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Evaluation of Food Safety Management Systems (HACCP and PRP's) in Chocolate Production

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ABSTRACT

HACCP is a system for analyzing hazards and critical control points, and is a real tool for continuous improvement. Implementing good hygiene practices is related to implementing HACCP, as it enables preventive management of the safety and salubrity of food supplied to consumers. Our aim is to assess the application of prerequisite programs and HACCP according to ISO22000: 2018 at BIMO chocolate factory. This evaluation revealed results that were broadly in line with the requirements of this international food safety management standard ISO 22000 : 2018. The PRP (program prerequisites) analysis showed 96.34% compliance, indicating that the majority of the basic measures required to control food safety hazards were in place and operating correctly. The HACCP (Hazard Analysis Critical Control Point) system, essential for identifying, assessing and controlling hazards significant to food safety, achieved 90% compliance, demonstrating effective and rigorous implementation of HACCP principles. Finally these results indicate that Chocolaterie Bimo is largely compliant with ISO 22000 requirements, although there is still room for improvement to achieve full compliance.

Keywords: Evaluation, HACCP (Hazard Analysis Critical Control Point), ISO22000, PRP (program prerequisites), food safety.

INTRODUCTION

Consuming chocolate is also an art of living, and while there is a whole vocabulary for precisely defining the sensations experienced when tasting a very good chocolate, it is also an ever-renewed source of inspiration for designers(Monteaux 2005). Today's connoisseurs are looking above all for quality in taste, but they also aspire to safety, and even to a plus for their health and nutrition (Barel 2015).

ISO 22000: 2018 is an international standard that describes the requirements for a food safety management system throughout the food chain, from primary production to the end consumer, aimed at improving the company's overall food safety performance. By complying with good hygiene practice, applying the HACCP method for hazard control, The implementation of an ISO 22000:2018-compliant food safety management system requires a verification plan to guarantee the effectiveness and compliance of the measures put in place. (Boutou 2020).

HACCP (Hazard Analysis Critical Control Point) is an approach developed in the 1960s to improve product safety. It is a scientifically-based, preventive approach based on hazard analysis and control of the “critical control points” identified during product processing. Its aim is to demonstrate the safety of the production process.(Sarrouf 2012)

Prerequisite programs are a prerequisite for the application of HACCP in an organization. According to ISO 22000, these programs correspond to “the basic conditions and activities necessary to maintain throughout the food chain a hygienic environment suitable for the production, handling and release of safe finished products and foodstuffs for human consumption”.(Bonne 2013)

Correct application of prerequisite programs makes HACCP implementation easier. In fact, inadequate application of PRPs can lead to more complex HACCP plans with a greater number of critical points (Bonne 2013) (Robert D. Byrne 2001) (Lee and Hathaway 1998). The role of prerequisite programs in HACCP implementation has been reported by several authors. According to (Lee and Hathaway 1998) the development of a HACCP plan should be preceded by the establishment of a prerequisite program consisting of good hygiene practices.

The objective of our work is to measure and evaluate the level of implementation of prerequisite programs (PRP) and the HACCP according to ISO22000: 2018 system at the chocolate manufacturing company Ambassadeur BIMO.

Material and methods :

Founded on September 12, 1984, Chocolaterie Bimo is a privately-owned manufacturer and marketer of chocolates and Vegecaos, and a leader in its field in Algeria. Its products are sold nationwide. Chocolaterie Bimo has made major investments in plant and equipment to ensure the long-term satisfaction of its customers and to offer them high-quality products. In 2019, the chocolate factory obtained ISO 22000: 2018 certification, demonstrating its commitment to continuous process improvement and customer satisfaction.

The working method therefore consists in assessing the food safety management system applicable to the BIMO chocolate factory., i.e. an audit of all the requirements of ISO22000: 2018. For the conformity assessment of the requirements illustrated in the following table according to ISO 22000: 2018. We drew up the following checklists and calculated conformity for each requirement and each chapter.

Chapter 8 Operational activities					
8.8 Audit of PRP and hazard control plan					
Subtitles	Standard requirements	conforming or not	Average per requirement %	Realization by requirement %	Remarks
8.8.1 Check	Has the organization established, implemented and maintained verification activities?	Conforme	100%	100%	
	Has the audit planning defined the audit objective, methods, frequencies and responsibilities?	Conforme	100%		
	Do the verification activities confirm the following points? a) The PRP(s) are implemented and effective;	Conforme	100%		
	b) The hazard control plan is implemented and is effective;	Conforme	100%		
	c) Hazard levels are at acceptable levels;	Conforme	100%		
	d) Hazard analysis inputs are updated;	Conforme	100%		
	e) Other actions determined by the organization are implemented and are effective.	Conforme	100%		

Table 1. Model table used in our assessment of chapter requirements.

