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Original Article

Assessment and Implementation of Pre-Requisite Programs in a Dairy Products Plant in Gaza Strip, Palestine

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Abstract

Background: Food safety in food industries requires compliance with the basic requirements of good hygiene practices or prerequisite programs (PRPs), along with a food safety management system (FSMS) such as HACCP and ISO 22000.
Objective(s): This study aimed to assess and implement PRPs in a dairy products plant, in Gaza strip, Palestine.
Methods: The assessment of the PRPs in the plant was conducted by using a pre-structured checklist for observation of the 14 PRPs parameters. It was followed by rehabilitation to ensure that products meet the prerequisite of quality and safety.
Results: The overall score percentage of the available required elements of the PRP was 60.2%, with highest score for product information and consumer awareness (100%). While the lowest score was for both environment and location (28.6%) and utilities as air, water, and energy (46.66%). The deficiency in PRP was more pronounced in the pest control and product recall procedures (0% each). After rehabilitation, the overall score percentage of PRPs parameters were improved to 95.5%. The score percentage of waste disposal, equipment suitability, cleaning and maintenance, management of purchased materials, measures for prevention of cross-contamination, cleaning and sanitizing product recall procedures, warehousing and training was improved to 100%. Also, the score percentage of pest control parameter increased to 85.7%.
Conclusion: Implantation of PRPs in a dairy products plant with sustainable rehabilitation is considered a prophylactic means for producing safe products and the foundation stone to apply any FSMS.

Keywords: Food Safety; Dairy Products; Pre-Requisite Programs; Rehabilitation; Manufacturing Practices

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INTRODUCTION

Pre-Requisite Programs (PRPs) are the fundamental requirements and actions required to uphold a wholesome environment in the food chain that is acceptable for the production, handling, assurance, or providing a safe finished food product for human consumption.(1) Pre-requisite programs describe the methods, equipment, facilities, and controls for producing processed food and it commonly refer to practices and approaches performed by way of food processor which can have an effect on the protection of the meals product. It may refer to the people, equipment, process and the environment in the manufacturing method.(2) PRP is an operational requirement indispensable to enable a dairy plant to produce milk and milk merchandise safely. The dairy business has a prison and moral responsibility to produce and prepare milk that will no longer harm the consumer. There can be a high price to the dairy commercial enterprise if it does not implement enough PRP. It consists of many basic operational prerequisites and procedures that are required to be met with the aid of the dairy business. These includes: the right building and design of the food premises, the condition of the exterior environment of the food premises, the adequate renovation of tools and utensils used inside the food business, the use of appropriate chemical compounds within and around the food premises such as cleansing

chemicals, pest control chemicals and machines lubricants, the identification and storage of waste inside and by way of the meals business. The cleanliness of the food premises, equipment's, utensils, floors, walls and ceilings.[3] PRPs are "Programs including Good Hygiene Practices, Good Agricultural Practices and Good Manufacturing Practices, as well as other practices and procedures such as training and traceability, that establish the basic environmental and operating conditions that set the foundation for implementation of a HACCP system". The success of implementing a food safety management system in any food industry depends on the existence of the prerequisite programs for this system, as they will help to activate the food safety management system and take into account the fundamental components on which it is founded or somehow connected to it.[4] The situation becomes extremely tough without these applications, even one of them, and the system's application in this situation becomes worthless and even expensive without them.[5] The establishment of prerequisite programs (PRPs) in food enterprises, regardless of size or complexity, is seen to be crucial to help control hazard.[6] The aim of the current study was to assess and implement PRPs in a dairy products plant, in Gaza strip, Palestine.

METHODS

Study design

A case study design was conducted in a dairy products (yogurt and cheese) plant located in Gaza Strip, Palestine from September 2021 to January 2022.

