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Hazard analysis and testing for implemented a HACCP system at a dairy factory in South West Algeria

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Abstract:

The poor quality of a food product may have more or less far-reaching consequences, ranging from a simple alteration of the product, causing loss of its organoleptic qualities or its commercial value, to foodborne disease constitutes a danger to human health. The objective of this study is to implement a HACCP system focusing on controlling up stream processes as much as possible in all stages of the food chain which it is developed through surveys and visits of the dairy factory in south-west Algeria (SUDLAIT-IGLI). The investigation showed much more failure in the hygiene context, in the program of human resource development (education, training, and motivation), a complete lack of retreat program and even a loss of control after bagging milk at the transport level, but after the efforts adopted by the leaders of the production unit, a HACCP platform namely prerequisites programs (PRP) can be accessed by the industrials, this is a first step towards the establishment of a quality system. The short and long-term assessment of this approach may contribute to the widening of HACCP strategy.

Keywords: HACCP, Milk and milk products, Prerequisite programs, Danger, Safety, SUDLAIT dairy, food-borne disease.

1. Introduction:

In Algeria is a country dairy tradition. Milk and dairy products are prominent in the diet of Algerians whose needs for milk and milk products are considerable, with an average consumption of 110 liters per inhabitant/year, estimated at 115 liters in 2010. Algeria is the largest consumer of milk in the Maghreb, Ghaoues (2011). Despite the evolution of production, Algeria remains dependent on the world market to supply in powder milk for consumption and processing.

The main constraint at all levels of the dairy sector is linked to poor hygiene and non-compliance with the regulations. The failures of links in the chain, determine the sanitary quality of the finished product.

The dairy food insecurity is linked to certain bacterial zoonotic diseases transmissible to humans and affecting dairy animals such as *Tuberculosis, Brucellosis, Salmonellosis*, *Staphylococcal mastitis* and *listeriosis* have led to consumer mistrust.

As a result, more effective mastery of food safety is essential to protect consumers from food poisoning.

Firstly, the quality systems adopted focused on toxicological and microbiological characteristics of food. Later on, other methods such as HACCP system (*Hazard Analysis and Critical Control Point*) have been developed for the mastery of food safety with an emphasis on identifying and preventing hazards.

Over the past decade, several international institutions (Codex Alimentarius, WHO and FAO) have established many regulations to help industrials to setup a methodology for managing the quality and safety of food.

Nowadays, ISO 22000 standard specifies the requirements for a system of food safety that involves interactive communication, system management, prerequisite programs and HACCP principles. It meets the needs of professionals who require strong means to ensure food safety and going further than the establishment of a HACCP plan.

In this study, we focused on the identification and analysis of hazards (microbiological, chemical and physical) according to ISO 22000, evaluation and installation of preventive measures that include controlled operational prerequisite programs (oPRP) and critical control points (CCP), and that at the production line of pasteurized milk in the dairy factory SUDLAIT-IGLI (Bechar, Algeria)

2. Geographic location of SUDLAIT dairy

The dairy "SUDLAIT" is located 3 km north of the Igli town between the big western Erg to the east and inter-municipal road Taghit-Igli and Oued of Saoura in the West (Figure 1). This dairy is one of the subsidiaries of GIPLAIT Group, and it was built between 1984 and 1986 by a French Company (Agricultural Equipment).