After assessing the compliance (status and documentation) of each chapter of the PRP and HACCP illustrated in the tables (see example in table 1).

A rating was given for each requirement, in order to calculate the company's percentage of satisfaction. Using a suggested rating for each requirement (Average per requirement), as follows:

- Compliant: 100%
- Needs improvement: 50%
- Non-compliant: 0%.

Achievement per requirement is calculated using the following formula:

$$\text{Realization by requirement (\%)} = \frac{\sum MPEi}{n}$$

MPE : Average per requirement / n : Number of requirements

Evaluation results are presented in the table 1 (only part of the table is shown), then the results are expressed in radar form.

RESULTS AND DISCUSSION

Results of the implementation of PRP

The bimo chocolate factory has 13 prerequisite program procedures. We carried out an evaluation of the prerequisite programs by checking:

- Document and record control (documentary verification).
- The effectiveness of the application of the pre-requisite programs recommended by standard 22002-1 within the company (on-site verification).

The results of our assessment are shown on the radar below.

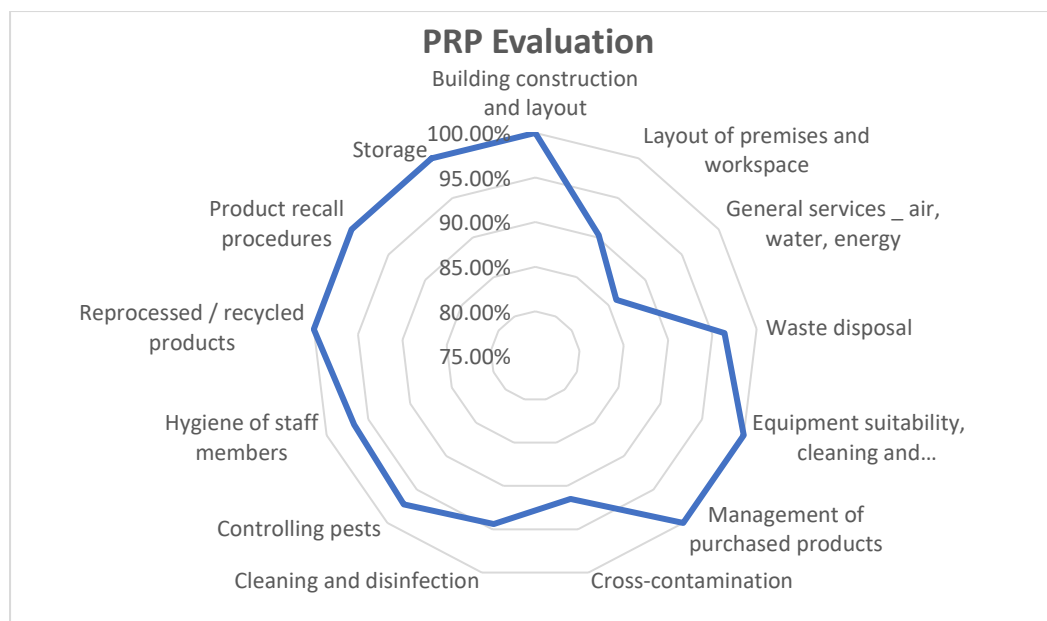


Figure 1 : Radar representation of PRP evaluation results of implementation.

From the analysis of this radar, we note that :

1- PRP - Building construction and layout

The radar shows that the PRP construction and building layout is 100% compliant, which means that the company complies fully with the requirements of the standard, hence our site visit where we found the facilities and buildings to have been adequately designed to avoid the risk of cross-contamination by respecting the flow of personnel, raw materials, waste streams and finished products.

2- PRP - Layout of premises and workspace

In this PRP, a percentage of 90.30% is posted, a score that is relatively in line with expectations, but with room for improvement in relation to raw materials storage areas, where there is non-compliance with the parameter of space between the arrangement of pallets to facilitate cleaning and avoid contamination.

