July –August 2020
ISSN: 0193-4120 Page No. 6619 -6623

Application of a Quality Management System in the Dairy Plant "ECOLAC"

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Abstract:
The consumption of milk and dairy products in the world population is growing significantly. The demand of the consumers to acquire safe and quality products, causes that the medium and small companies, have the urgent necessity to implement Quality Management Systems (QMS), in such a way that it allows them to enter the highly competitive markets. This research analyzes the effects of the application of the QMS on the organoleptic, physiochemical and microbiological parameters of raw and pasteurized milk. The samples were taken in the processes of raw material reception, pasteurization and storage, and the analyses were performed in triplicate for each of the samples. For the analysis of the data a "Students t" test was applied, to determine the differences after the application of the QMS. The results indicate that the application of QMS had positive effects on the physicochemical parameter of acidity and on the microbiological load of mesophilic aerobes in the milk reception process. On the other hand, not effects on organoleptic characteristics, density, pH, fat and total coliforms growth were evidenced. These findings are important since they can be replicated in other dairy processing plants.

Keywords: *Quality management system, milk, organoleptic, physicochemical, microbiological*

1. INTRODUCTION

Currently, talking about the Quality Management System (QMS) as a means to achieve continuous improvement of the processes that accelerate companies with the users of goods and services, is an imperative need, without distinguishing from the business model to which it is applied, since in the end, the result of quality management points to the achievement of efficiency and effectiveness in the optimization of resources to compete in meeting the needs of community members, accompanied by acts of execution, evaluation, and control that allow detecting successes or mistakes, making adjustments or repeating the process as the case may be. (Barrios, 2013).

The QMS is used in different functional areas of the company, such as finances, operations, human resources and others (Badia, 2002; Ardila and Vargas, 2013), for its operation it has to plan and implement processes (analysis, evaluation and monitoring) with the aim of verifying compliance with the system and the quality of the products and favouring continuous improvement (Dumas, 2014; Vélez, 2018), allowing the compatibility of other management systems, such as Good Manufacturing Practices (BPM) , Sanitation Standard Operational Procedures (SOPs), Hazard Analysis and Critical Control Points (HACCP), Total Quality Management (TQM),

International Organization for Standardization (ISO) and Food Safety (CCI, 2008; Herrera, et al. 2014). The importance of the application of the QMS is based on reviewing the operation of each of the processes that allow delivering a product to the client seeking to satisfy needs (Benítez, 2011).

According to the Survey of Agricultural Area and Production (2018) revealed that milk production in Ecuador is approximately 5 million liters / day; In the province of Chimborazo there is an estimated 408,746 liters / day, placing it in sixth place at the national level (INEN, 2014).

In criteria of safety and quality management in production, it is important to take into account diseases that have their origin or are transmitted by food, commonly called Foodborne Diseases, which are responsible for a high number of events that include deaths and poisonings in many cases, therefore, it is important to counteract or at least

July –August 2020
ISSN: 0193-4120 Page No. 6619 -6623

mitigate these types of impacts on the population (Arispe y Tapia, 2007; OPS, 2015).

In the case of milk, quality includes physicochemical attributes (acidity, density, total solids, percentage of fat and protein, among others), organoleptic (color, aroma, flavor and texture) and microbiological (mesophilic aerobes and total coliforms) (INEN, 2012), which is why it is essential to implement a QMS within a company, in order to maintain traceability from the moment of milking, transformation to consumption (Barragán Vinueza et al., 2020).

In order to improve the production chain of the ECOLAC dairy company, located in the San Martín community of the Columbe parish, province of Chimborazo, a QMS was implemented in accordance with Regulation 067 (ARCSA, 2015). To evaluate the effect of the QMS, sensory, physicochemical and microbiological analyzes were carried out, before and after implementation, in the raw material reception, pasteurization and storage processes, in order to verify the effectiveness of the application of the QMS.

