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Research Article

# Evaluation of the Effectiveness of the Implemented Food Safety Management System ISO 22000:2018 in a Dairy Products Plant in Gaza strip, Palestine

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## ABSTRACT

**Aim:** This study aimed to evaluate the effectiveness of implemented FSMS ISO 22000:2018 in a dairy products plant.

**Method:** For evaluation the effectiveness of the system, the same types and numbers of samples (n=88) that were collected before implementation of the ISO22000:2018 were collected from the plant once again after ISO 22000:2018 implementation.

**Result:** The results revealed that the physical, chemical and microbial profile of the dairy products, water and swabs were improved. The mean values of microbial profile of yogurt showed that the mesophilic count (CFU/g), Total coliform (MPN/g), and *E. coli* (MPN/g) were decreased after ISO 22000:2018 Implementation, especially in end product where the mesophilic bacterial count decreased from ($1.5 \times 10^4$ CFU/g to $1.1 \times 10^3$ CFU/g), and Total coliform (MPN/g), and *E. coli* (MPN/g) decreased from ($6.2 \times 10^3$ and $2.2 \times 10^3$ respectively) to <3 and 0.0. Also, the mean values of microbial profile of cheese, showed that psychrotrophic count (CFU/g) and mesophilic count (CFU/g) were decreased after ISO 22000:2018 Implementation, especially in end product where psychrotrophic bacterial count decreased from ($2.3 \times 10^2$ CFU/g to $2.7 \times 10$ CFU/g), and Mesophilic bacterial count decreased from ($2.0 \times 10^4$ CFU/g to $2.5 \times 10^3$ CFU/g). Regarding the microbiological examination of swab samples, the mean value of total viable count and *Staphylococcus aureus* (CFU/g) were absent after implementation of ISO22000:2018 in the worker`s hands, equipment and utensils and packaging materials swabs. Meanwhile total coliform counts (MPN/g) were also decreased in equipment and utensils swabs and packaging materials swabs from ($5.1 \times 10$ (MPN/g) and 9 (MPN/g), respectively) to be absent. All samples were free from pesticides and antimicrobial residues and heavy metals contaminants still within its MAC for (Pb and As) with absence of Cd.

**Conclusion:** It could be concluded from the study that Implementation of FSMS ISO 22000:2018 on the dairy plant is very important as a prophylactic and preventive mean for guarantee producing safe and high quality product.

**Keywords:** FSMS; ISO22000:2018; Dairy products; Microbial profile; Physical; Chemical analysis; Water supply; Yogurt; Cheese; *L. Monocytogene*; *Campylobacter jejuni*; *Staphylococcus* Spp.; Coliform

**Abbreviations:** FSMS: Food Safety Management System; MAC: Maximum Allowed Concentration; MPN: Most Probable Number; CFU: Colony Forming Unit