3- PRP - General services - air, water, energy

The relatively lower score of 86.05% for this PRP indicates shortcomings in the compressed air used, although the air does not come into direct contact with the product but there is still a probability, which requires treatment of the compressed air to make it sterile, also in relation to the water used for cleaning which lacks some treatment in the station, this does not cause a risk of contamination since water is not an ingredient in the recipe.

4- PRP - Waste disposal

The Waste Management PRP achieved a very good score of 96.38%, demonstrating total efficiency in waste disposal, with respect for waste flows and classification of waste by type. However, some minor improvements could still be added to achieve full compliance.

5- PRP - Equipment suitability, cleaning and maintenance

The radar shows 100% compliance with the requirements of this PRP, indicating that the BIMO chocolate factory uses equipment adapted to production needs, and has good control over its maintenance and cleaning, ensuring that it presents no risk of contamination for the product.

6- PRP - Management of purchased products

The requirements of the Raw Materials Purchasing PRP are well mastered and compliant, which indicates that the bimo company sets evaluation criteria that meet food safety standards for the proper selection of its suppliers and the right choice of raw materials and other products purchased before their use in the production chain.

7- PRP - Cross-contamination

The cross-contamination PRP radar shows a small degree of non-compliance with the standard's requirements, including in areas where good cleaning product handling practices are not fully respected. This shows that there are still areas for improvement to prevent all risks of cross-contamination.

8- PRP - Cleaning and disinfection

The cleaning and disinfection PRP reached a percentage of 94.40%, showing almost total compliance with the requirements of the standard. However, there are still a few areas for improvement in relation to the documentation of the procedure, where the team forgot to mention a few parameters that are present in the field but absent from the documentation.

9- PRP - Controlling pests

The same goes for the previous PRP, the requirements of this PRP are well respected and achieve almost total compliance, lacking only a few improvements in relation to the documentation.

10- PRP - Hygiene of staff members

Such a high score in the staff member's Hygiene PRP shows that staff awareness and training are up to date and effective, and that employees comply with good hygiene practices, except for a lack of procedure documentation to achieve full compliance.

11- PRP- Reprocessed / recycled products

The radar shows that BIMO has fully satisfied the PRP requirements for recycled and reprocessed products, guaranteeing that the company processes and controls its recycled products and complies with the requirements of the standard with regard to the risks of handling and contamination of these products.

12- PRP- Product recall procedures

This PRP achieves overall satisfaction of the standard's requirements, indicating effective control of product recall procedures, and that the documentation of this procedure is well established to react rapidly in the event of a product recall that is on the market and likely to harm consumer health.

13- PRP - Storage

Storage of finished products at the company is very well controlled, given the 100% GWP, guaranteeing rigorous control of humidity and temperature in storage areas, and ensuring the safety and wholesomeness of the products.

In conclusion, the assessment of the implementation of PRPs (Prerequisite Programs) in the chocolate production plant demonstrates a high level of compliance with the requirements of the food safety management system. First and foremost, PRPs that have achieved 100% compliance include PRP-building construction and layout, PRP-maintenance of equipment, PRP-management of reprocessed/recycled products and PRP-product recall, ensuring the company's commitment to achieving optimum levels.

Nevertheless, there are opportunities for improvement in some PRPs, particularly in the PRP-air, water, energy, where the compliance rate is 86.05%, suggesting shortcomings in the management of essential resources. Assessment of the PRP-cross-contamination (91.50%) and PRP-cleaning and disinfection (94.40%) show that, even if appropriate management is implemented, it is essential to be more vigilant in order to reduce the potential risks of introducing microbial hazards into the production chain.

In addition, despite a relatively high compliance rate in the PRP-workspace and premises management (90.30%), there is still a small margin for improving the efficiency of space management to optimize production flows and reduce contamination risks. Last but not least, the documentation of the PRP-Hygiene procedure for the staff member needs to be improved to ensure full compliance with the regulatory requirements of the standard.