Data collection tool

A pre-structured checklist was used to check PRPs in the plant in accordance with ISO 22002-1:2009-1[7] and Codex Alimentarius CXC1-1969 [8] through observation of 14 parameters: Environment & location (7 points), layout of premises & workplace (18 points), utilities as air, water, energy (15 points), waste disposal (7 points), equipment suitability, cleaning and maintenance (14 points), management of purchased materials (10 points), measures for prevention of cross-contamination (12 points), cleaning and sanitizing (10 points), pest control (7 points), personnel hygiene and employee facilities (13 points), product recall procedures (2 points), warehousing (12 points), training (2 points), product information and consumer awareness (2 points).

The total score of the checklist was 133 points. In order for the parameter scores to be comparable, the scores were changed into percentages.

Ethical Considerations

The study protocol was approved by the Ethics Committee of Alexandria University, High Institute of Public Health. Also, permission was obtained from the General Directorate in the Palestinian Ministry of Agriculture, the Palestinian Ministry of Health and the plant of the dairy products in Gaza strip, Palestine.

RESULTS

According to the present study the overall score percentage of the required of the PRPs was (60.2%). Meanwhile, 39.8% of the PRP requirements were absent. The highest score percentage among the present PRP was in product information and consumer awareness (100%), Warehousing & Measurement for prevention of cross contamination (91.7% each), Equipment suitability, cleaning, and maintenance (85.7%) and waste disposal (77.8%). Meanwhile, a poor level was observed regarding Environment & Location (28.6%) & Utilities –air, water, and energy (46.66%). The data also showed that the deficiency in the PRP were more pronounced in the pest control (0.0%), Product recall procedures (100%), Environment & Location (71.4%), Utilities –air, water, and energy (53.34%) and Layout of premises & workplace, Management of purchased materials, Cleaning & Sanitizing and Training (50.0% each). (Table 1)

Location of the plant:

In the current study, the dairy plant located in polluted area with industrial activities near the plant; there were uncontrolled entrance of harmful substances or contaminants, litter and trees were around; and boundaries of the plant as well as roads and yards were not controlled.

Layout of premises and workplace:

According to the current study, most of layout of premises and workplace of the dairy plant parameters were available. The internal design and layout category permitted adequate maintenance and cleaning; the flow of operation including movement of personnel and material were designed to minimize cross contamination; and there was separation of operations. However, there was a space between the ground and doors that may permit entrance of foreign matters and pests. The internal structures and fittings category showed that the plant was soundly built of durable, non-toxic, and easily cleaned materials; the plant was provided with service facilities including changing clothes room, bathroom, etc. The floor of the production hall was designed in a way to ensure drainage and cleaning operations, made of non-slippery, absorbent, and non-toxic material; but had some cracks, cervices and broken in some area. The walls were not painted with non-toxic, humidity-resistant, oily, and washable materials; there were

holes and many cracks in walls. There were doors that not made of non-absorbent materials, and not provided with self-closure device. The windows were in poor condition; not provided with proper closure, and not fitted with removable, cleanable insect-proof screens. The ceilings were designated to prevent accumulation of dirt and coated with cleanable and humidity resistant materials. Regarding the laboratory facilities category, there was a microbiological laboratory, but it was not isolated from the production area.

Utilities including air, water, and energy:
The utilities parameter including air, water, and energy in the dairy plant were available. The plant had an adequate supply of potable water with suitable facilities for its temperature control, storage, and distribution. The potable water was not clean, and the chlorination process was not checked or monitored regularly to be compliant with the requirement of the Palestinian Standards. The potable water tanks also were not cleaned and sanitized regularly, and the same water rapper tube was used for both potable and non-potable water supply. In addition, the plant had no maintained records for water analysis results.
The plant had a mechanical ventilation system to remove unwanted and excess steam, dust, and odors, but the ventilation system was not effective to control temperature, humidity and prevent air flow from outside the environment around the plant to the production area and not maintained or cleaned regularly. There was no protocol for monitoring and controlling the quality of the air.
The plant was provided with sufficient artificial lighting which covered properly. The plant had adequate facilities for heating, cooking, cooling and refrigerating the products with the availability of tools to measure temperature. But the plant had not any procedures and records for temperature control.