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# INTRODUCTION

The safety of dairy products with respect to food-borne diseases is a great concern around the world. This is particularly true in countries where production of milk and various dairy products take place under unsanitary conditions and poor production practices. ISO 22000:2018 can be used by all the direct and indirect food chain stakeholders, regardless of their size or their location and it covers the food supply chain from the primary production to consumptions. It helps organizations to identify and control food safety hazards. The benefit to improve health and safety through minimizing the food risks, to meet the regulatory requirements, to improve customer satisfaction and to increase response to risks. There is a lot of concern worldwide about the safety of dairy products in terms of food-borne illnesses. This is especially true in poorer nations where milk and other dairy products are produced using subpar production methods and generally unhygienic circumstances [1]. The spread of the bacterium during processing, distribution, and handling is caused by poor food hygiene procedures during food preparation [2]. Additionally affecting the microbiological quality of dairy products are the pre-processing flora of raw milk, the processing conditions, and contamination after heat treatment. Due to the presence of pathogenic bacteria, mold, and yeast, poor sanitary procedures in the local processing plant and distribution pose a risk to public health [3]. Lactic acid bacteria, coliforms, and gram-negative psychrotrophs are harmful bacteria that can contaminate dairy products. In addition, in addition to dairy products, milk may contain *Salmonella* sp., *Listeria monocytogenes*, *Campylobacter jejuni*, *Yersinia enterocolitica*, pathogenic strains of *Escherichia coli*, and enterotoxigenic strains of *Staphylococcus aureus* [4]. According to reports from developed nations, milk and dairy products are linked to 1-6% of all bacterial foodborne outbreaks [5], with 39.1% of those outbreaks being blamed on milk, 53.1% on cheese, and 7.8% on other dairy products [6]. Cheese is produced in either huge, well-equipped facilities, tiny facilities, farmers' homes, or unlicensed factories. The last three locations, particularly the one without a license, are a mess. These locations make cheese more susceptible to contamination, and any manufacturing error could result in several risks [7]. Cheeses prepared from raw milk are especially vulnerable because microorganisms that were originally present in the milk may contaminate them. If hygiene and process controls are not sufficient, pathogens may potentially enter cheese while it is being processed [8]. A poor production process and the need for corrective measures were revealed by additional research on the microbiological quality of regional cheeses made using conventional methods [9-11]. According to reports, the most traditional cheeses are typically produced in nearby dairy plants using a variety of manufacturing techniques in unhygienic settings [12]. The primary causes of contamination are food handlers and the inadequately cleaned surroundings of dairy factories. Total coliforms and *Escherichia coli* contamination in foods of animal origin also points to irresponsible production practices, handling of the processed food products, and the use of inadequately sanitized equipment. Additionally, the high quantities of coliforms and *Escherichia coli* found in dairy products are likely a result of improper pasteurization caused by malfunctioning machinery and a lack of process monitoring [13]. Coliforms are frequently employed as a quality indication for food products and as a recognized safety indicator in the HACCP system [14]. Even when proper sanitation and hygiene are employed, *L. monocytogenes* can still be found in cheese manufacturing. It regularly contaminates surfaces, including drains, and it could be found in cooling systems [15]. Even in small amounts, the presence of yeast and mold in dairy products is undesirable since they quickly multiply there and lower the product's quality. Mold and yeast counts are used to gauge soft cheese's level of hygienic compliance and quality flaws [16]. The International Organization for Standardization (ISO) began work on an auditable standard for management systems for food safety in 2001. This work culminated in the creation of the newly formed ISO 22000, which was supported by an ISO Technical Committee (ISO/TC 34), and further clarifies the role of HACCP in FSMS [17]. Adopting ISO 22000 helps businesses reduce food hazards and perform better in terms of food safety. It accomplishes this by giving them a framework for creating an FSMS, a logical method of resolving food safety concerns [18]. With respect to other management systems, ISO 22000:2018 is more interoperable and adapts to the most recent market trends. The new standard is less commandment than the previous one, focusing instead on performance through a combination of risk-based thinking and a process approach, as well as employment. Changes to other management system standards include using consistent terminology throughout all standards and matching sub-clauses to the top-level structure. Additionally, ISO 22000:2018 implements the ISO High Level Structure (HLS), a design shared by all ISO standards, including ISO 9001 and ISO 14001, to guarantee fully integrated systems.

# MATERIALS AND METHODS

This is case study design conducted in a dairy products plant in Gaza strip, Palestine. For evaluation the effectiveness of the system, the same types and numbers of samples (n=88) that were collected before implementation of the ISO 22000:2018 from the plant once again were collected after ISO 22000:2018 implementation, then comparison of the analysis results. The analysis and results were based on physical, chemical and microbiological criteria and requirement of Palestinian standards [19-22].

## Sampling

A total of 88 samples were collected from the dairy plant, before and after implementation of FSMS ISO 22000:2018 These samples were distributed as follow:

- **Twenty one cheese samples:** Three samples from each step during processing (Received raw milk, pasteurized milk, after adding rennet, after curd formation, after adding brine solution, after pressing and cutting the curd and final packaged product).
- **Eighteen yogurt samples:** Three samples from each step during processing (received raw milk, pasteurized milk, after adding starter culture, after filling into the cup, after incubation and curd formation and final refrigerated packaged product).
- Ten swab samples from the dairy plant processing surfaces.

