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On the implementation of good manufacturing practices in a small processing unity of mozzarella cheese in Brazil

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ABSTRACT

This study reports the implementation of GMPs in a mozzarella cheese processing plant. The mozzarella cheese manufacturing unit is located in the Southwestern region of the state of Parana, Brazil, and processes 20,000 L of milk daily. The implementation of GMP took place with the creation of a multidisciplinary team and it was carried out in four steps: diagnosis, report of the diagnosis and road map, corrective measures and follow-up of GMP implementation. The effectiveness of actions taken and GMP implementation was compared by the total percentages of non-conformities and conformities before and after implementation of GMP. Microbiological indicators were also used to assess the implementation of GMP in the mozzarella cheese processing facility. Results showed that the average percentage of conformity after the implementation of GMP was significant increased to 66%, while before it was 32% ($p < 0.05$). The populations of aerobic microorganisms and total coliforms in equipment were significantly reduced ($p < 0.05$) after the implementation of GMP, as well as the populations of total coliforms in the hands of food handlers ($p < 0.05$). In conclusion, GMP implementation changed the overall organization of the cheese processing unity, as well as managers and food handlers' behavior and knowledge on the quality and safety of products manufactured.

1. Introduction

Mozzarella is a cheese obtained by stretching acidified curd complemented or not by the addition of lactic acid bacteria. The curd is obtained after coagulation of milk by rennet and/or coagulant enzymes (Anon, 1997b; Kindstedt, 2004). Mozzarella cheese presents up to 60% of humidity, pH between 5.1 and 5.3 and maximum of 2% of salt (Anon, 1997b), which provides adequate conditions for the survival and growth of pathogenic microorganisms that may pose risks to human health (Amagliani, Giammarini, Omiccioli, Brandi, & Magnani, 2007; Buzi, Pinto, Ramos, & Biondi, 2009; Teixeira, Fonseca, & Menezes, 2007). It is known that the microbiological quality of milk and the procedures adopted during milking and processing will affect cheese quality (Carvalho, Viotto, & Kuaye, 2007; Naldini, Viotto, & Kuaye, 2009; Silva et al., 2010; Wolf, Perotti, Bernal, & Zalazar, 2010). Therefore, the application of any measures to ensure the quality of milk used for making mozzarella cheese as well as hygienic conditions during its processing are mandatory to obtain safe and high quality cheeses.

The implementation of good manufacturing practices (GMP) during milking and dairy processing might avoid or reduce the contamination of dairy products by biological, chemical and physical hazards (Codex, 2004). GMP encompasses a series of measures to be adopted by the food industries in order to guarantee the safety and conformity of food products to specific regulations (Anon, 1997a). Moreover, GMP is essential for the implementation of management systems such as HACCP (Lockis et al., 2011; Papademas & Bintsis, 2010; Sarter, Sarter, & Gilabert, 2010).

General measures to be implemented by food industries to accomplish with GMP as described by *Codex Alimentarius* include: hygiene in the primary production, hygienic design of equipment and facilities, control of operations, maintenance and sanitation practices, personal hygiene, transportation, product information

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and consumer awareness and training (Codex, 2003). Although the *Codex Alimentarius* (2003, 2004) and countries may establish general guidelines for hygienic practices (Anon, 1997a), procedures and practices adopted routinely by each industry to address regulatory requirements might vary among them. Thus, the practices of each processing plant to obtain high quality and safe foods must be documented in GMP manuals (Anon, 1997a). The existence of a manual describing how GMPs are accomplished by each processing plant is of foremost importance to ensure their continuous evaluation and improvement by processing plants, governments and partners (Senai, 2001).

The implementation of GMPs is a continuous process based on the management concepts of the PDCA cycle (plan, do, check and action). Considering the PDCA cycle, the implementation of GMPs can be divided in four steps: initial diagnosis, elaboration of road map, addressing of non-conformities and re-evaluation of corrective measures implemented. Initial diagnosis and re-evaluation of corrective measures implemented are usually carried out by auditing the processing facilities using a check-list based on the legislation regulating the GMPs in the country. Road maps will be generated after auditing, while the implementation of corrective measures requires the decision of resource priorities and efforts. The real benefits and effectiveness of the implementation of GMPs to food safety and quality are assessed by the use of indicators. Several indicators can be used to assess the effectiveness of the implementation of GMPs such as, microbiological indicators, pre- and post-implementation costs of GMPs, among others (Amoa-Awua et al., 2007; Lockis et al., 2011; Martins & Germano, 2008; Santana et al., 2009).