2. METHODOLOGY

This research was developed at the "ECOLAC" dairy plant of the San Martín Bajo Community, Columbe Parish, Colta, province of Chimborazo (Ecuador) The microbiological analyzes were carried out in the en el Laboratorio de Biotecnología de la Facultad de Ciencias Pecuarias de la Escuela Superior Politécnica de Chimborazo.

The investigation began with a situational diagnosis by applying a "check list" (ARCSA, 2015). Milk samples were used as experimental units, to which organoleptic, physicochemical and microbiological tests were carried out; before and after implementing the QMS.

To evaluate the effect of the introduction of the SGC, milk samples were taken in the processes of reception of raw material, pasteurization and finished product, the samples were analyzed in triplicate.

2.1.Diagnosis Of The Current Situation Of The Process Plant

It was determined by applying a "check list" in which the following aspects were considered: hygienic requirements in the facilities, equipment and utensils, food handling, raw materials and supplies, production operations, packaging, labelling and packaging operations , transportation and marketing, storage, distribution and quality assurance.

2.2.Quality Management System Evaluation

a. Organoleptic Analysis Of Milk

For the organoleptic analyzes, acceptability tests were carried out and the hedonic scale of Sancho, (2002) was applied, which consists of: appearance, color, flavor and aroma (Maximum 5 points; Minimum 1 point).

b. Physicochemical Analysis Of Milk

For the samples it was determined: titratable acidity (%), fat (%), density (g / ml), pH and alcohol test (INEN Standard, 009: 2012 Raw Milk; 010: 2012 Pasteurized Milk).

c. Microbiological Analysis Of Milk

Total coliform bacteria and total mesophilic aerobes were determined (INEN Standard, 009: 2012 Raw Milk; 010: 2012 Pasteurized Milk).

2.3.Statistical Analysis

A statistical analysis was performed using regression and the "Student's t" test to demonstrate the organoleptic, physicochemical and microbiological changes in the milk after the application of the QMS. The data were analyzed with the IBM SPSS Statistics 22 program, using the "Student's t" analysis, using the Tukey HSD test, with a significance level of 5% ($p \leq 0.05$) between the evaluation stages.

3. RESULTS AND DISCUSSION

3.1. Organoleptic Analysis

Table 1 shows the results of the organoleptic analyzes found in the milk in the reception, pasteurization and storage processes before the application of the Quality Management System and the results after its application.

The results indicate that the application of the QMS did not allow to significantly improve the sensory characteristics of the milk such as color, flavor, aroma and appearance in each of the processes. These data are within the provisions of Standard NTE INEN 09: Raw Milk and Standard NTE INEN 10: Pasteurized Milk.

Table 1. Organoleptic characteristics of milk in the reception, pasteurization and storage processes

July –August 2020
ISSN: 0193-4120 Page No. 6619 -6623

Stages of the Assessment			
Variables	**Before applying the QMS**	**After applying the QMS**	**P-Value**
Reception			
Color	3,00	3,67	0,18
Flavor	3,67	4,00	0,42
Aroma	3,00	3,67	0,18
Appearance	3,00	3,33	0,42
Pasteurization			
Color	3,67	3,67	-
Flavor	2,67	3,67	-
Aroma	3,67	4,33	0,18
Appearance	3,67	4,00	0,42
Storage			
Color	3,67	3,67	-
Flavor	3,67	4,33	0,18
Aroma	3,00	3,67	0,42
Appearance	3,67	4,00	0,42

3.2.Physicochemical Analysis

The results presented in table 2 correspond to the physicochemical characteristics of the milk before and after the application of the QMS. It was observed that no significant differences were found in the physicochemical characteristics after the application of the QMS, with the exception of acidity in the reception process.

In accordance with the NTE INEN 09 Standard: Raw Milk and the NTE INEN 10 Standard: Pasteurized Milk, the density and fat results obtained in each of the processes are within the parameters established in these standards. However, the acidity parameter is not among the parameters established in both the reception and storage processes. On the other hand, the pH in the storage process is outside the ranges of 6,6 and 6,8, which differ from those observed in raw milk by Reyes et al. (2010).

