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Implementation of Hazard Analysis Critical Control Points (HACCP) in a SME: Case Study of a Bakery

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Key words: Hazard Analysis Critical Control Points (HACCP); hazards; Critical Control Points (CCP's); Pre-Requirements Operational Program (PROP); food safety; small and medium enterprise bakery

This article provides technical details concerning the development and implementation of Hazard Analysis Critical Control Points (HACCP) in one of the largest bakeries of Cova da Beira – Portugal. A generic HACCP plan in accordance with legal requirements was made through a detailed audit and analysis of data collected in the company. It was verified by overview of the HACCP system implemented in the bakery, that there was no reduction in quality of the final product during the manufacturing process and the implementation of the requirements was particularly strong, having been instrumental the total commitment and sense of responsibility of all workers.

INTRODUCTION TO HACCP

There is now a growing concern in the population about food. Increasingly, what people eat is of utmost importance, especially in aspects related to health and nutrition.

Many of the diseases currently affecting the general population, such as cardiovascular disease, osteoporosis, diabetes or certain cancers, are caused or associated with the food we eat, substantially reducing consumer confidence in relation to food safety. Simultaneously, the consumer's attention to food safety and quality has increased. The cases of bovine spongiform encephalopathy (BSE) transmissible to humans (Creutzfeldt-Jakob disease), the use of hormones in the production of meat, the use of antibiotics as animal growth promoters, the pesticide residues in plants and animals, the presence of nitrates in the waters, the doubts associated with the genetically modified organisms market, or cases of avian influenza in humans, reduced consumer confidence regarding the safety of food [Moura *et al.*, 2008]. On the other hand, the major hazard in food production is the microbiological contamination [Jeng & Fang, 2003; Walker *et al.*, 2003; Bas *et al.*, 2007].

To increase consumer confidence it is essential to implement systems that require producers and companies to follow criteria of food safety. The new challenges facing the consumer, their selection criteria and the perception of food risk [de Jonge *et al.*, 2004; Yeung & Yee, 2012], are overcome using an objective tool, the Hazard Analysis and Critical Control Points (HACCP).

HACCP system does a systematic and structured approach to identifying hazards – biological, chemical and physical – and the likelihood of these occurring at all stages of food production, from raw material to the final product, and define preventive measures to minimize occurrence of these dangers by application of immediate corrective measures to ensure the safety of food produced, *i.e.*, of the final product. This has been proved the most, or the one of the most, effective way to ensure food safety (*e.g.* [Ropkins & Beck, 2002; Ropkins *et al.*, 2003; Arvanitoyannis & Traikou, 2005; Varzakas & Arvanitoyannis, 2007; Arvanitoyannis & Varzakas, 2008, 2009; Raspor & Jevšnik, 2008; Arvanitoyannis *et al.*, 2009; Jonnalagadda *et al.*, 2009; Varzakas, 2011]. The HACCP methodology is referred to by various organizations, as the system of analysis and control of health risks associated with a food product. Its application is mandatory from 1 January 2006, by EC Regulation No. 852/2004 of April 29, laying down general rules to be implemented by all operators. Consequently, these operators must implement self-regulation systems based on the principles of HACCP, a preventive system that allows a systematic and proactive management of food safety hazards.

The implementation and effective functioning of a HACCP system require knowledge of the hazards inherent to the infrastructures, tools and human resources. A HACCP system that really works in practice will depend on the competency

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of the people who both developed and operate it, and the prerequisite programs, that support it [Mortimore, 2001].

To prevent, reduce or eliminate contamination of food during storage and preparation, every aspect should be controlled using pre-requisite procedures and a HACCP plan. The prerequisites provide the foundation for effective HACCP implementation and should be in operation before HACCP. Once this has been achieved, the HACCP plan may be developed and implemented. As a general rule the prerequisites should be used to control hazards associated with the food service environment (premises and structures, services, personnel, plant and equipment), while HACCP should be used to control hazards associated directly with food processes (storage and preparation) [Bolton & Maunsell, 2004]. Therefore, pre-requisites are an essential element in the task of developing simple, effective HACCP systems, but in many areas there is a lack of understanding of the prerequisites concept, and even a fear in some sectors that prerequisites might dilute the strength of HACCP [Wallace & Williams, 2001].

HACCP has been progressively introduced and applied in food industry, but HACCP systems have not been homogeneously implemented across all food industry sectors, more by technical barriers (Barriers prior to HACCP implementation are: illusion of control, company size, type of product, company's customers food safety requirements, *etc.*; Barriers during the process of HACCP implementation are: Management, Personnel, Infrastructure; and Barriers after HACCP systems have been implemented are: Difficulties in verification and validation of HACCP) and unwillingness by manufacturers [Panisello & Quantick, 2001]. Experiences highlighted a number of barriers, burdens and also perceived benefits of the successful implementation and operation of HACCP [Taylor, 2001; Bas *et al*., 2007; Jeng & Fang, 2003; Eves & Dervesi, 2005; Taylor & Kane, 2005; Damikouka *et al.*, 2007].