Results of the implementation of HACCP

In this section, we will present the results obtained after verifying compliance with the requirements of subchapters 8 of ISO 22000: 2018, which is the HACCP, represented in the radar as follows:

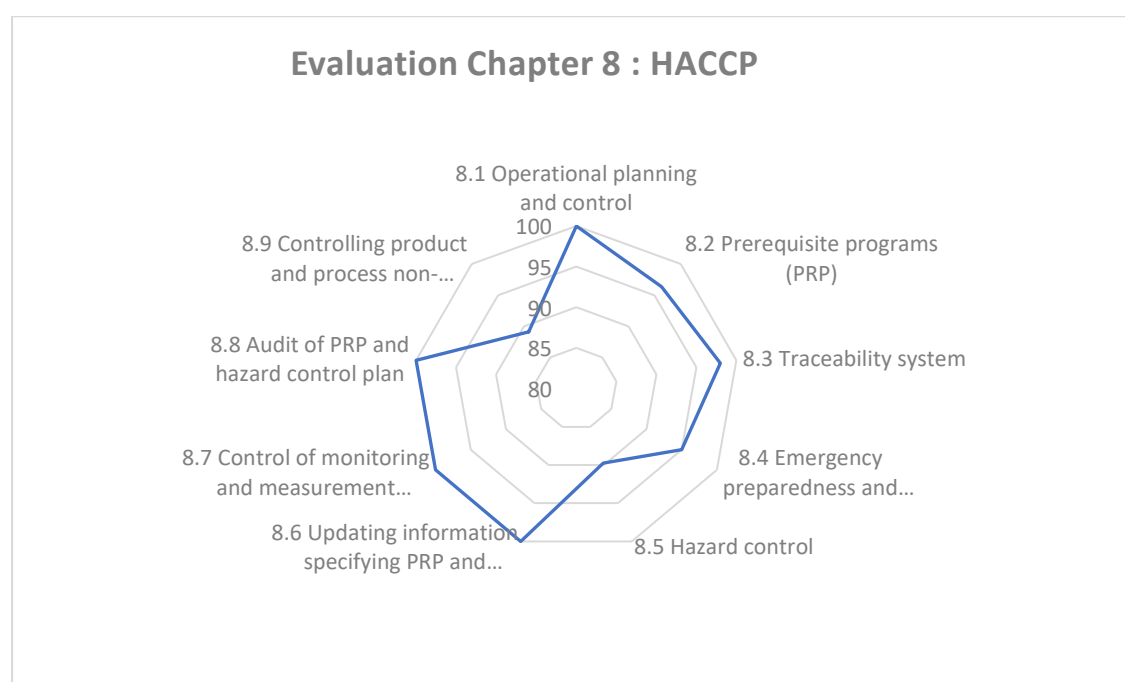


Figure 2 : Radar representation of chapitre 8 of ISO22000 : HACCP evaluation results

§ this sign refers to the subchapter of the ISO22000 standard

1- §8.1 Operational Planning and Control (100%)

The radar shows that operational planning and control requirements are 100% compliant, testifying to effective management of all the processes required to produce safe products. This testifies to well-organized planning and rigorous application of operational plans within the company.

2- §8.2 Prerequisite Programs (PRP) (96.34%)

A high rate of compliance indicates that prerequisite programs are well established, and applied on site, although some improvements may be necessary to achieve full compliance. PRPs are essential to maintain a clean and safe production environment before starting production.

3- §8.3 Traceability System (98%)

The requirements of the 3rd sub-section, the traceability system, show 98% compliance, ensuring that raw materials and ingredients are tracked before they arrive, and that products are monitored at every stage of production and even after distribution. This high level of compliance is of paramount importance for the rapid identification of possible sources of contamination in the event of product withdrawal or recall.

4- §8.4 Emergency Preparedness and Response (95%)

Although the percentage of this sub-chapter is high, there are still a number of requirements to be improved to ensure an even more rapid and effective response to emergency situations likely to have an impact on food safety.

5- §8.5 Hazard Control (89.74%)

In this sub-section, the radar shows one of the lowest compliance rates. This is due to shortcomings in identifying the characteristics of raw materials in relation to their documentation and acceptance criteria. Action plans for improvement need to be taken.

6- §8.6 Updating Information Specifying PRP and Hazard Control Plan (100%)

Information on PRPs and hazard control plans is regularly updated, hence the 100% radar for this sub-section, which implies that procedures are regularly reviewed and adapted as required.

7- §8.7 Control of Monitoring and Measurement Activities (100%)

The requirements for monitoring and measurement activities are fully compliant, guaranteeing monitoring of equipment calibration and regular assessment of processes essential to food safety.

8- §8.8 Audit of PRP and Hazard Control Plan (100%)

The radar shows full compliance with PRP and HACCP verification requirements, which means that the chocolate factory guarantees that PRP, CCP and HACCP verification and monitoring operations are carried out correctly.

