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# Assessing the costs involved in the implementation of GMP and HACCP in a small dairy factory

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**RESEARCH ARTICLE**

## Abstract

The present study describes the costs for implementation of food safety systems in a small dairy plant located in the central region of the state of São Paulo, Brazil. The steps involved in the implementation of a food safety system include a diagnosis of the prerequisites, implementation of the good manufacturing practices, standard sanitation operating procedures (SSOPs), training of the food handlers and hazard analysis and critical control points (HACCP). After implementation of the food safety system, the total cost of implementing the food safety system was US$ 61,812.00, signifying an impact of US$ 3.81/t of yogurt packed (0.5% of the production costs). The resources used for investment signified an additional US$ 12.92/t (1.5% of the cost per kg of yogurt packed). It was concluded that the application of HACCP considered in this study for the yogurt production line presented an adequate cost-benefit relationship, which would improve with the passage of time and with the improvement and sedimentation of the culture of food safety in the company.

**Keywords:** costs, dairy foods, food safety, GMP, HACCP, quality

## 1. Introduction

Due to globalisation of the food productive chain, foodborne diseases (FBDs) have acquired a new dimension (Lineback *et al*., 2009; Motarjemi and Käfersyein, 1999). FBDs represent one of the major public health problems on a worldwide scale, since they annually affect a great number of people (Greig and Ravel, 2009; Nyachuba, 2010; Pires *et al*., 2012; Scallan *et al*., 2011a,b). According to the World Health Organization (WHO), at least 1.8 million people die annually as a consequence of diarrheal diseases, a considerable proportion of these cases being attributed to contamination by food or water (WHO, 2002). Given the above, countries members of the World Trade Organization have the right to apply sanitary and phytosanitary measures on food trade based on scientific evidences that the risks to human, animal, plant life or health are unacceptable (FAO/WHO, 2003; WTO, 2010). Then, under this context, the microbial safety of foods has to be managed from farm-to-table and based on risk analysis principles (FAO/WHO, 2003; WTO, 2010).

The implementation of good manufacturing practices (GMPs) and standard sanitation operating procedures (SSOPs) is considered the first step in the development of the hazard analysis and critical control point (HACCP) system in food industries. The implementation of GMPs and SSOPs require investments to improve the hygienic design of equipment and facilities, control of operations, maintenance and sanitation practices, personal hygiene, transportation and training in order to ensure the fabrication of safe foods (Codex Alimentarius, 2003). Thus

by implementing the GMPs and SSOPs before the HACCP, one can minimise the difficulties and costs associated with implementation of the latter (Bata *et al*., 2006). A successful implementation of GMPs and SSOPs is of major importance for HACCP as these systems constitute the building blocks of food safety in the processing level.

Implementation of the HACCP system is more common in companies directed at exportation and/or large companies with sufficient resources to invest in implementing the system (Donovan *et al*., 2001), where the association with economic benefit for production units has been well proven (Lupin *et al*., 2010). The difficulties in understanding the benefits provided by the HACCP system (Henson *et al*., 1999) and the common association between the implementation of this system and an increase in costs of production (Garayoa *et al*., 2011; Henson *et al*., 1999) has led to a reduced use of HACCP by small to medium sized companies (Ehiri *et al*., 1995; Sampers *et al*., 2012; Taylor, 2003). Additionally, as small to medium sized dairy industries are the main suppliers of dairy products in Brazil, the implementation of the HACCP system in these factories is of major importance to ensure food safety and public health protection. Therefore, the objective of the present study was to determine the costs of implementation of food safety systems in small dairy factory located in Sao Paulo state, Brazil.

## 2. Material and methods

### The processing plant and steps for implementation of food safety systems

The study was carried out in a dairy located in the central region of the State of São Paulo, inspected by the Federal Inspection Service (SIF/MAPA) between August 2006 and August 2007. The plant processed approximately 15,000 litres of milk per day, used for the production of yoghurts, chocolate-flavoured milk and fresh dairy cream.

The implementation of the food safety systems was carried out in two main steps, i.e. (1) preliminary steps; and (2) implementation of HACCP system in the yogurt processing line. The preliminary steps comprised the diagnosis of the prerequisite programs, implementation of the GMPs and SSOPs and training of the food handlers. Further details on the implementation of the food safety system can be found in Cusato *et al*. (2013). It should be highlighted that the HACCP was only implemented for the yoghurt production line, taking into account the specific product-process nature of this system.

### Determination of the costs involved in implementing food safety systems

All the costs involved in making the necessary adjustments according to the prerequisite programs (GMP, SSOP), and implementation of the HACCP system were estimated for the period from August 2006 to August 2007. The values expressed in the present study considered an exchange rate between the American dollar and the Brazilian real (Brazilian currency; R$) of US$ 1.00 = R$ 1.72.