- Ten swab samples from worker's hands.
- Ten swab samples from packaging material as cups and buckets
- Ten samples of water supply used in production and cleaning purposes (two from the main well, plant`s station of desalination, 4 from non-potable water supply networks, and 4 from potable water supply networks)
- Nine samples from dairy products (three samples of raw milk, three samples of yogurt and three samples of cheese) for detection of antibiotic drug residues, pesticides residues and heavy metals contaminants.

# RESULTS AND DISCUSSION

Evaluation of the effectiveness of implementing ISO 22000:2018 system according to the laboratory results of the dairy products and environmental samples that was taken after implementation of ISO 22000:2018.

Table 1 shows the chemical and physical properties of water used in dairy product plant before and after implementation of FSMS ISO 22000:2018. It can be seen from the table that the taste of the water was still acceptable and there were no any abnormal odor detected. The concentrations of most the tested chemical elements (total dissolved solids, nitrate, chloride, free chlorine) were increased to better readings, which still within the range of Palestinian standard limits for drinking water (PS-41-2005).

**Table 1:** The chemical and physical properties of the water supply in the dairy products plant before and after implementation of FSMS ISO 22000:2018.

| Elements | Implementation | | P. S. limits |
|---|---|---|---|
| | Before | After | |
| Taste | Accepted | Accepted | Accepted |
| Odor | None | None | - |
| Turbidity | 1.50 NTU | 0.70 NTU | 5 |
| pH | 7 | 6.74 | 6.5-9.5 |
| Electric conductivity | 163 | 316 | <=2500 |
| | Micro mho/cm | Micro mho/cm | |
| Total dissolved solids | 82.0 mg/L | 158.0 mg/L | <=1000 |
| Nitrate | 19.0 mg/L as $NO_3^-$ | 35.0 mg/L | <=50 |
| Chloride | 57.0 mg/L as $Cl^-$ | 60.0 mg/L as $Cl^-$ | <=250 |
| Free chlorine | 0.12 ± 0.2 mg/L | 0.57 ± 0.2 mg/L | 0.2-0.8 |

For the purpose of preparing food as well as other environmental and commercial activities that need high water quality, water must have favorable physical characteristics (temperature, color, smell, turbidity, and taste) [23].

Table 2 shows the mean values of microbiological examination of water supply in dairy products plant before and after implementation of FSMS ISO 22000:2018. It can be seen from the table that the mean value of the total coliform in the potable water supply in the plant was 6.8 colony/100 ml. and the mean value of the fecal coliform was 0.8 colony/100 ml, before ISO 22000:2018 implementation indicating that the microbial limits of potable water does not comply with Palestinian standard for drinking water (3 colony/100 ml for coliform count and zero colony/100 ml for fecal coliform). However, the mean values of total coliforms and fecal coliforms counts were decreased for both non potable and potable water samples to 0.4, 0 and 0.0, 0.0 Colony/100 ml respectively, after ISO 22000:2018 implementation, *i.e.* from non-conformity to be within the range of Palestinian standard limits.

**Table 2:** The mean values of microbiological examination of water supply in the dairy products plant before and after implementation of FSMS ISO 22000:2018.

| Type of water samples | Total coliform | Fecal coliform |
|---|---|---|
| | Colony/100 ml | Colony/100 ml |
| Non-potable points | | |

| | | |
|---|---|---|
| Before ISO 22000:2018 | 1.2 × 10 | 0.2 |
| After ISO 22000:2018 | 0.4 | 0 |
| Potable points | | |
| Before ISO 22000:2018 | 6.8 | 0.8 |
| After ISO 22000:2018 | 0 | 0 |

Coliforms are frequently found in high-quality treated waters, and the presence of these organisms is frequently attributed to inadequate cleaning and/or bacterial regrowth in distribution networks [24].

When applying water in a production process, it may be necessary to use water that contains no microorganisms or just a small amount of them, as permitted by the regulations (in such cases, complete sterilization of water is needed) [25].

Disinfection is the primary barrier for avoiding pathogen breakout into water supply systems and a crucial final stage in the process of treating drinking water. The most popular technique for disinfecting community water distribution systems is chlorination [26].