Waste disposal:
It was observed the presence of designated place for garbage collection, and it was far from the production area. It was clean, covered to prevent gathering of insect and rodent, had a pedal operated tight lid and emptied regularly.
Also, the data showed a good hygienic system for waste management and removal. The plant had adequate and systematic frequency for collection of spoiled materials and foods and transported them to specific area outside the plant to prevent accumulation and spread of contamination. However, there were no records retained in the plant to verify this procedure. Furthermore, the sewage network was separated from the public sewage, the piping and ductwork were drainable, cleanable and with no dead ends. The plumbing is not covered and needs maintenance.

Equipment suitability, cleaning, and maintenance:
There were soundly hygienic designs of equipment to be easily cleaned, sanitized, and maintained to avoid contamination. Equipment was made of non-toxic, durable material, movable to be disassemble for repair, cleaning and sanitizing. Also, food contact surfaces of equipment were corrosion resistant, smooth, free from pits and regularly cleaned. The corrective and preventive maintenance were carried out in a way to prevent exposing the production or equipment to risk of contamination. Equipment was checked after any maintenance or fixes and was undergo cleaning and sanitizing program after maintenance and before reuse. There were adequate facilities for cleaning equipment and there were trained people for performing maintenance of equipment. However, there were neither written preventive equipment maintenance programs nor calibration programs to be followed.

Management of purchased materials:
Materials were purchased from a certified supplier. However, there were gaps in assessment procedures for selecting an approved supplier, monitoring the supplier's performance, monitoring the vehicles used in raw material transfer, documentation for method verification, and procedures for dealing with nonconformity materials. On the other hand, vital raw material information was kept and documented, the receiving duck was recognized, and the packaging materials were safe, acceptable for food usage, and carried out under sanitary conditions.

Measures for prevention of cross contamination:
The prevention of microbiological cross contamination was soundly managed as there was separation of raw material from finished or semi-finished products, structural segregation between the production area and other facilities as toilets. Also, there were effective disinfecting and sanitizing programs to prevent cross contamination through people, material, and equipment. A periodic inspection was carried out during storage of the finished product to ensure that the food was fit for human consumption and that it complied with the standard specifications of the finished product and the plant used the QC operation to assure the quality of manufactured product.
The plant had effective measures to prevent physical contamination either through a suitable effective metal detector to prevent inclusion of metals or other extraneous materials in food or through assurance that the packaging of materials was free from any substances causing objectionable changes in the product.

Table 1: Assessment of the prerequisite programs (PRPs) in a dairy products plant in Gaza

PRPs Parameters	Available Score %
1. Environment & Location	**28.6**
2. Layout of premises & workplace	**50.0**
1. Internal design & layout	75.0
2. Internal Structure & Layout	41.7
3. Laboratory Facilities	50.0
3. Utilities –air, water, and energy	**46.66**
1. Water supply	28.6
2. Air quality & Ventilation	33.3
3. Lighting	100.0
4. Temperature	66.7
4. Waste disposal	**77.8**
1. Containers for Waste	100.0
2. Waste Management & Removal	66.7
3. Drainage	66.7
5. Equipment suitability, cleaning and maintenance	**85.7**
1. Hygienic design	100.0
2. Product contact surface	100.0
3. Temperature control and monitoring equipment	100.0
4. Preventive and corrective maintenance	75.0
6. Management of purchased materials	**50.0**
1. Selection and management of suppliers	33.3
2. Incoming material requirements (raw/ingredients/packaging)	57.1
7. Measurement for prevention of cross contamination	**91.7**
1. Microbiological cross-contamination	100.0
2. Allergen management	50.0
3. Physical contamination	100.0
8. Cleaning & Sanitizing	**50.0**
1. Cleaning and sanitizing agents and tools	80.0
2. Cleaning and sanitizing programs	33.3
3. Monitoring sanitation effectiveness	0.0
9. Pest Control	**0.0**
1. Pest control programs	0.0
2. Preventing access, Harborage and infestation	0.0
3. Monitoring and detection	0.0
4. Eradication	0.0
10. Personal hygiene & employees' facilities	**61.5**
1. Personal hygiene facilities and toilets	60.0
2. Work wear and protective clothing	66.7
3. Health status, illness and injuries	50.0
4. Personal cleanliness and behavior	66.7
11. Product recall procedures	**0.0**
12. Warehousing	**91.7**
1. Warehousing requirements	100.0
2. vehicles, conveyances, and containers	75.0
13. Training	**50.0**
14. Product information and consumer awareness	**100.0**
Overall	**60.2**