The method of cost appropriation used was the estimate of costs by absorption, which consists of the accounting of all the direct and indirect expenses involved in the HACCP (Lockis *et al*., 2011). The expenses determined were classified as two types: (1) investment: expenses on assets to be used as required in elaborating the HACCP plan, in making adjustments according to the prerequisite programs and in implementing the HACCP system; and (2) cost estimate: monthly expenses to maintain the HACCP system implemented.

The following items were considered in the cost estimate: (1) technical support: expenses with contracting a consultancy service to help elaborate the HACCP plan and coordinate the implementation process; (2) an employee to elaborate the plan; (3) training of the workers in GMPs and HACCP; (4) acquiring equipment; (5) laboratory analyses; (6) structural changes in the plant; (7) time spent by the employee in monitoring the CCPs and filling in the registers; and (8) time spent by employee in verifying and evaluating the HACCP system.

## 3. Results and discussion

Table 1 shows the total value necessary to implement the food safety system. The investment (US$ 61,812.00) covers adjustment to the prerequisite programs, elaboration of the HACCP plan and implementation of the system. Of the total investment, 53.4% (US$ 33,030.00) was used to elaborate the HACCP plan, considering the time required (hours) for a consultancy firm to carry out this task together with the HACCP team. The adjustment to the prerequisite programs represented 21.6% of the investment (US$ 13,345.00), an expressive amount that included structural changes, training of personnel and the elaboration of documentation. McAaloon (2003) and Suwanrangsi (2000) reported that one can make a significant reduction in the initial time and investment of implementing the HACCP system, when the good manufacturing practices have already been implanted and are being carried out properly on a day to day basis in the company. In a Brazilian dairy industry, Roberto *et al*. (2006) found a reduction of 24% in the total costs of implementing HACCP due to a prior adjustment to the prerequisite programs. The results obtained in the present study show that the costs would be about 22% lower had

**Table 1. Total cost of investment for the HACCP implementation in a yogurt factory.**

| Investment item | US$[1] | % |
|---|---|---|
| Elaboration of the plan | | |
| Consulting services (diagnosis) | 2,850 | 4.6 |
| Consulting services (elaboration of the plan) | 26,350 | 42.6 |
| Services of the HACCP team (elaboration of the plan) | 3,830 | 6.2 |
| Subtotal | 33,030 | 53.4 |
| Adequacy with the pre-requisite programs | | |
| Services of adequacy to GMP and SSOP | 4,186 | 6.7 |
| Changes and structural reforms | 1,070 | 1.7 |
| Materials for structural reforms | 1,813 | 2.9 |
| Pest control equipment | 232 | 0.4 |
| Equipment for waste control | 1,784 | 2.9 |
| Safety equipment | 1,300 | 2.1 |
| Personal protective equipment | 634 | 1.0 |
| Service training for pre-requisite programs | 2,326 | 3.8 |
| Subtotal | 13,345 | 21.6 |
| Implementation of the plan | | |
| Service training for the HACCP implementation | 3,525 | 5.7 |
| Equipment | 4,616 | 7.5 |
| Readjustment of the filling machine | 2,770 | 4.5 |
| Shelter for the cold load | 4,535 | 7.3 |
| Subtotal | 15,446 | 25.0 |
| Total of investment | 61,821 | 100.0 |

[1] Exchange rate: U$ 1.00 = R$ 1.72.
GMP = good manufacturing practice; HACCP = hazard analysis and critical control points; SSOP = standard sanitation operating procedures.

these programs been duly implanted. Finally the investment involved in implementing the system represented 25% of the total value (US$ 15,446.00), relative to the training of the personnel and acquisition of equipment and materials.

A detailed examination of the composition of the investment showed that 47.23% (US$ 29,200.00) referred to external consultancy. This value was composed of an estimate of the cost of a visit for the initial diagnosis, plus a further 176 work hours destined to orientation of the HACCP team, including travel resources for the consultant. Bata *et al*. (2006), in an experiment carried out in a meals industry, reported 11% of the total investment on HACCP spent on consultancy to develop the plan, and Maldonado *et al*. (2005) reported that this item cost more than expected by the professionals in the meat sector in Mexico, representing the second highest cost in implementing the HACCP. In the present study, these values represented a significant part of the resources, a fact which, according to Taylor (2003) and Bata *et al*. (2006), is common in medium sized companies with limited personnel resources, who have neither the availability of time or necessary experience to elaborate and implant the system.