9- §8.9 Controlling Product and Process Non-Conformities (89.1%)

The radar reading shows a relatively low level of compliance in the non-conformance, product and process control sub-chapter. This reveals weaknesses in procedure in relation to established standards, which could lead to product safety hazards if this non-conformity is recurrent. It is therefore crucial to strengthen non-conformity correction procedures.

Finally, the HACCP system implementation assessment reports very high levels of conformity in the majority of sub-chapters of ISO22000 chapter 8. Subchapters §8.1 Operational planning and control, §8.6 Updating information on PRP and hazard control plan, §8.7 Control of monitoring and measurement activities, and §8.8 Verification of PRP and hazard control plan all achieve 100% compliance. This demonstrates careful management and rigorous monitoring of processes, ensuring adequate identification, monitoring and control of potential hazards. However, there is still room for improvement in some areas.

Compliance with prerequisite programs (PRP) §8.2 at 96.34% and emergency preparedness §8.4 at 95% are satisfactory overall, but suggest that there are still some areas for improvement to ensure optimum management of resources and crisis response plans. Hazard control §8.5 scores 89.74%, revealing potential shortcomings in the control of hazards that may be present in foodstuffs. In addition, the management of product and process non-conformities §8.9, with a rate of 89.1%, is another area in need of strengthening. Better management of deviations from standards could reduce the risk of non-compliant products reaching consumers.

Having evaluated the HACCP system at chocolate factory BIMO, we conclude that the HACCP system is generally well implemented and followed, particularly in the key areas of monitoring and auditing, there are still shortcomings in the control of hazards and the management of non-conformities. Strengthening these areas could help to improve food safety more comprehensively.

The study of (Haq and Ratnaningsih 2022) evaluates the application of HACCP in a catering company in Indonesia concerning their grilled chicken menu. The results show that, although

recommendations have been put in place to reduce the number of cases of food safety problems.

The study carried out by (Wu et al. 2020) compared the effectiveness of HACCP (Hazard Analysis and Critical Control Point) certified and non-HACCP slaughterhouses in controlling contamination by antimicrobial-resistant *Salmonella* species in north-east Thailand. The results show that HACCP-certified abattoirs are better at controlling *Salmonella* contamination, particularly antimicrobial-resistant strains, than non-HACCP abattoirs. In summary, this research highlights the crucial importance of implementing rigorous food safety management systems such as HACCP in abattoirs to better control microbial hazards and enhance food safety nationally and internationally.

A comparative analysis of the application of ISO 22000 food safety management systems and HACCP (Hazard Analysis Critical Control Point) systems in cocoa processing and milk chocolate manufacture was carried out by (Afoakwa et al. 2013).

Critical control points (CCPs) were found by the researchers by doing risk assessments during both processes, accounting for microbiological, chemical, and physical risks at various phases of production. The researchers came to the conclusion that combining ISO 22000 and HACCP (Hazard Analysis Critical Control Point) improves the efficacy of a food safety system. The ISO 22000 method sped up the procedure by lowering the number of HACCP (Hazard Analysis Critical Control Point) points that needed to be kept an eye on while still allowing for efficient risk management.

The study of the evaluation and implementation of the HACCP system for frozen saku tuna by (Esulima and Ningsih 2015) identified significant improvements in the production process, and highlighted the importance of proper water treatment in processing units. This more structured approach, combined with rigorous monitoring and precise documentation of critical control points, resulted in improved compliance with export standards and a greater guarantee of the food safety of the final product. These improvements demonstrate the effectiveness of a revised and properly implemented HACCP system in the tuna processing industry.

Conclusion

The implementation of a food safety management system enables us to respond effectively to customer, regulatory and legal requirements, and to win the confidence of consumers.

Having assessed the entire system at Chocolate Factory BIMO, we conclude that it complies overall with international food safety and quality standards. The results show high overall compliance with PRPs, indicating that the chocolate plant is effectively implementing food safety management systems. However, certain categories such as general services (air, water, energy) and the layout of premises and workspaces show room for improvement. It would be useful to focus on improving these aspects to further enhance the plant's safety and efficiency.

Our assessment of the HACCP system shows that, overall, it complies with international food safety and quality standards. However, we have identified certain non-conformities relating to documentation and compliance with regulations. These non-conformities require adjustments to ensure continuous improvement of the system, while reinforcing the confidence of consumers and interested parties.

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