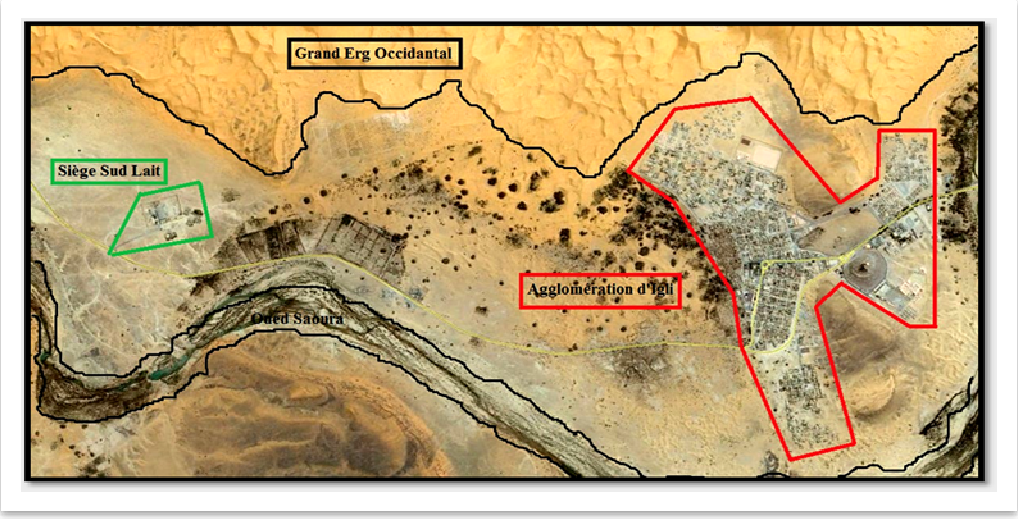

Figure 1. Location of the dairy factory "SUDLAIT" Google Earth (2014).

3. Characteristics of the dairy: Description of installations

The dairy buildings are arranged on a ground approximately 5,54 acres and are distributed as follows (Figure 2):

- Production workshop,
- A storage building of raw materials
- Guards' housing and accommodation for transformers and power generators
- Wastewater treatment station of liquid effluents from the dairy.

Figure 2. Structural organization of the dairy "SUDLAIT", Google Earth (2014).

(1): Computer security, (2): Administration, (3): Storage area, (4): Storage area, (5): Cooling tower, (6): Production workshop, (7): transformer station and generator, (8): Water covers, (9): Oil tank, (10): maintenance workshop, (11): Wastewater treatment station of liquid effluents.

The unit is designed to produce up to 40,000 liters of pasteurized milk and 10,000 liters of fermented milk per day, knowing that the unit has a main activity in manufacturing reconstituted pasteurized milk, fermented milk and recently pasteurized raw camels' milk production began in November 2013 with the production of 2200 liters in the last seven months to June 2014 (Table 1).

4. Materials and Methods

This is a preliminary study describing the work conditions in the dairy factory "SUDLAIT" including sanitary measures of different sites of the production unit. From our investigation, a program of preventive measures is determined in order to apply the HACCP system. Therefore, a visit to the various departments of the production workshop, reception and storage of raw materials and laboratory services, was conducted.

4.1 Surveys:

A survey allows having the maximum information on production conditions developed on the basis of points we considered as important for the assurance of food safety and in direct relation to the quality of the finished product through "the five M's (5M) rules", the oPRP, GHP and GMP, namely:

- The raw material (milk powder, process water);
- The workforce (training, requirements of personal hygiene and clothing, behavior…etc.)
- Local production, storage and distribution;
- The production line (installation, maintenance and condition of equipment);
- Frequency of cleaning and disinfecting procedures;
- Finished product.

The surveys that we have established, were used to identify critical points and discuss the questions relating to each axis cited, then we translated the answers based on a percentage to determine the level of control and mastery of the manufacturing chain.
A percentage above 60% is considered as satisfying; whereas a percentage under 60% is considered as insufficient for each criterion, Boussouar (2007) and after various observations revealed, we proposed a program of prevention and health assurance, fundamental pillar in the application of HACCP system to ensure product safety and provide consumers with healthy and safe products keeping all components of their quality.

4.2 Identification and hazard analysis 'HACCP plan'

The implementation of HACCP system "*Hazard analysis and critical control points*" is performed in several successive stages, at first, it is to apply the prerequisite programs (PRP) to reduce the level of certain contaminants, identify hazards at each stage of production, processing or preparation of the product, evaluate the corresponding risks and to determine the stage where it is possible to act effectively, Faye & Loiseau (2000).
The quality management by the analysis of risks or potential hazards associated with a product or process (HACCP) must be applied on the entire chain from the cow to the consumer, Leyral & Vierling (2007). Hazard identification was performed using the Ishikawa diagram "Diagram cause-effect" detailing 5 causes to consider "5M Method" staff (Hands work), Air (Medium), surfaces (Material), Products (Raw Materials) to which should be added the organizational methods, manufacturing and implementation (Methods) to maintain a hygienic environment throughout the production, Notermans *et al.* (1994), Blanc (2007), and again, the determination of a "Critical Point for Control CCP," is mainly facilitated by the application of a specific decision tree to HACCP, indicating logical reasoning approach, while the risk was studied by Zurich Hazard Analysis approach which involves assessing qualitatively and semi-quantitatively of the risk, the severity of the hazard, its frequency of occurrence and its frequency of non-detection, Codex Alimentarius (2003).
At each of the identified potential risks corresponding the relevant corrective actions and control plans (mastery system of the deviations) associated with critical limits and monitoring procedures (preventive action), verification and registration system (traceability system) for the validity of the HACCP plan and compliance of system established.

