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A Deep Dive into Hygiene Practices in Dairy Processing

A. Pramanik[1*], S. Mondal[2], T. Roy[3], B. Godara[1] and B. Lakshmaiah[4]

[1]Ph. D. Scholar, Animal Biotechnology Division, ICAR-National Dairy Research Institute, Karnal, Haryana, India.
[2]Ph. D. Scholar, Dairy Technology Division, ICAR-National Dairy Research Institute, Karnal, Haryana, India.
[3]Ph. D. Scholar, Dairy Chemistry Division, ICAR-National Dairy Research Institute, Karnal, Haryana, India.
[4]Ph. D. Scholar, Dairy Microbiology Division, ICAR-National Dairy Research Institute, Karnal, Haryana, India.
*Corresponding Author: amritapramanik2020@gmail.com

Abstract

Hygiene in dairy processing is a critical aspect that ensures the safety, quality, and integrity of dairy products. This article delves into the world of hygiene practices in dairy processing, highlighting the essential role cleanliness plays in maintaining consumer trust and upholding industry standards. From personal hygiene protocols to facility sanitation, regulatory compliance, and continuous improvement initiatives, the article explores how hygiene practices form the foundation of excellence in dairy processing. By emphasizing the importance of hygiene, the article aims to showcase the commitment of the dairy industry to delivering safe, pure, and high-quality dairy products to consumers worldwide.

Introduction

Contamination of the milk typically occurs when the raw milk encounters contaminated teats and milking equipment, feeds, water, and soil at the farm level. Due to the vulnerability of contamination of raw milk, good hygiene and sanitary conditions of the dairy setting are crucial and imperative matters as they directly impact the quality and safety of the dairy products. This challenge of ensuring the safety and quality of the products necessitates the development of food safety management system (FSMS) targeted at producers and personnel at all levels. In the field of dairy processing, milk transforms into an array of delectable products that ensures safety and quality is hygiene.

Sources of contamination in dairy processing

Entry points for microbial contamination of milk are contaminated water, aerosols, and packaging materials are some of the. The microbes may also form an attached community that may persist in the processing environment, thereby causing spoilage of the product and foodborne illnesses when consumed. This makes the need for GHP (Good Hygiene Practice) in the dairy chain a critical issue that will aid in the production of a safe and quality product. The dairy industry requires continuous monitoring and improvement of hygiene and safety control measures to meet increasing regulatory standards and consumer demands.

Bioaerosols

Air often serves as a medium for microdroplets and suspended biological agents, including viruses, bacteria, dust, parasites, yeasts and molds, skin particles, and water droplets. Microbial aerosols can be free-floating bacterial or fungal spores either suspended in droplets or adhered to dust. The quality of air inside milking and dairy processing areas plays a vital role in the final quality of raw milk and processed milk products. This is because raw milk and milk products are highly susceptible to extraneous contamination by microbes, and the indoor air of the dairy processing plant is a vehicle for such biological aerosols or contaminants. These bioaerosols may harbour pathogenic organisms or spoilage microbes, that affect both safety and product shelf life.

A critical factor in controlling airborne microbial contamination of processing areas is the management of air quality entering processing plants using clean air systems. The air entering the processing plant is usually filtered to remove suspended particulate matters such as microbes, after which it is cooled and gentle pumped into processing areas. Nonetheless, uncontrolled factors such as personnel clothing and footwear, structures, ingredients, and food contact surfaces may initiate the release of bioaerosols into the processing environments causing post-pasteurization contamination. For example, microorganisms such as L. monocytogenes and E. coli can be dispersed in the aerosol produced by cleaning operations such as

applying hoses and spray lances and condensate on the cooling fins of evaporative chillers. The concentration of microbes suspended in an aerosol is dependent on several factors which include the size of the particulate materials in suspension, location, season, weather conditions, and the level of soil cover such as ground covering.

Contaminated water

Water plays a crucial role in the food industry, especially in the dairy sector where it is used extensively for cleaning equipment during production cycles. The dairy industry consumes significant amounts of water, leading to the generation of large volumes of wastewater. Contaminated water used for cleaning equipment can act as a carrier for foodborne pathogens in dairy processing. While most dairy farms and processing plants rely on treated municipal water for cleaning, the microbial quality of this water depends on the effectiveness of treatments to eliminate pathogens. Despite conventional water treatment facilities being designed to remove pathogens, bacteria in pipeline biofilms can introduce contamination into the purified water supply system. Furthermore, aging pipes or poor engineering in municipal water systems can lead to contamination through leakages, posing risks from sewage runoff and overloaded treatment systems. To mitigate these risks, dairy processing plants often implement additional water treatment processes like filtration to ensure a safe water supply, which is crucial for controlling microbial contamination in milk and dairy products.

Personnel hygiene

Poor personnel hygiene is frequently one of the sources of contamination in dairy processing. In most cases, negligence is often cited as the cause of poor personnel hygiene. Critics believe that most foodborne illness outbreaks (including dairy outbreaks) may have been caused by food workers' contact with food, particularly those that were ill. As carriers of foodborne pathogens, infected workers can be reservoirs and vehicles for the contamination to milk and dairy products. Microorganisms can harbour the human external body surfaces such as the skin and hair, and mucosal surfaces such as nose, and mouth, or be excreted from the alimentary tract via feces. The most implicated microorganisms to increase the risk of cross contamination from personnel to food products or process environments in the food industry.