Cleaning and sanitizing:
The food contact surfaces; establishment and equipment were kept in an appropriate state of cleaning. Cleaning chemicals were handled, used carefully and in accordance with manufacture`s instruction. However, there were no documented procedures for selection and application of detergent and the proper temperature used. Despite the plant following cleaning regimes for equipment, floors, walls, and drains. There were no written cleaning schedules, no records to support application of cleaning regimes and there was no monitoring and verifying for the effectiveness of cleaning and sanitizing programs.

Pest control:
The plant had no pest control plan or program. The preventive facilities were unsuitable, as the plant did not have enough bait or traps used to monitor the pest control. In addition to that the plant had no eradication programs to be used if there is any evidence of pest infestation.

Personnel hygiene and employee facilities:
There were adequate means of hygienically washing and drying hands, including wash basins and a supply of hot and cold water, available of toilet rooms usually kept in sanitary condition, equipped with suitable heating and cooling systems, and were provided with hand washing and drying facilities and there were adequate changing facilities for employees provided with lockers to keep their own personal belongings. However, there were no documented procedures for personal hygiene and behaviors, and there was not a specified area for eating or smoking so the staff used to go out of the production area for drinking and eating.

The employees were wearing clean and protective clothes. Protective clothing for visitors was available. Exclusion for employees suffering from or carrying a disease likely to be transmitted through food, was applied, but employees had not undergone periodic health examination and did not have a valid health certificate.

Employees washed and sanitized their hands after each visit to the toilet, before starting work, and when touch any contaminated material. However, there was no documented policy for personal behavior and hygiene maintained in the plant.

Product recall procedures:
The plant had no procedures, documentation, or records dealing with recall products.

Warehousing:
The warehouses were provided with temperature and humidity control devices, special place for isolation of damaged products, designated place for the process of checking and inspecting the incoming materials, and storage facilities depending on the nature of the food. Doors and windows were tightly closed; the materials were stored in plastic pallets. Application of FIFO principles for all stored materials whether raw materials or finished products were observed. For transportation of food, food was adequately protected during transport. Conveyances and bulk containers were effectively cleaned, disinfected as necessary; foods were separated from non-food items. However, there was no effective monitoring for temperature and humidity in conveyances.

Employee training:
There were no documented procedures, programs or plans relevant for identifying training needs and training personnel.

Product information and consumer awareness:
It was observed that all food products were labeled with clear information and instruction and accompanied by adequate information to enable the next person in the food chain to handle, display, store and use the product safely and correctly.

PRPs rehabilitation
According to the above observation, we rehabilitated the plant to fulfill all the required PRP elements to reduce hazards and increase safety of food is presented in Table 2.

Assessment of the Pre-Requisite Programs (PRPs) situation of the plant after rehabilitation
In the present study the overall total score percentage of the 14 parameters was improved significantly from 60.2% to 95.5% after rehabilitation. The data also showed that the score percentage of waste disposal, cleaning, maintenance and equipment suitability, cleaning and maintenance, management of purchased materials, measures for prevention of cross-contamination, cleaning and sanitizing product recall procedures, warehousing, and training (77.8%, 85.7%, 50%, 91.7%, 50%, 0.0%, 91.7%, and 50%, respectively) increased to 100% for each. The score percentage of pest control parameter also increased from 0.0 % to 85.7% after rehabilitation. Meanwhile, the score percentage of location increased from 28.6% to 71.4%, the score percentage of the layout of premises and workplace parameter increased from 50 % to 94.4%, and utilities- air, water, energy parameter increased from 46.66 % to 93.3%. (Figure 1)

