however aflatoxin M1 was found in 20% of the samples in a concentration of 4.59 µg/kg. 13.3% of the examined fresh Kareish cheese was contaminated by aflatoxin M1 in a concentration of 2.6 µg/kg cheese. Aflatoxins B1, B2, G1, G2, and M1 were detected in 73.3, 53.3, 60, 40 and 26-7% of the examined pickled kareish cheese samples in average concentrations of 12.67, 9.24, 6.49, 7.45 and 6.03 µg /kg, respectively. 80% of the of examined Damieta cheese samples contained aflatoxin M1 and 20% contained aflatoxin B1, their average concentrations were 8.03 and 8.02 µg/kg (El.Shrief,2000).Microbiological properties of commercial Ras cheese made from raw milk were evaluated by Awad, et al (2003) Staphylococcus were detected in all Ras cheese samples. Coliforms were detected in 33% of samples, whereas moulds and yeasts were detected in 44% of Ras cheese samples.

Aly, and Galal. (2002), suggest that, pasteurization greatly improves the keeping quality of soft Domiatti cheese and increase its shelf life. The total number of mesophilic Aeromonas isolates from 120 examined samples was 103 isolates of which 71 (69%) isolates were A. hydrophila, 21 (20.4%) isolates were A. caviae and 11 (10.6%) isolates were A. sorbia. The highest number of isolates 39 (37.9%) were recovered from raw milk samples while the lowest number of isolates 10 (9.7%) were recovered from pasteurized milk samples. (Korashy, 2006).

Accordingly Egyptian authorizes considers that it is important to draw attention to the real hazards to human health due to pathogenic bacteria in raw milk cheeses, particularly of the soft and semi-soft type and to encourage the use of pasteurized milk in the production of cheeses. In Egypt, the information about the involvement of Domiatti cheese in human illness and economic losses are unknown.

HACCP, or the Hazard Analysis and Critical Control Point System has been recognized as an effective and rational means of assuring food safety from primary production through to final consumption, using a "farm to table" methodology. The application of this preventive oriented approach would give the food producer better control over operation, better manufacturing practices and greater efficiencies, including reduced wastes (El-Hofi, et al.2010).

This study was aimed at getting a better understanding of the milk value chain as well as identifying the critical points for quality insurance of cheese produced in Egypt .

Material and Methods

Milk production practices:

Milk production practices influenced the level of contamination at the farm level. Some of the most important practices and the extent of their implementation are illustrated in Figure1. Farmers majority did not tie the cow's tail during milking, had no appropriate milking place, milked animals on treatment, did not wash hands and clean the udder before milking, did not cover the milk and had no potable water for washing hands and utensils. Some farmers used preservatives namely formalin and H2O2 to postpone milk spoilage or acid developments. In some areas salt is usually added to reduce the rate of bacterial development in the milk .Tying of the tail is important in the local setting because cows carry a lot of dust or mud from the stable on their body. During milking, a lot of this dust is dislodged by the constant waving of the tail to drive way flies. This constitutes one of the most direct methods of milk contamination.

As reported by Hofi (2007), there was a very high total viable count at cheese factory level. The total microbial load increased dramatically from farm level until delivery and received in cheese factory. Total and faecal coliforms were observed in milk samples collected right at the farm level and rapidly multiplied in numbers until reaching the cheese factories. All microbiological quality parameters indicated low milk quality just before the milk is transferred into cheese factories. These results suggest that milk is heavily contaminated right from the farm level. That is,

regardless of the area the sample was collected. Similar results were recorded by Grimaud et al 2007 in Uganda.

Critical points of the raw milk chain:-

Following the milk chain from the primary production region to the cheese factory, it was possible to visualize the critical points where value is lost. The characteristic problems of the milk chain in Egypt are mainly associated with the source of the raw milk. An analysis of on-farm milk production practices showed that the majority of farmers did not employ good milking practices to minimize contamination of milk on the farm. For instance, most farmers did not tie the cow's tail while milking. In addition, milk-handling equipment was not sufficiently cleaned. Lack of potable water and use of detergents was a major constrain to hygienic practices on the farm. Many farmers did not sufficiently clean the udder before milking. Yet pre-milking udder preparation plays an important role in the contamination of milk during milking.

Milk is transported from the farm either to cheese factory or to milk collecting centers, where it is generally chilled. From these centers, it is further transported to the cheese processing in insulated trucks which allows minimal temperature increases from 4℃ to about 10℃. At the same time large number of dairy farms transported milk direct to cheese factories in cans on open vehicles. The later means of transport is the second most critical point that influenced the microbiological quality of milk in this study. The two most critical points of control that have been elucidated in this study hence, are: (I) at the farm level &, (II) during the transportation when the milk is un-chilled.