5. Results and Discussion

5.1 Interpretation of the survey :

The average percentage of the answer given "Yes" of the seven criteria was (83,81%), it is greater than 60% considered a satisfactory criterion. While the average of the response by "No" was (16,19%) (Figure 3).

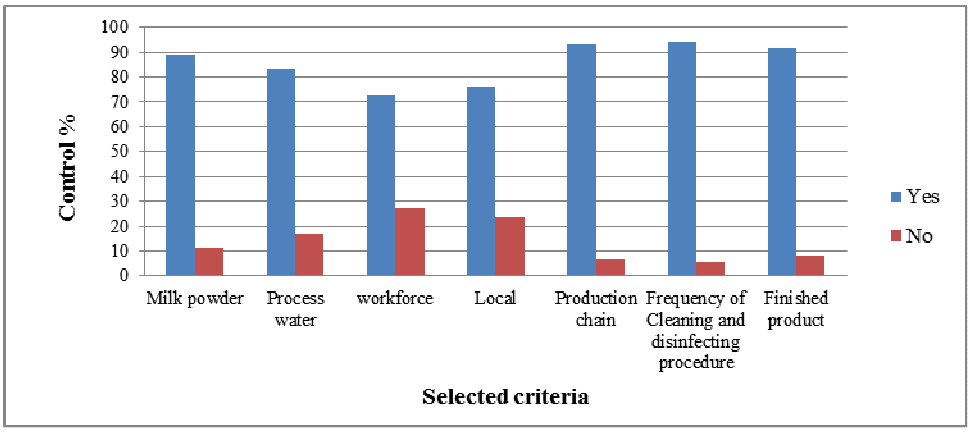

Figure 3. Prerequisite programs analysis of selected criteria.

Regarding the evaluation of prerequisite programs implemented, and based on the seven selected criteria (milk powder, process water, workforce, local, production chain, frequency of cleaning and disinfecting procedure, and finally the finished product), the results obtained were: 88,89; 83,33; 72,72; 76,30; 93,33; 94,44 and 91,67% respectively, which means that almost all the measures and procedures applied are mastered.

The results of the survey for the criteria (raw material), showed that there're points poorly planned and that in particular, the lack of traceability and more faulty analysis that do not follow all the parameters recommended by the Algerian regulations. This is probably due to the lack of analytical means. These results are similar to those observed in the study of Boussouar (2007) in Algeria.

17% of responses per "No" relevant to the criterion (process water), however, the physicochemical and bacteriological quality of water is in conformity with the regulations, and because of low frequency cleaning of the water tarp, there might be cross contamination of microbial origin.

For the criterion 'workforce', the survey revealed that it does not have a good knowledge about the basics of hygiene, this is mainly attributed to lack of training on these bases (Good Hygiene Practices 'GHP'), "*A staff is not trained on the basics of hygiene never meet hygiene*" Worsfold & Griffith (2003), and non-compliance with good manufacturing practices (GMP). Our results are consistent with those cited by Gouri-Djaaboub (2010).

The results of criterion 'local' showed failure by the absence of adequate ventilation, lack of regular maintenance of the lighting system and local (production workshop, storage of raw material and finished product), the cleaning system is very classic and still probably not suitable to different types of surface and finally, low frequency cleaning.

The parameters studied of the production chain criterion presented lack of maintenance facilities which can be due to financial constraints and the spare parts are not available because the unit's equipment is relatively old.

This type of enterprise requires high availability of production equipment which requests the develop of an optimization policy and maintenance organization to satisfy the requirements in the context of this type of industry considering the size specificities of dairy factory, brittle manufacturing process and especially in terms of technological manufacturing process that do not support abrupt stops, which may affect the organoleptic quality of matter and food during processing (Benzouai & Titouna, 2007).

Ineffective cleaning and disinfecting depends on the conception of the unit and also the design of installations and equipment, the arrangement of the unit and the lack of documentation and registration of cleaning programs. These results are consistent with the work of Benzouai *et al.* (2007).