Microorganisms can be transients or resident skin microflora. Gram-negative bacteria such as Salmonella spp., E. coli, Pseudomonas spp., and Klebsiella spp. are examples of transient organisms that can be acquired from handling raw materials, processed foods, contaminated equipment, and contaminated clothing, touching other body parts or poor toilet hygiene. In most cases, the transient organisms like S. aureus do not have sufficient residence time to multiply, and they are easy to remove by washing hands with detergents and they can reside on the localized lesions of skin surfaces for longer periods and this makes them temporary res idents. Viruses, although not a familiar threat in food industries such as the dairy sector can also be transferred by food handlers to the food via contaminated hands or through the air via coughing or sneezing.

The personnel who work around open food may contaminate the food or surfaces that the food may encounter. Usually, the personnel who often dismantle and reassemble machinery for cleaning procedures and those who maintain the operation of machinery during production are often a source of contamination. Besides such contamination, the movement of personnel from processing areas of low hygiene to high hygiene areas increases the risk of product contamination.

Biofilms

Biofilms, which are communities of microorganisms attached to surfaces and producing extracellular polymeric substances, naturally exist in dairy processing environments. They can detach and reattach elsewhere, growing on various plant parts and leading to product spoilage, reduced shelf life, and potential foodborne illness if the microbes are pathogenic. Biofilms in dairy plants are highly resistant, posing a significant challenge and making prevention crucial. Factors influencing biofilm formation include equipment surface roughness, milk remnants, processed product composition,

electrostatic charge, and surface hydrophobicity. Addressing these factors is essential to mitigate biofilm-related risks and ensure the production of safe, high-quality dairy products.

The quality of raw milk significantly influences biofilm formation, with microorganisms originating from various sources like milking animals, the dairy farm environment, equipment, tanks, transport vehicles, and processing equipment. Some resilient microbes, such as Bacillus spp. spores, can survive pasteurization and CIP processes, persisting in processing lines and posing control challenges. Biofilms, particularly their inner regions, are hotspots for sporulation and persister cell formation, with spores within biofilms capable of regenerating new biofilms post-CIP, complicating microbial control efforts.

Sanitation and cleaning in place

The Cleaning-in-Place (CIP) system is an automated method for cleaning hard-to-reach internal parts such as pipelines and processing equipment in the dairy industry without requiring dismantling. This system utilizes recycled and reused cleaning solutions, offering safe, reproducible results and economic process optimization. The cleaning solutions used in CIP may include detergents, sanitizers, disinfectants, and enzymes, forming an integral part of food safety systems to eliminate potential microbial contaminants. Standard CIP regimes in dairy processing plants typically involve the use of various biocides in combination, with appropriate flow rates and temperatures. A common CIP regime includes water rinse, 1% sodium hydroxide at 65°C for 10 minutes, water rinse, 1.0% nitric acid at 65°C for 10 minutes, and a final water rinse.

In the dairy industry, bacteria can become attached to surfaces even after undergoing bactofugation or microfiltration processes before milk pasteurization, which are designed to reduce microbial contamination significantly. Despite these processes, certain microbes, particularly thermophilic spore formers, can survive or lead to post-processing contamination, impacting product shelf life. Traditional Cleaning-in-Place (CIP) methods often struggle to eliminate vegetative cells, biofilms, and spores of these contaminants, prompting the need for innovative techniques. High-pressure spray and mechanical scrubbing are effective in removing biofilms on exposed surfaces but may not be as successful in eliminating biofilms in hard-to-reach areas within dairy facilities. It is important to design the most effective CIP regime for a dairy processing plant. Monitoring fouling during the CIP process is vital in controlling contamination by spoilage and pathogenic microbes in the dairy processing plant.

Packaging material

The choice of packaging material in the dairy industry is crucial, as it significantly impacts product quality, safety, cost, and marketing to consumers. While there is growing interest in innovative packaging applications like smart packaging, modified atmosphere packaging, active packaging, and sustainability, studies have revealed that packaging material can introduce contamination to various dairy products. Interactions between food and packaging material, including gas and water vapor permeability and migration of package components into the food, can directly affect product quality and shelf life. In the dairy industry, packaging materials can influence the microbiological quality of milk and milk products by harbouring microbes on their surfaces or allowing microbial growth due to their permeable nature. Therefore, the careful selection of packaging material in the dairy industry is vital to create a barrier that preserves product quality and enables a reasonable shelf life, among other important considerations.

In conclusion, the meticulous attention to hygiene practices in dairy processing is paramount for ensuring the safety, quality, and integrity of dairy products. By implementing stringent protocols, adhering to regulatory standards, and fostering a culture of cleanliness and accountability, dairy processing facilities can uphold consumer trust, mitigate health risks, and maintain the reputation of the dairy industry. Continuous improvement, regular monitoring, and a commitment to best practices are essential for safeguarding the entire dairy processing chain, from farm to table. Ultimately, a deep dive into hygiene practices reveals that cleanliness is not just a

requirement but a cornerstone of excellence in dairy processing, where every step towards hygiene is a step towards delivering safe and delightful dairy products to consumers.

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