Table 3 shows the chemical properties of raw milk and dairy products before and after implementation of FSMS ISO 22000:2018. It can be noted from the table that the mean value of fat, solid matter, NFS, and acidity % for the raw milk samples used in processing of dairy products were increased after ISO 22000:2018 Implementation, But still within the range of Palestinian standard limits for raw milk (PS-600-2014). Also, the mean value of fat, solid matter and NFS, were increased for yoghurt and cheese and still within the range of the Palestinian standard limits for yogurt and cheese (PS-18-1-2019) (PS-836-4-2016)., while the acidity of yoghurt decreased after ISO 22000:2018 implementation, but till within the range of Palestinian standard limits for yogurt (PS-18-1-2019).

**Table 3:** The chemical properties of raw milk and dairy products before and after implementation of FSMS ISO 22000:2018.

| Sample type | No. of samples | Implementation | Chemical parameters (mean value) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Moisture | Fat | Nacl | Solid matter | NFS | pH | Acidity % |
| | | | % | % | % | % | % | - | % |
| Raw milk | 6 | Before | NA | 2.02 | NA | 11.08 | 8.97 | 6.7 | 0.12 |
| | 6 | After | NA | 2.81 | NA | 12.61 | 9.94 | 6.65 | 0.14 |
| Yoghurt | 3 | Before | NA | 2.07 | NA | 10.79 | 8.72 | 4.39 | 0.74 |
| | 3 | After | NA | 3.02 | NA | 12.3 | 9.3 | 4.2 | 0.66 |
| Cheese | 3 | Before | 70.83 | 3.17 | 3.99 | 29.17 | NA | NA | NA |
| | 3 | After | 63.6 | 15.16 | 4.45 | 36.43 | NA | NA | NA |

Table 4 shows the microbiological examination of yoghurt samples along processing chain in dairy product plant before and after implementation of FSMS ISO 22000:2018. It can be noted from the table that the mean value of mesophilic count (CFU/g), total coliform (MPN/g), and *E. coli* (MPN/g) were decreased after ISO 22000:2018 Implementation, especially in the end product where the mesophilic bacterial count decreased from ($1.5 \times 10^4$ CFU/g to 1.1 × 10 CFU/g), and Total coliform (MPN/g), and *E. coli* (MPN/g) decreased from ( 6.2 × 10 and 2.2 × 10 respectively ) to <3 and 0.0 respectively and became comply with the Palestinian standard limits for raw milk and yogurt (PS-600-2014), (PS-18-1-2019).

**Table 4:** The microbiological examination of milk and yoghurt samples along processing chain in the dairy products plant before and after implementation of FSMS ISO 22000:2018.

| Sample type | Total number of samples | Before/ after | Microbiological examination (Mean) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Psychrotrophic count | Mesophilic count | Total coliforms | *E. coli* | Mold | Yeast | *Staphylococcus aureus* | *Salmonella* spp. | *Listeria* spp. | *Campylobacter* spp. |
| | | | (CFU/g) | (CFU/g) | (MPN/g) | (MPN/g) | (CFU/g) | (CFU/g) | (CFU/g) | (CFU/g) | (CFU/g) | (CFU/g) |
| Raw milk | 3 | Before | $5.1 \times 10^5$ | $9.7 \times 10^5$ | $5.4 \times 10^5$ | $1.8 \times 10^3$ | 0 | $4.2 \times 10^5$ | $2.5 \times 10^3$ | 0 | 0 | $3.7 \times 10^2$ |
| | 3 | After | $5.0 \times 10^5$ | $9.1 \times 10^5$ | $5.1 \times 10^5$ | $1.5 \times 10^3$ | 0 | $4.6 \times 10^3$ | $2.5 \times 10^2$ | 0 | 0 | 0 |
| Pasteurized milk | 3 | Before | 0 | 0 | <3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 3 | After | 0 | 0 | <3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Milk after starter addition | 3 | Before | 0 | $9.0 \times 10^4$ | <3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 3 | After | 0 | $1.0 \times 10^4$ | <3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| After packaging | 3 | Before | 0 | $5.0 \times 10^4$ | $1.7 \times 10^3$ | $3.4 \times 10^2$ | 0 | 0 | 0 | 0 | 0 | 0 |
| | 3 | After | 0 | $1.2 \times 10^4$ | <3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| After incubation | 3 | Before | 0 | $2.5 \times 10^4$ | $3.3 \times 10^3$ | $6.8 \times 10^2$ | 0 | 0 | 0 | 0 | 0 | 0 |
| | 3 | After | 0 | $1.3 \times 10$ | <3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Yoghurt (final product) | 3 | Before | 0 | $1.5 \times 10^4$ | $6.2 \times 10^3$ | $2.2 \times 10^3$ | 0 | 0 | 0 | 0 | 0 | 0 |
| | 3 | After | 0 | $1.1 \times 10^3$ | <3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