The final criterion, the finished product presented necessary points to control in transport vehicles and storage locations that are not well-maintained (cold chain) and the complete lack of retreat program. This can cause a hazard especially of microbial origin.

Based on the survey data, we can say that the platform of HACCP plan is much more assimilated by the dairy, despite the failures that have been reported mainly for workforce criterion.

5.2 Prerequisite programs (PRP):

The prerequisite programs represent the conditions and basic activities necessary to maintain a hygienic environment for the production, storage and delivery of finished products safe throughout the process.

In the prerequisite part, we focused our efforts on education and staff training in hygiene behavior, organized the movement of raw materials, waste and workforce to avoid cross contamination.

The determinations of PRP required for the activity are shown in Table 2 and an example of audit PRP plan is presented in Table 3.

5.3 Team responsible for food safety:

We have proposed the creation of a team of food safety (Table 4).

5.4 Establishment of operational prerequisite programs (oPRP) and HACCP Plan (CCP):

The hazard analysis has been established, after the process flow diagram, was developed and verified. It was carried out step by step, beginning from the receipt of raw materials to the shipment of the finished product.

The main purpose of the hazard analysis is the determination of CCP and oPRP to focus the inspection at these points and enable process improvement.

A HACCP plan bringing together the key information of hazard identification revealed the existence of seven critical points in different stages of the manufacturing process. They are at; milking for raw milk "farm", collection and transport, receipt and storage of raw materials “raw milk and milk powder”, pasteurization, inoculation and maturation of fermented milk, refrigeration and finished product storage, cleaning and disinfecting, which are confirmed in our series of studies on the quality system in the state dairy subsidiaries in Algeria, Benyagoub & Ayat (2013); Benyagoub *et al.* (2014a).

The corrective actions are taken when critical limits are exceeded for CCP’s and when measures controlled are not respected for oPRP. They are drawn up to regain the mastery of CCP quickly and prevent the loss of their, Benyagoub *et al.* (2014b).

These programs are designed to eliminate or quickly restore the critical control points and prevent the recurrence of danger, and it is imperative to establish preventive and corrective measures so that the dairy industry must undertake activities to prevent the frequency of occurrence especially microbiological hazards appearance causing out breaks of foodborne disease among consumers. The table 5 shows an example of a CCP form at the pasteurization step.

In perspective, a study estimated the costs for implementation of food safety systems is crucial to knowing its impact on the relative cost-benefit relationship, and on the basis study of Cusato *et al.* (2014) for the yogurt production line in a small dairy factory in Sao Paulo-Brazil, showed that the cost of the installation of “HACCP”

and Good Manufacturing Practice "GMP" represents 0,5% of production costs, which is a 1,5% increase of the cost per kg of yogurt packed.

6. Conclusion

In this work, we conducted a preliminary study describing the working conditions and quality system that can be applied to the dairy factory "SUDLAIT".

From the results obtained, we proposed the prerequisite programs so that the production unit acquires hygienic conditions throughout the production chain for the effective application of HACCP system. This study highlights the following key points:

Lack of control over the raw materials' quality, which leads to various problems encountered during manufacture; the total absence of retreat program, an installation where the control and monitoring are unreliable, also, there's still a lack of staff training should be avoided to get qualified hands works and aware of the importance of their work in the hygiene context; production area should primarily benefit of maintenance activities and if necessary some sites of the workshop should be rebuilt in a way to ensure a hygienic environment for the activity of milk production; some production equipment require periodic maintenance program and the major problem of breaking the cold chain remains relevant and requires rapid intervention. The cleaning equipment is generally correct, but must be renewed regularly using disinfectant solutions.

In general, our study allowed making an overview of prevailing conditions at the dairy factory studied and a subsequent effective for the application of the HACCP plan.

The short and longer-term valuation of this approach may contribute to the spread of HACCP strategy.

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Notes:

Table 1. Production capacity of pasteurized milk and fermented milk, SUDLAIT dairy (2014).