Table 2. Physicochemical characteristics of milk in the reception, pasteurization and storage processes

Stages of the Assessment			
Variables	**Before applying the QMS**	**After applying the QMS**	**P-Value**
Reception			
Acidity (%)	0,20	0,18	0,02**
Density (g/ml)	1,028	1,029	0,23
Fat (%)	3,30	3,23	0,75
pH	6,30	6,30	-
Pasteurization			
Acidity (%)	0,19	0,17	0,27
Density (g/ml)	1,028	1,028	0,84
Fat (%)	3,20	3,20	-
pH	6,83	6,93	0,23
Storage			
Acidity (%)	0,18	0,19	0,42
Density (g/ml)	1,027	1,028	0,42
Fat (%)	3,03	3,00	0,42
pH	6,77	6,80	0,42

**P<0,05

3.3.Microbiologic Analysis

The results presented in table 3 correspond to the microbiological characteristics of the milk before and after the application of the QMS. It was observed that the mesophilic aerobes and total coliforms did not present significant differences in the pasteurization and storage processes after applying the QMS. On the other hand, differences were observed in the reception process, only for mesophilic aerobes.

These results of the microbiological characteristics are within the parameters established in the NTE INEN 09 Standard: Raw Milk and the NTE INEN 10 Standard: Pasteurized Milk. It could be shown that the application of the SGC decreased the microbiological load of the milk.

Tabla 3. Microbiological characteristics of milk in the reception, pasteurization and storage processes

Stages of the Assessment			
Variables	**Before applying the QMS**	**After applying the QMS**	**P-Value**
Reception			
Aerobic mesophilic UFC/ml	5833,33	3400,00	0,00**
Total Coliforms UFC/ml	300,00	160,00	0,20

July –August 2020
ISSN: 0193-4120 Page No. 6619 -6623

Pasteurization			
Aerobic mesophilic UFC/ml	760,00	316,67	0,26
Total Coliforms UFC/ml	0,00	0,00	-
Storage			
Aerobic mesophilic UFC/ml	46,67	28,33	0,13
Total Coliforms UFC/ml	0,00	0,00	-

**P<0,05

CONCLUSIONS AND RECOMMENDATIONS

In general terms, the implementation of the Quality Management System in the ECOLAC dairy plant in the community of San Martín, has made it possible to improve the quality of the milk and improve the image of the company and the income of small producers in the area.

Among the relevant points of the application of the QMS, in the raw material reception process, it was evidenced that in the sensory analyzes their values increased in all the processes, except for the color in the pasteurization and storage processes.

In the pasteurization and storage processes, an improvement was observed in the physicochemical parameters of acidity (0.17%) and density (1,028 g / ml), allowing to adjust to the NTE INEN 10, on the other hand, a decrease in acidity could be evidenced (0.18%) in the raw material reception process, allowing to adjust to the parameters of the NTE INEN 09.

Finally, a decrease in the microbiological load of total coliforms and mesophilic aerobes was observed in the reception process, with significant differences only for mesophilic aerobes which were reduced to 3.4 x 10 ^ 3 CFU / ml, allowing to improve the quality of the final product .

The findings of this study show that the application of the QMS in dairy processing companies can considerably improve the quality of the product, its acceptance among consumers and consequently the income and living conditions of local producers.