The most frequent potential risks in the majority of dairy products are microbiological ones. Testing for these risks is frequently needed to ensure that raw materials are delivered in accordance with local criteria as well as a method of supervision for choosing and approving suppliers. Indicators for the quality of cheese include the total aerobic count, the coliforms count, and the total yeast and mold counts [27].

The most significant source of pathogenic microorganisms is raw milk the primary biological risk in cheese factories [28].

The findings of a study on cheese conducted in the Egyptian governorate of El-Beheira found that the most dangerous sources of contamination with various germs were raw milk and equipment swabs. Additionally, the processing circumstances have an effect on the product's quality and safety, as do the variety of microorganisms and their numbers in some raw materials, food handlers, and food contact surfaces [29].

In a study conducted in the dairy sector in Kenya, it was determined how the size of the production facility and current food safety management systems affected microbiological quality. They came to the conclusion that dairy producers produced safer goods when they implemented HACCP systems or ISO 22000 recommendations because they received the highest possible MSLP (Microbial Safety Level Profile) scores [30].

The results of another study that was conducted to assess the effectiveness of food safety management systems in Serbian dairy industries indicated that the increase and improvement of the safety and qualities of dairy products was the primary driver for Serbian dairy producers to adopt food safety management systems. It also shown that Serbian dairy sectors had a high degree of HACCP implementation, either as a stand-alone food safety system or one that was integrated with ISO 22000, and that the advantages to the country's dairy sector were substantial [31].

Table 5 shows the microbiological examination of cheese samples along processing chain in dairy product plant before and after implementation of FSMS ISO 22000:2018. It can be noted from the table that the mean value of psychrotrophic count (CFU/g) and mesophilic count (CFU/g) were decreased after ISO 22000:2018 implementation, especially in the end product where the psychrotrophic bacterial count decreased from ($2.3 \times 10^2$ CFU/g to $2.7 \times 10$ CFU/g), and Mesophilic bacterial count decreased from ($2.0 \times 10^4$ CFU/g to $2.5 \times 10^3$ CFU/g) and became comply with the Palestinian standard limits for raw milk and cheese (PS-600-2014), (PS-836-4-2016).

**Table 5:** The microbiological examination of cheese samples along processing chain in dairy product plant before and after implementation of FSMS ISO 22000:2018.

| Type of samples | No. of samples | Microbiological examination (Mean value) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Psychrotrophic count | Mesophilic count | Total coliforms | *E. coli* | Mold | Yeast | *Staph. aureus* | *Salmonella* spp. | *Listeria* spp. | *Campylobacter* spp. |
| | | (CFU/g) | (CFU/g) | (MPN/g) | (MPN/g) | (CFU/g) | (CFU/g) | (CFU/g) | (CFU/g) | (CFU/g) | (CFU/g) |
| Raw milk | Before | $2.0 \times 10^5$ | $5.5 \times 10^5$ | $2.3 \times 10^4$ | $4.0 \times 10^5$ | 0 | $2.7 \times 10^2$ | $1.8 \times 10^3$ | 0 | 0 | $3.0 \times 10^2$ |
| | After | $2.0 \times 10^3$ | $1.2 \times 10^5$ | $1.4 \times 10^4$ | $1.7 \times 10^3$ | 0 | $1.3 \times 10^2$ | $1.1 \times 10^3$ | 0 | 0 | 0 |
| Pasteurized milk | Before | 0 | 0 | <3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | After | 0 | 0 | <3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Milk after rennet addition | Before | 0 | 0 | <3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | After | 0 | 0 | <3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Coagulation | Before | 0 | 0 | <3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | After | 0 | 0 | <3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cutting | Before | 0 | 0 | $3.3 \times 10^3$ | 0 | 0 | $1.5 \times 10^3$ | 0 | 0 | 0 | 0 |
| | After | 0 | 0 | <3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brine addition | Before | 0 | 0 | <3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | After | 0 | 0 | <3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Final product cheese | Before | $2.3 \times 10^2$ | $2.0 \times 10^4$ | <3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | After | $2.7 \times 10$ | $2.5 \times 10^3$ | <3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Similar results were recorded in a study carried out on cheese produced by modern dairies. The mean values for microbial count was 5 × 10, Zero, Zero, and 10 CFU/ml for total count, Coliform, *Staphylococus aureus*, and Yeast and mold count, respectively [8]. In another study carried out on Domiati cheese in Egypt, the mean value of aerobic plate count, psychrotrophic count, and total yeast and mold count was $1.8 \times 10^5$ CFU/gm, $9.0 \times 10^4$ CFU/gm, $6.2 \times 10^2$ CFU/ml, respectively [32].