Product	Production capacity (liters / year)
Reconstituted pasteurized milk conditioned in bag	14 047 291
Fermented milk conditioned in bag	34 1 749

Table 2. Prerequisite programs

Prerequisite programs	Control measure
Hygiene of the premises and buildings	-State of lighting -Cleanliness -Separation of areas the soil-sealing -Drained soil
Water and vapor	-Water quality of the main cistern -Effectiveness of sand filter -Effectiveness of activated charcoal -Effectiveness of particulate filters -Quality of vapor from the boiler
Cross-contamination	-Flow of raw materials finished -Protection materials and semi finished products -Management of utensils -Staff flux
Waste management	-Identification of areas -State of waste discharge
Hygiene and health of Staff	-Uniforms clothing + body hygiene -On hand hygiene -Staff health -Staff behavior -Training of personnel
Cleaning and disinfecting	-Preparation building -Conditioning workshop -Surrounding area at workshops
Strive against the harmful	-Crawling insects -Flying insects -Rodents
Transport and storage	-Humidity and Temperature -Stacking height -Separation of the products -hygienic condition
Purchasing and receiving raw materials	-Hygienic condition for receipt of raw materials -Certificate of conformity

Table 3. Audit plan of hygiene and Staff health

Control measure	Verification procedure		
	Method	Frequency	Supervisor
Uniforms clothing+ Body hygiene	Visual	Once a day	Hygienist
On hand hygiene	Swab	Once a day for two persons	Laboratory technician
Staff health	Medical examination	Once a year, each Staffing	Occupational physician
Staff behavior	Valuation	Once a day	Hygienist
Staff training	Assessment test	At each training	Hygienist

Table 4. Management system of food safety

Member	Job Mission in relation to the food safety
Responsible of food safety management Management of food safety	-Participate in the definition of food safety policy, following its effectiveness and implementation; -Lead the team responsible for food safety products and organize work; -Ensure appropriate training, initial and continuing, members of the team responsible for food safety; -Ensure that the management system is established, implemented, maintained and updated;
Hygienist	-Ensure compliance with good manufacturing practices and hygiene. -Supervising daily staff to ensure rigorous application of body hygiene and clothing following prerequisite programs developed. -Supervising activities of cleaning and disinfecting. -Supervising control activities against pest.
Laboratory responsible	-Define and establish quality control methods, -Follow the control of physicochemical and microbiological quality of raw materials, finished products and means of production.
Production manager	-Planning and coordinating production operations. -Elaborate manufacturing diagrams
Maintenance manager	-Ensure the smooth operation of manufacturing equipment. -Program and plan of the days for revision and preventive maintenance. -Reduce downtime.
Responsible for procurement and stock management	-Check daily receiving raw materials and shipping the finished product. -Ensure compliance with the conformity of products purchased according to the technical specifications.
Commercial manager	-Communicate interactively with clients. -Analyze and process the customer complaints.

Table 5. CCP form at the pasteurization step

	CCP N° 1
Diagram	Pasteurized milk, partly skimmed
Steps	Pasteurization
Hazard	No respect of the pasteurization scale (temperature/ time) may cause under pasteurization and therefore the survival of bacterial pathogens.
Control measure	Pasteurization of the product at a temperature of 92-95°C
Monitoring parameters	Pasteurization temperature: 92-95°C.
Critical limit	Objective value of pasteurization, 94°C, time 20 sec; (temperature consistently maintained at roomers for 16 to 20 sec).
Mode and monitoring tools	Control of scale: temperature/time. 1) Continuously monitor the actual temperature displayed at the PID controller (loop automatic temperature control). 2) The existence of a sound and light signaling device of any deviation of the pasteurization temperature.
Frequency and responsible for monitoring	In a continuous controller (supervision by the operator).
Correction	Existence of an automatic deflection for insufficiently treated milk (temperature outside the critical limits)
Corrective Action	1) Recycling (treatment in closed circuit). 2) The operator must: a) Cool down (4-6°C) and send the milk to storage tanks before pasteurization. b) Stop the process and appeal to the maintenance technician to make corrections. c) Record and report quality control and Maintenance 3) The operator must: a) Repeat the process of pasteurization for the entire manufactured dose. b) Record and report quality control and Maintenance - Responsibility: Production and maintenance.
Verification	1) The supervisor must check the tape recorder of the temperature throughout the operation. Frequency: at the end of any pasteurization process. 2) The laboratory technician must take a sample of completely pasteurized dose and make a bacteriological analysis (result after 48 hours) to confirm the reliability of the system and therefore the reliability of the HACCP plan. Frequency: Each dose of pasteurized milk.

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