The second highest cost of implementing the system was spent on structural changes of the plant and in acquiring instruments, with a total of 30.35% of the investment (US$ 18,754.00). Of this amount, 19.29% (US$ 11,921.00) was exclusively for HACCP, the greater part being spent on acquiring a cooler for the raw milk, and a shelter for the loading platform for the cold store. A similar result was found by Maldonado *et al*. (2005), where the acquisition of instruments was shown to be the most expensive item of the total costs. However the opposite was found by Henson *et al*. (1999) in dairy industries in the UK, where this item, as also external consultancy, were the least important items. It is important to point out that it is difficult to compare the available data in the literature concerning the costs of HACCP, due to differences in the individual conditions of the active sector in each plant, and also in the methodology used to determine and analyse the costs.

Table 2 shows the total values required to run the HACCP system implemented for the yogurt processing line. The total monthly value was US$ 1,521.50, covering the costs of laboratory and office materials, manual labour to monitor the CCPs and to check and review the plan, and to train the personnel. The greatest expenditure to maintain the system

**Table 2. Total costs associated to the maintenance of the HACCP system implemented in the yogurt production.**

| Costing items | US$[1] | % |
|---|---|---|
| Laboratory material | 430 | 28.3 |
| Office supplies | 210 | 13.8 |
| Manpower for monitoring CCPs[2] | | |
| Laboratory analyst | 360 | 23.7 |
| Pasteurisation operator | 14.50 | 0.9 |
| Employee responsible for dispatching | 17 | 1.1 |
| Manager | 79 | 5.2 |
| Subtotal | 470.50 | 30.9 |
| Manpower for checking CCPs[2] | | |
| Laboratory analyst | 45 | 2.9 |
| Manpower for HACCP plan revision[2] | | |
| Manager | 188 | 12.4 |
| Training program (GMP and HACCP) every other 4 months | 178 | 11.7 |
| Total monthly cost | 1,521.50 | 100.0 |

[1] Exchange rate: US$ 1.00 = R$ 1.72.
[2] Value calculated in function of the number of hours used by the employee to perform the task.
HACCP = hazard analysis and critical control point system; GMP = good manufacturing practice; HACCP = hazard analysis and critical control points; CCP = critical control points.

was that spent on monitoring the CCPs, corresponding to 30.9% of the total expenditure (US$ 470.50/month), including the records and corrective actions. Other studies carried out in various sectors of different industries have also indicated the time spent on making records for the HACCP as the greatest maintenance cost, generally costing more than expected by the professionals (Bata *et al*., 2006; Bucheweitz, 2001; Henson *et al*., 1999). It was shown that the greater part of the expenses were due to the activity of monitoring, and thus a reduction in the number of CCPs, which could occur as the good manufacturing practices became better consolidated, would result in a reduction in these values with time. The cost of the laboratory material corresponded to 28.26% of the monthly expenses (US$ 430.00), since the majority of the monitoring and verification was carried out by way of laboratory analyses. Maldonado *et al*. (2005) reported that the expenses on analyses were the most significant in the operationalisation of the plan, also more than expected. With respect to the periodic training given to the workers, recycling every four months was considered, provided by a contracted professional instructor, representing 11.70% of the costs (US$ 178.00/month). By monitoring the CCPs, the training periods were shown to be indispensable for the perfect functioning of the HACCP, and according to Bucheweitz (2001), studying food catering companies, this activity was the second biggest cost in maintaining the system.

Considering the mean monthly production of the dairy of approx. 400 t of yogurt, the cost of maintaining the system represented an impact of US$ 3.81/t of packaged yogurt, equivalent of 0.5% of the production costs. On the other hand, the resources used for investment, if diluted for the production of a single year, would signify an additional US$ 12.92/t, representing a total of 1.5% of the cost of one kilo of packaged yogurt. The results of the present study are coherent with those obtained by Bucheweitz (2001), who found that the expenses on the maintenance of the HACCP system presented a participation of between 0.01 and 2.91% of the production costs, with a mean value of 1.42%. According to the author, the total costs of HACCP tend to become lower with an increase in the size of the company.

In order to assess the successful implementation of the food safety system in the industry, microbiological indicators were used (Cusato *et al*., 2013). The results indicated that implementation of the food safety system resulted in a significant decrease in the populations of yeasts and moulds ($P<0.05$) (Cusato *et al*., 2013). The reduction in the counts of these microorganisms will further reflect in the increase of product's shelf-life, also contributing for the reduction of the overall costs for yogurt production.

## 4. Conclusions

Of the main difficulties encountered in implanting the HACCP system, the lack of speed in carrying out corrective actions stood out, especially when these were related to the need for investment. The delay or absence of such action contributed to a decrease in the effectiveness of the plan.

The three main costs related to implantation of the plan were related to external consultancy, adjustment to the prerequisite programs, acquisition of equipment and structural changes. It was concluded that the application of HACCP to the yogurt processing line considered in this study was feasible with respect to the costs. In addition since the product was sensitive to variations in processing and the system managed to efficiently control these variations, it could contribute to guaranteeing the standard of quality and subsequent consumer satisfaction.

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## Conflict of interest

The authors declare no conflict of interest.

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