Cheese manufacture practices:-

Cheese production practices influenced the level of contamination at factory level. Some of the most important practices and the extent of their implementation are illustrated in Figure 2. The majority of cheese producers accept either un-chilled milk (higher. 10-15 c) or refused milk, which is usually refused by modern dairy factories due to its low bacteriological quality .Traditional cheese milk processors have not focused much attention on milk bacteriological quality, Almost half of cheese processors did not covered the cheese vat to eliminate contamination .64% of cheese factories without cooling facilities for the milk and cheese or cheese ingredients. Pasteurizing is not applied in 80% of cheese factories in spite of 35% owned pasteurizing units. Some of them want to prove for the control authorities that, factory equipped with such unit as indication for applying pasteurization and respecting the new low of mandatory application. Some cheese factories had no potable water for washing hands and utensils. Such bad practices led to heavy contamination prior, during and after pasteurization process, therefore about one third of processors adding high level of preservatives such as formalin or H2O2.

Critical points of the cheese chain:-

Following the cheese chain from cheese factory to the table of the consumers, it was possible to visualize the critical points where value is lost. An analysis of cheese production practices indicated that the majority of producers did not employ good hygiene practices to minimize contamination of cheese. For instance, most cheese producers did not test the bacteriological quality of the received milk. Traditional cheese processors have not focused much attention on milk bacteriological quality In addition, milk- handling equipment and cheese making facilities was not sufficiently cleaned. Lack of potable water and use of detergents was a major constrain to hygienic practices on cheese factory. The most critical points of control that have been elucidated in this study hence, are: (I) at the cheese factory level. The heavy contamination that occurs at the factory level exposes many individuals to risk as 80 % of the cheese produced in by such cheese factories Egypt.

Managing quality along the supply chain:

In developing countries, various factors combine to compromise the hygienic quality of milk products: the organization of milk supply chains themselves, dysfunction of the regulatory systems and quality control structures. The problem is compounded by local climatic conditions, where both heat and, at times, humidity do not favor the preservation of the product in optimal conditions when the cold chain cannot be maintained. Studies done in Egypt show that all the potential hazards linked to poor quality milk are present.

Two alternative approaches are used in the world to ensure the safety of dairy products. In the U.S.A., control and sterilization are the predominant methods, whereas in Europe quality and safety are managed all along the supply chain. In light of the situation observed in tropical countries and the results obtained in Europe, it seems opportune to promote the latter approach to guarantee the dairy product safety in Egypt. The management of the quality by risk analysis or identification of potential hazards linked to a product or a process (Hazard Analysis and Critical Control Points or HACCP-type approach), must be applied along the whole supply chain, from the cow to the consumer (El-Hofi, et al.2010). For each identified potential risk, one identifies feasible corrective actions and control plans. A quantitative risk assessment determines the probability that the exposure to a particular risk can cause a disease for a given individual. It is necessary to take in account the predisposition or the sensibility of certain consumers to pathogenic agents. The risk factors linked to a consumer are age, immune system defenses, sex and stress levels. The measure of quantitative risks allows for the calculation of an "acceptable" risk level and for the establishment of quality norms or criteria adapted to the different situations.

As an example of the supply chain approach to milk safety and the identification of hazards from cow to consumer, the following two tables provide the results of the qualitative studies for dairy supply chains for 2 types of products: milk (Table 1) and cheese (Table 2).

Table 1. Milk supply chain:

Steps	Hazards	Risk factors
Farm	.Fecal Contamination : *E. coli, Salmonella, Clostridium*	Transmission by the hands of the milkman contamination by the animal at milking, by the tail and the splashes when the bucket is near the animals
	• Contamination by environmental germs : psychrotrophes flora (*Listeria, Pseudomonas*), Enterobacterias, yeast and fungus	Milk in open air at milking time
	• Multiplication of bacteria on milking material	Inefficient cleaning and disinfecting of material and/or poor drying
	• Contamination by pathogen bacteria : *Staphylococcus aureus, Steptococcus, Listeria, Mycobacterium tuberculosis, bovis, Brucella, E. coli*	Healthy carrier animals:*Mycobacterium, Brucella*, Animals with mastitis:*Staphylococcus, E coli*, Man : *Staphylococcus sp., Steptococcus sp.* Environment : *Listeria sp.*
	• Contamination by chemical residues	Non-respect of waiting time for veterinary Medicin
	. Addition of chemical	Formalin and H2O2
	• Lipolysis and raw milk turning rancid	Frequent and brutal decanting
	• Proteolysis : gelification of UHT milk, decreasing of cheese yield; appearance of sour components	Collecting milk with mastitis
	• Inhibition of the lactic fermentation : problems for milk processing	Deliver milk from cows on treatments Addition of preservatives (Formalin and H2O2)
	.Multiplication of microbial flora	Lack of cooling facilities
Transport	• Growing of microbial flora	Carrying time too long, at high temperature by un-insulated tank
	• Contamination by material	Cleaning and inefficient disinfecting of material and/or bad drying
Collecting center	• Cross-contamination	Cleaning and inefficient disinfecting of materials Absence or bad quality control of the milk before mixing
	• Human contamination	Hand contacts with the milk at the time of sampling
	• Contamination by environmental germs	Use of contaminated water for cleaning the material
	• Development of psychrotrophic flora : synthesis of proteolytic thermostable enzymes	Temperature of cooling tanks not regulated and too lengthy storage
	• Development of coliform flora	Absence of cooling
	• Lipolysis	Manual filling of the tanks from the top
Dairy plant	• Cross contamination	Absence or bad quality control of the milk
	• Recontamination by environmental germs	Non hermetically sealed packing Poor hygiene at packaging
	• Persistence of micro-organisms	Absence of thermal treatment or insufficient treatment : no respect of time/temperature
Consumers	Food-borne disease : diarrheic syndrome, listeriosis, tuberculosis, brucellosis	Consumption of contaminated raw milk Poor quality (fragility of the components)
	• Poor preservation of milk	High temperature and too lengthy preservation

Table 2. Cheese supply chain :

Steps	Consumers	Risk Factors
Milk	• Presence of pathogen micro-organisms : *Salmonella, Staphylococcus aureus*, *E. coli*,	Poor hygiene of collecting Absence of cooling
	• Presence of deterioration micro-organisms	Transport time too lengthy Poor cleaning and disinfecting material Use contaminated additives(salt and rennet)
	• Cross-contamination	Poor hygiene of housing and staff Absence of systematic control upon arrival
	. Low milk quality	Accept refused milk Accept un-chilled milk (higher 10 c)
Cheese plant	Contamination by the staff	Poor staff hygiene Absence of cloth and head-dress Absence of potable water and/or good quality water Absence of toilets and washbasin Lack of "quality culture"
	• Contamination by materials	Absence or bad cleaning and disinfecting of Materials
	• Contamination by the environment : dust, insects	Open housing with bad cover, close to pig farms, presence of flying insects, cheese vat not covered
	• Contamination by the process water	Low availability of water, absence or bad decontamination of treatment, absence of control of the water's microbiological quality
	• Persistence and multiplication of pathogen and deterioration germs	Use of raw or badly heated milk Absence of pasteurization Use of highly contaminated milk
	• Swelling cheese	Process steps for making cheese adapted to the taste of the consumers: less salty, less dry, less acid; low level of refinement Low or insufficient lactic acidification: insufficient number of natural fermenting agents, badly adapted to making conditions, non controlled washing, not using selected fermenting agents Low enzymatic coagulation: bad quality of enzymatic preparations used at very high temperatures. Using of contaminated salt and rennet High temperature and humidity in the Workshops Lack of cooling facilities (cool storage) Hermetic packing
	• Development of contaminants in storage and transport	Absence or bad cooling in storage, transport and distribution
Consumers	• Food-borne disease: diarrheic syndrome	Absence or insufficient control quality of the products

Conclusion

The hygienic quality of both milk and consequently cheese is important for insuring consumer safety and for optimum economic value. Therefore implementing good hygienic practice during milk production at farm level and during cheese manufacture is very important before implementing pasteurization in order to produce milk with quality suitable for pasteurizations. Quality control measure highly recommended and qualified employees are required. In this study it was demonstrated that the decrease and/or loss in hygienic quality of raw milk on arrival in the cheese factory ,as well as poor hygienic quality of cheese on the market, was due to a number of factors: (I) the contamination originating from the farm at the beginning of the value chain, (II) the milk handling conditions especially during transportation of milk from the primary production area to cheese factory and cheese manufacture, storage and handling conditions until reaching market place. Accordingly, this study provided baseline information for development and implementation of HACCP system to ensure the hygienic quality of milk and cheese. The value chain forms a continuum over which value can be lost. Hence its management depends on optimum involvement of all its functional units. At the end of the chain, the conditions of storage and transportation of the retail product should ensure that quality is maintained. In this respect refrigerated storage and handling at retail points is important to complete the value chain from farm to the table. Given the fact that refrigerated storage is still a major constrain in Egypt as is the case in most tropical countries, small scale milk processing could be considered as an alternative.

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