Swabs from freshly cleaned surfaces, food service personnel's hands, and surfaces in touch with food can be used to assess the environment. Environmental sampling is one way to make sure products adhere to food safety regulations [30].

Table 6 shows the microbiological examination of swab samples along processing chain in dairy product plant before and after implementation of FSMS ISO 22000:2018. It can be noted from the table that the mean value of total viable count and *staphylococcus aureus* (CFU/g) were highly decreased to be absent after implementation of ISO 22000:2018 in the worker`s hands, equipment and utensils and packaging materials swabs. Meanwhile total coliform counts (MPN/g) were also decreased in equipment and utensils swabs and packaging materials swabs from (5.1 × 10 ( MPN/g) and 9 (MPN/g), respectively) to be absent in both after implementation of FSMS ISO 22000:2018 to still within the Palestinian standard limits.

**Table 6:** The microbiological examination of swab samples along processing chain before and after implementation of FSMS ISO 22000.

| Sample type | Before/after | Microbiological examination (Mean) | | | |
|---|---|---|---|---|---|
| | | Total viable count | Total coliforms | Fecal coliforms | *Staphylococcus aureus* |
| | | (CFU/g) | (MPN/g) | (MPN/g) | (CFU/g) |
| Worker's hands | Before | $1.3 \times 10^3$ | <3 | <3 | $2.1 \times 10^2$ |
| | After | 0.2 | <3 | <3 | 0 |
| Equipments and utensils | Before | $1.1 \times 10^3$ | 5.1 × 10 | <3 | $1.5 \times 10^2$ |
| | After | 0 | <3 | <3 | 0 |
| Packaging materials | Before | $7.7 \times 10^2$ | 9 | <3 | 6.3 × 10 |
| | After | 0 | <3 | <3 | 0 |

In a study carried out in Gaza, the mean log(10) for total Bacterial Counts, coliform counts and Staphylococci counts of hand workers swabs before implementation of HACCP system was 5 ± 4.1 cfu/$cm^2$, 1.7 ± 0.5 MPN/$cm^2$ and 1.2 ± 0.3 cfu/$cm^2$, respectively. While total bacterial count and coliform count of surfaces swabs before Implementation of HACCP System was 4.5 ± 4.1 cfu/$cm^2$ and 2.0 ± 1.1 MPN/$cm^2$, respectively [24].

Equipment, surfaces that come into contact with food, and hands of food handlers are the main causes of cross-contamination [33]. When surfaces are not thoroughly cleaned or are left wet between cleaning and use, they can become a source of contamination [34]. Because these employees may be asymptomatic carriers of germs that cause foodborne diseases, food handlers play a significant role in potential cross-contamination.