Table 2: The Rehabilitation works for PRPs according to requirements of ISO\TS 22002 and Codex Alimentarius CXC 1-1969 in a dairy products plant in Gaza

Parameter	Prerequisite program modification
1-Environment and location	➢ Closing any openings to prevent entrance of any harmful substance. ➢ The litter, weeds, and trees around the plant were regularly removed. ➢ The roads and yards are maintained, new parking area are established.
2-Layout of premises and workplace	➢ The floors were maintained with non-toxic materials (Epoxy) to prevent slipping; the holes and cracks were sealed with moisture- absorbing material. ➢ Walls were maintained and built with washable, smooth, non-toxic and humidity resistant materials and any damage including holes and cracks in the walls was sealed. ➢ Doors were painted with smooth, non-absorbent material. ➢ Windows were fitted with removable and cleanable insect-proof screens. ➢ Ceilings were covered to protect accumulation of dirt and to be easy to clean.
3. Utilities- air, water, energy	➢ The water supply was treated and verified through chemical and microbiological analysis by Ministry of Health to comply with Palestinian standards. ➢ Potable water supply tanks were cleaned and sanitized properly. ➢ Separate color-identified water hose for potable and non-potable water was used. ➢ Records of water analysis were kept in the plant. ➢ The ventilation system had been maintained in a way that properly controls the humidity and temperature and prevent contamination. Records were developed for procedures, work instructions and temperature control.
4. Waste disposal	A procedure, work instruction and records to control the waste management were developed and retained. The plumping had been maintained and covered with stainless steel coverage.
5. Equipment suitability, cleaning and maintenance	This parameter proved good hygienic indicator so the only implemented modifications were a written calibration program to be followed in records and development a preventive maintenance plan for all devices to control the food safety hazards.
6. Management of purchased materials	➢ An assessment procedure for selecting approved suppliers and developed procedure for monitoring the performance of approved supplier through regular visiting were developed. ➢ Documented procedures for the vehicles used in transferring raw material to be checked and monitored to verify the quality and safety of materials. ➢ Documented procedures had been established dealing with unconformity incoming material.
7. Measures for prevention of cross contamination	➢ The only modifications in this parameter were establishing adequate documentation procedures for possible allergen ingredients.
8. Cleaning and sanitizing	➢ Procedures for cleaning and sanitizing program and a cleaning schedule were adapted. ➢ The cleaning and sanitizing programs was monitored and verified for effectiveness by applying quality control procedures using periodically microbiological analysis.
9. Pest control	➢ The pest control parameter was completely absent. ➢ Pest control procedures therefore was firstly adopted, then facilities were modified to prevent entrance of insect, rodent and bird to the plant, adequate number of baits or traps were used, weekly control on all outside pest breeding places as well as all inside harboring and hibernating spots, thirdly floors, walls and conveyors were frequently inspected for detecting the presence of any sign of pest and finally the eradication measures were documented to be used if there any evidence of pest infestation.
10. Personnel hygiene and employee facilities	➢ A documented procedure for personal hygiene policy and behavior requirements to ensure food safety was established, as well as a documented procedure dealing with visitors. ➢ The employees should undergo a periodic health examination and are obligated to have a valid health certificate.
11. Product recall procedures	➢ A documented, maintained recall or traceability procedures was adopted enabling rapid recall of any implicated lot of the finished product from the market and retained records of processing, production and distribution for a period exceeding the shelf life of the product through using record that identified raw, ingredient, packaging and batch number for each production process.
12. Warehousing	➢ Quality control procedure for monitoring conveyances and bulk container to ensure effectively maintained the temperature; humidity during transportation was applied.
13. Training	➢ A training procedure for identifying training needs was adopted with a training plan
14. Product information and consumer awareness	➢ There was no modification required.