Although several studies on the impacts of hygienic conditions and food safety knowledge of food handlers on the microbiological quality of foods have been carried out (Capunzo et al., 2005; Jevšnik, Hlebec, & Raspor, 2009; Nieto-Montenegro, Brown, & LaBorde, 2008; Nunes et al., 2010; Seaman & Eves, 2010), to our knowledge few studies reported GMPs implementation in small food processing facilities. Therefore, the aim of this study was to describe the implementation of GMPs in a small processing plant of mozzarella cheese located in the state of Paraná, Brazil.

2. Material and methods

2.1. Characteristics of the cheese processing plant

The mozzarella cheese processing unity is located in the Southwestern region of the state of Parana – Brazil. The unity processes 20,000 L of milk daily, which is exclusively used for the manufacturing of mozzarella. This cheese manufacturing plant is a small scale factory with about 15 employers.

2.2. Implementation of GMPs in the mozzarella cheese processing plant

A multidisciplinary team composed by technical supervisor, quality inspector, production manager and administrative staff was formed. The implementation of GMP was carried out in four steps as follows:

2.2.1. Diagnosis

This step aimed to provide information on the current hygienic and manufacturing practices adopted in the factory before the implementation of GMP. The diagnosis (internal audit) was carried out by an *in situ* inspection of the factory using a check-list based on Regulation n°368/97 of the Brazilian Ministry of Agriculture, Livestock and Food Supply (Anon, 1997a; 1997b). The check-list (supplementary material) was divided into five sections: *i)* reception of raw materials, *ii)* building and facilities, *iii)* equipment and tools, *iv)* personal hygiene and *v)* documentation and records.

For each item of check-list assessed, a status of "conformity" (when the requisite was fully adhered), "non-conformity" (when the requisite was partially adhered or not adhered) or "not applicable" was assigned. The percentage of conformities and non-conformities per section audited was calculated. Any further observations regarding the section assessed in the check-list were also recorded at this step. The output of the diagnosis was a report containing the results of the factory's status regarding the implementation of the GMP.

2.2.2. Preparation of the report of the diagnosis and road map

The diagnosis report was first presented and discussed with of each sector responsible, and then, it was presented to the owners and general manager by the multidisciplinary team. The objectives were to get a full support of managers regarding the implementation of GMP and to establish the list of priorities to be implemented under the supervision of the multidisciplinary team (road map). For establishing priorities of implementation, cost-benefit (immediate investments needed and the feedback to food safety) were considered. Then, the list of non-conformities and priorities were discussed with all the involved sectors in the mozzarella cheese processing before corrective measures were implemented.

2.2.3. Implementation of corrective measures

The collaborators within the multidisciplinary team were requested to monitor, ensure and motivate food handlers to accomplish with the implementation of GMP. The implementation of corrective measures stated in the road map was done gradually based on immediate investments required and the feedback to food safety.

For a successful implementation of GMP, food handlers were trained towards the importance of GMP by attending short courses and lectures. The technical responsible and quality control team promoted periodically trainings (personal hygiene, sanitization methods, preparation and handling of sanitizers and quality control) for all food handlers. All the trainings were registered and all the information such as names of food handlers, date and total time of training were recorded for future auditing.

During the implementation step, whenever non-conformities were addressed, the manual of GMP was updated to represent the current practices of the mozzarella cheese facility regarding hygienic practices. The manual of GMP was structured based on instructions for food handlers, good manufacturing practices (GMP) and sanitation standard operating procedures (SSOP).

2.2.4. Follow-up on GMP implementation

Monitoring of all items depicted in the check-list used in the study, and particularly, of those previously assigned as "non-conform" was carried out by the quality control team during and after their corrections. The nature of non-conformities, date and time observed as this stage was registered. The effectiveness of actions taken and implementation of GMP was compared by the total percentages of non-conformities and conformities before the diagnosis and after implementation of GMP. In addition, microbiological indicators were used to assess the implementation of GMP in the mozzarella cheese processing facility before and after implementation of GMP. Microbiological analysis (total plate count and total coliforms) were carried out in the surface of equipment and hands of food handlers through the swab method using Plate count agar (PCA) and Violet-Red bile Agar (VRBA), respectively, according to Kornacki and Johnson (2001) and Morton (2001). Samples were collected from six equipment and hands of four food handlers. All analyzes were carried out in duplicate.