Table 7 shows pesticides residues, antimicrobial drugs residues and heavy metals levels in dairy products before and after implementation of FSMS ISO 22000:2018. It can be noted from the table that pesticides residues and antimicrobial residues in raw milk, yogurt and cheese samples were absent before and after implementation of FSMS ISO 22000:2018. Meanwhile, there were a decrease in the levels of heavy metals contaminants. Lead level decreased to (0.002 ppm), (0.011 ppm) and (0.001 ppm) in raw milk, yogurt and cheese respectively. Also the arsenic level decreased to (0.001 ppm), (0.0005 ppm) and (0.0003 ppm) in raw milk, yogurt and cheese respectively. The cadmium was absent in all samples after implementation of FSMS ISO 22000:2018. However the level of heavy metals before and after implementation of FSMS ISO 22000:2018 were still within the maximum allowed concentration according to the international dairy federation (Pb (0.1 ppm), Cd(0.03 ppm), As (0.05 ppm) for raw milk, and Pb (0.3 ppm), Cd (0.1 ppm), As (0.2 ppm)for dairy product.

**Table 7:** Pesticides residues, antimicrobial drugs residues and heavy metals levelsin dairy products before and after implementation of FSMS ISO 22000:2018.

| Sample | Before/After | Pesticides residues | Antimicrobial residues | Heavy metals contaminants (ppm) | | |
|---|---|---|---|---|---|---|
| | | | | Lead Pb | Cadmium Cd | Arsenic As |
| Raw milk | Before | Nil | Nil | 0.041 | 0.001 | 0.04 |
| | After | Nil | Nil | 0.002 | 0 | 0 |
| Yogurt | Before | Nil | Nil | 0.038 | 0.001 | 0 |
| | After | Nil | Nil | 0.011 | 0 | 0 |
| Cheese | Before | Nil | Nil | 0.031 | 0.001 | 0.06 |
| | After | Nil | Nil | 0.001 | 0 | 0 |

In a study on the Palestinian dairy market, UHT milk products showed 10% of positive results for antibiotic residues (+Sulfamethazine), which was more than the Maximum Residue Level (MRL=100 g/L) and noticeably higher than other sources of milk products.

In a study carried out on milk and dairy products in Beni-Suef Gov., the concentrations of Pb in milk, and kareish cheese samples were in the ranges of 0.0546–0.4086, and 0.194–0.6495 ppm with mean concentrations of 0.214 ± 0.021, and 0.43 ± 0.029 ppm respectively. While, the concentration of cadmium in milk, and kareish cheese samples were in the ranges of 0.008-0.104, and 0.01-0.162 ppm with mean concentration of 0.051 ± 0.005 and 0.09 ± 0.009 ppm respectively.

In a study carried out in Almaty region, Kazakhstan on milk and fermented milk products, indicated that the milk samples contained cadmium in amounts ranging from 0.0025 to 0.0029 ppm, which was below the Maximum Allowed Concentration value (MAC). The examined milk samples had lead levels that ranged from 0.0010 to 0.008 ppm, on average 0.0045 ppm. In addition, it was revealed that cottage cheese contained cadmium, lead, and arsenic.

## CONCLUSION

Implementation of FSMS ISO 22000:2018 on the dairy products plant considering as a prophylactic and preventive mean for guarantee producing safe and high quality product. The physical, chemical properties and microbiological analysis results of the water supply in the dairy product plant showed positive improvement for the benefit of implementation of FSMS ISO 22000:2018. Gaza strip need increasing the investment in the industrial sectors to help food industries organization applying FSMS 22000:2018 and increasing the attention towards establishing laboratories and animal farms meeting the international standardization.

## LIMITATIONS

- Limited number of approval laboratories, with high cost of sample analysis.
- Unstable political situations.

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## AVAILABILITY OF DATA AND MATERIALS

The datasets generated and analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

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## AUTHOR`S CONTRIBUTIONS

R.YT.A. participated in the design, data collection, analyzing and drafeted the manuscript. A.O. and N.A. supervising the study and participated in the draft review. All authors have read and approved the final version of the manuscript and agree with order of presentation of the authors.

## ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study protocol was approved the Ethics Committee of Alexandria University-High Institute of Public Health. Also permission was obtained from the general directorate in the the Palestinian Ministry of Agriculture, the Palestinian Ministry of Health and the plant of the dairy products in Gaza strip, Plestine.

## CONSENT FOR PUBLICATION

Not applicable.

## COMPETING OF INTEREST

There were no any potential conflicts of interest concerning this research, authorship, and/or publication of this article.

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