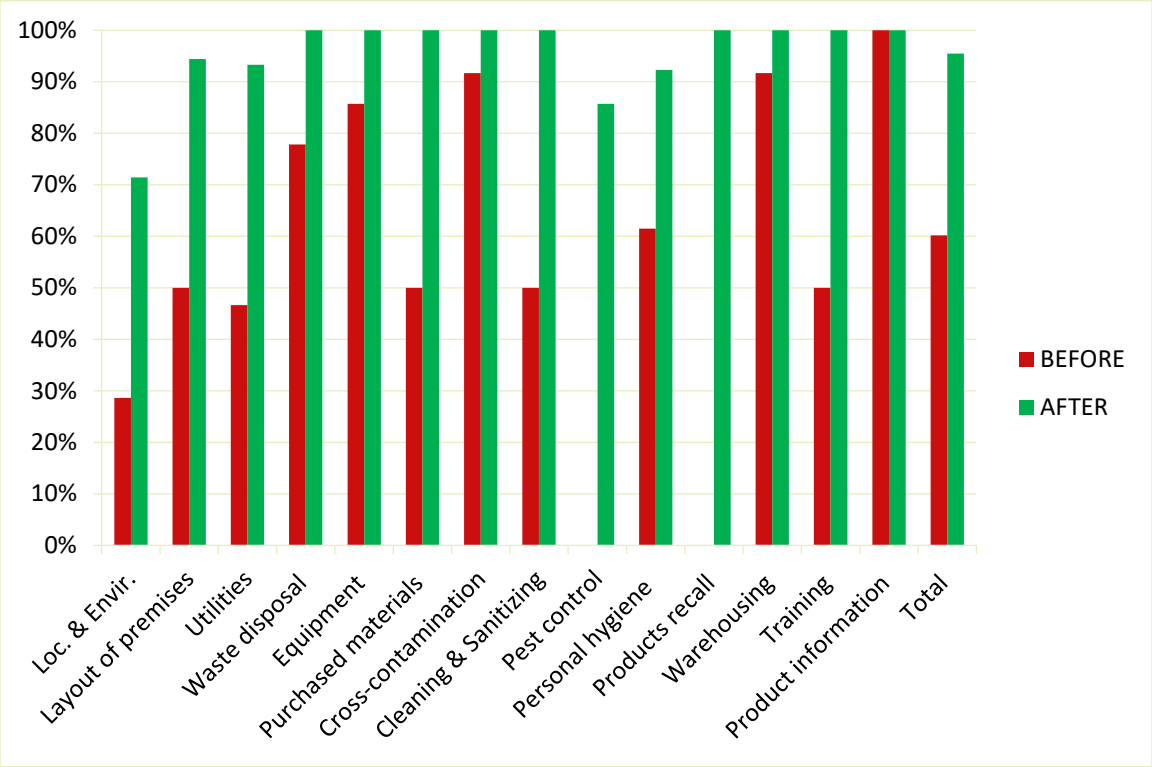

Figure 1: The score percentage of prerequisite programs parameters before and after rehabilitation in the dairy products plant, Gaza

DISCUSSION

The overall score percentage of the required elements of the PRP (60.2%) in the present study (Table 1), was similar to the results of a study conducted in a puffed snakes' industries, where the total score of GMP evaluation was 69.0%. The highest score percentage among the GMP evaluation was in building & Facilities (80%), and the lower for sanitary operations (51%).[9] Other study conducted in a pork laughter plant in China found that the 60 pork companies' average GMP score was 62.7%. Pest management score (31.7%), and product contamination control (28.3%) showed the lowest score. Meanwhile, the highest score was in facility and equipment maintenance (92.9%).[10] In a study carried out in Ethiopia for dairy industries showed that 89% of milk processing plants have enough room for setting up equipment, processing, packing, and material storage. Also, 90.5% of milk processing plants have sufficient lighting, and walls were built with suitable anti-corrosion materials for dry wash and painted in light color, 95 % of the ground had a waste canal and a correct slope. Dust-proven materials were used in the construction of 67.0% of the processing room ceiling. In 76.0% of the hot and cold water were sufficient. 76.2% had a secure, separate place to store chemicals. 76.2% employ diverse pest control techniques. 95.24% of the plant's employees demonstrated excellent attention to personal hygiene and regular medical checkups. Hand washing stations were available in 85.7% of milk processing facilities. Only, 19% of milk processing plants, offered ongoing training. [11] To guarantee that residual chlorine levels in water sources stay within the ranges specified in relevant regulations, they must be chlorinated and tested at the point of use. Non-potable water must be supplied by a separate, clearly marked system that is unconnected from the system for potable water. It is required to provide ventilation (natural or mechanical) to get rid of extra or undesirable steam, dust, odors, temperature, and/or humidity. It is necessary to establish protocols for controlling and monitoring air quality. It must be built and designed in a way that prevents air from moving from dirty or contaminated areas to clean ones. Systems must be accessible for maintenance, filter changes, and cleaning. It is important to have enough natural or artificial illumination so that employees can work safely and hygienically. With the availability of suitable tools for sensing temperatures and humidity, adequate facilities for cooking, cooling, and storing food should be available.[12]