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BIBLIOGRAPHY

- Arispe, I., & Tapia, S. (2007). Inocuidad y calidad: requisitos indispensables para la protección de la salud de los consumidores. Agroalimentaria, 13(24), 105-117
- ARCSA. (2015). Agencia Nacional de Regulación, Control y Vigilancia Sanitaria. Normativa Técnica Sanitaria Unificada para Alimentos Procesados, plantas procesadoras de alimentos, establecimientos de distribución, comercialización, transporte de alimentos y establecimientos de alimentación colectiva. ARCSA-DE-067-2015-GGG. QUITO
- Ardila, H. & Vargas, M. (2013). Evaluación de la gestión de la calidad en fábricas procesadoras de lácteos: un estudio de caso. Revista Facultad de Ciencias Económicas, 21(2), 43-52. doi: https://doi.org/10.18359/rfce.655
- Badia, A. (2002). Calidad: modelo ISO 9001. Bilbao, España: Deusto.
- Barragán Vinueza, U., Ramón C, R., Altuna, J.L., Bayas-Morejón, F. (2020). Ancestral Practice in the Production of Cheeses, Attends the Health and Good Living of the Consumer in San Pablo De Atenas, Province of Bolivar (Ecuador). Advances in Economics and Business, 8(1), 28 - 31. DOI: 10.13189/aeb.2020.080103.
- Barrios, C. (2013). Propuesta de un sistema de gestión de la calidad en la empresa inversiones Ceissar C.A. bajo el modelo de certificación de las normas COVENIN ISO 9001:2000 Maturin-Edo-Monagas (Master's thesis, Maturin: Venezuela. Instituto Universitario Politécnico “Santiago Mariño”, 2018).
- Benítez, A. (2011). Guía administrativa para implementar el sistema de gestión de calidad en las PYMEs en Boyacá.
- CCI, (2008). Centro de Comercio Internacional. ISO 22000 Sistema de gestión de la inocuidad de los alimentos. Lista de verificación para las PYME. Bogotá: UNIT.

July –August 2020
ISSN: 0193-4120 Page No. 6619 -6623

- Dumas, P. (2014). Herramientas para Implementar un Sistema de Gestión de Calidad. Bogotá-Colombia. No es accesible.
- ESPAC, (2018). Encuesta de Superficie y Producción Agropecuaria Continua. Recuperado el 28 de junio de 2020, de https://www.ecuadorencifras.gob.ec/documentos/web-inec/Estdeadisticas_agropecuarias/espac/espac-2018/Presentacion%20de%20principales%20resultados.pdf
- Herrera, B., Tamayo, G., Rodríguez, L., Vasco, C., & Escobar, J. A. (2014). Efecto de la aplicación del Sistema de Gestión de Calidad en la Cadena Productiva de Leche. El Caso de Tuntataco, Chimborazo. Revista Amazónica Ciencia y Tecnología, 3(2), 130-139.
- Sancho, J. Bota, E., Castro J. 2002. Introducción al análisis sensorial de los alimentos. Edit Universidad de Barcelona, España
- INEN, (2012). Norma Técnica Ecuatoriana 10. Leche pasteurizada. Requisitos. INEN. Quito.
- INEN, (2012). Norma Técnica Ecuatoriana 9. Leche cruda. Requisitos. INEN. Quito.
- INEC, (2014). Instituto Nacional de Estadística y Censos. Encuesta de Producción Agropecuaria Continua. Recuperado el 28 de junio de 2020, de https://www.ecuadorencifras.gob.ec/encuesta-de-produccion-agropecuaria-continua/
- OPS, (2015). Organización Panamericana de Salud. Enfermedades transmitidas por alimentos (ETA). Recuperado el 28 de junio de 2020, de https://www.paho.org/hq/index.php?option=com_content&view=article&id=10836:2015-enfermedades-transmitidas-por-alimentos-eta&Itemid=41432&lang=es
- Pinto, P. U. (2017). Macroorganismos indicadores. 1–14.
- Reyes G., Molina B., Coca R. (2010). Primer Foro sobre Ganadería Lechera de la Zona Alta de Veracruz. Calidad de la Leche Cruda. 4
- Vélez, M. (2018). Diseño de un sistema de gestión de calidad para los procesos realizados en el taller de lácteos de la ESPAM MFL (Master's thesis, Quito: Universidad de las Américas, 2018).