There is proof that training not only leads to improved topic knowledge but also to better

performance, lower turnover rates, and fewer injuries.[13] Cross-contamination, poor personal hygiene, and time-temperature abuse were the three major food safety practices that were the subject of a study at 31 restaurants across three Midwestern states to determine the impact of training on knowledge and behavior. The study demonstrated that training can significantly affect knowledge and behavior improvement. However, as evidenced by the high scores on knowledge and low percentages on matching behaviors; improving information does not guarantee that behaviors will change. They came to the conclusion that altering behavior requires more than just knowledge.[14]

The present results (Figure 1) are in complained with the result of a previous study conducted in mozzarella cheese in Brazil, where the GMP was increased significantly from 32% to 66% ($p<0.05$) after implementation. Their study showed that the score percentage of reception of raw materials, building and facility, equipment, utensils and tools, personal hygiene, and documentation and records were 43.0%, 31.0%, 17.0%, 40.0%, 31.0%, respectively increased to 64.0%, 58.0%, 67.0%, 93.0%, 47.0%, respectively, after implementation of GMP.[15]

These results are also similar to the results of a study in a puffed snakes industries, where the total score of GMP was improved and increased from 69% before implementation of HACCP system to 94% after implementation of HACCP system. The score percentage of building& Facilities, sanitary operation, sanitary facilities and control, equipment and utilities, production and process control, warehousing and distribution and personal hygiene were 80.0%, 51.0%, 72.0%, 71.0%, 77.0%, 60.0%, 63.0%, respectively which increased to 91.0%, 97.0%, 95.0%, 96.0%, 95.0%, 93.0%, 93.0%, respectively after implementation of HACCP system.[9]

Also a study carried out in a processing natural sausage casing factory showed that the score percentage among PRP parameters were 14.2%, 43.3%, 62.1%, 40.0%, 43.3%, 45.6%, 0.0%, 21.7%, 33.3%, and 36.0%, respectively, which increased to 42.8%, 100.0%, 96.6%, 100.0%, 96.7%, 92.4%, 71.4%, 100.0%, 100.0%, and 92.0% for location, premises and rooms, supplies and utilities, waste and sewage facilities, suitability of equipment, management of purchased materials, prevention of cross contamination, cleaning and sanitizing, pest control and personal hygiene, respectively after implementation of ISO 22000:2005.[16]

Limitations:

- High cost of implanting and rehabilitating PRPs in food industry made it difficult to apply by all food industries organization.
- Absence of approval calibration organization in Palestine.
- Absence of approval pest control organizations.
- Limited number of approval laboratories, with high cost of sample analysis.

No periodic assessment to water supply in food industries.

CONCLUSION AND RECOMMENDATIONS

The rehabilitation of PRPs improved the level of the parameters of the dairy plant and minimized the food safety hazards and played a role in putting the basic requirements for any FSMS. All dairy products plants should apply PRPs and commit to the development and implementation of PRPs. The authority must work on providing the integrated pest control management system (IPCMS) in Palestine, improving and paving the roads and the environment around the food industrial area, increasing the attention towards the animal farm to meet the international standards, and providing approval for calibration procedures or providing approval for Palestinian companies specialized in calibration of instruments and equipment.

CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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