A recent study realized by Mensah & Julien [2011] shows that there is no significant effect of size of enterprise on the drivers, benefits and challenges to compliance with food safety regulation. However, importance has been given to the specific situation of the Small and Medium Enterprises (SME's) (*e.g*. [Taylor, 2001; Bas *et al.*, 2007; Taylor & Kane, 2005; Walker *et al*., 2003; Poumeyrol *et al*., 2010]). The barriers are even greater, given the size and structure of institutions, bearing in mind that the operators require good knowledge necessary to implement the system and also good information and training of all employees [Panisello & Quantick, 2001; Taylor, 2001; Bas *et al.*, 2007; Walker *et al.*, 2003; Taylor & Kane, 2005; Eves & Dervesi, 2005; Mensah & Julien, 2011].

Its principles can be applied in a variety of locations. HACCP has evolved continuously over the years, becoming nowadays the most complete and efficient system [Costa Neto & Figueiredo, 2001; Surak, 2009].

The seven principles of HACCP

The proper identification of CCPs (Critical Control Points) is a key issue in HACCP, because the major efforts in process control will be directed towards these steps [Damikouka *et al.*, 2007]. For the practical application of the HACCP concept according to Codex Alimentarius [FAO, 1997], 7 rules have to be followed which are laid down in 7 main principles and constitute the basis for the establishment of a HACCP plan, all of them to be considered in its practical application [Almeida, 1998; UNIHSNOR, 2005]:

***1st Principle*:** Hazard analysis and identification of preventive measures – This phase identifies the physical, biological and chemical hazards in each process set defined in the flowchart;

***2nd Principle*:** Identification of the Critical Control Points (CCP) – The identification of Critical Control Points is established according to the decision tree;

***3rd Principle*:** Establishment of critical limits – The establishment of critical limits is essential for consistency in the safety analysis of the processes involved;

***4th Principle*:** Establishment and implementation of monitoring procedures to control the CCP – It is important to assess whether the CCP is effectively under control through proper monitoring procedures;

***5th Principle*:** Determine corrective actions in case of deviation of critical limits – This principle intends to establish actions to correct deviations in the monitoring of each CCP;

***6th Principle*:** Establishing systems for recording and archiving data that document the HACCP – This principle intends to establish procedures to ensure that the HACCP plan is being effective;

***7th Principle*:** Procedure to assess whether the HACCP system is working properly – This principle aims to define the procedures for the keeping of records and documentation relating to the plan. These procedures are monitoring, sampling, analysis, audit of HACCP, validation of critical limits (confirming that the CCP is kept under control) and inspection of manufacturing processes.

CASE STUDY

Any company wishing to implement the HACCP system should have as its main concern to provide its customers safe and healthy products. To do these, it needs to create, establish, document and maintain a system of self-control based on the seven HACCP principles referred to above, ensuring food safety.

This control system identifies all hazards, whether biological, chemical or physical, negatively affecting food and turning it unsafe for consumption. Through analysis of these hazards preventive measures are specified that must be followed to avoid food contamination. This process requires the commitment of the whole team involved, since only united will able to eliminate all risks and prevent the onset of these.

Through a detailed audit and analysis of data collected in the company studied, a plan was elaborated to implement the HACCP system in accordance with legal requirements. Once implemented, this should be followed by the team responsible and amended where necessary.

Company identification

Bakery based in the Canhoso Industrial Park, Covilhã, Portugal, which bakery and pastry are the main activities, as well as commercial establishments, breakfast pastries and retailing of food products.

The products the company produces and sell are divided into four families: bread (40%), biscuits (10%), assorted pastries (30%) and snacks (20%). The products and services are directed exclusively to the internal market.

Definition of the team responsible

A team was constituted to analyze and coordinate all processes involved in implementing the system. Only by setting the team responsible it is possible to increase the quality levels of all processes and products.

Thus, given the quality of human resources available and the characteristics of the company, the HACCP team consists of the following elements:

- Administrator
- Bakery Administrator (responsible for the production sector of the bakery)
- Director of Quality (team coordinator)
- Pastry Administrator (responsible of the production sector of the pastry)

The team meets regularly to discuss and define where necessary the following [Pinto *et al.*, 2010]:

– The company's quality policy with regard to food safety, setting clear objectives;

- Coordination of efforts;
- Analysis of results and set targets for improvement;
- Analyze and investigate possible deviations from normality, seeking to identify causes and take corrective measures;
- Revise the self-control plan as needed.

The administrator, as the highest authority, ensures the smooth running of the company and makes them comply with all legal requirements for its proper functioning. It is also his responsibility to monitor all phases of the plan and the responsibilities and coordination of all running operations, both internal and external of the company.

The team coordinator is responsible for implementing, maintaining and monitoring the plan. The organization of team work is essential. The quality of raw materials and products is his responsibility. To keep plans previously established to the organization of work, cleanliness and hygiene of premises and equipment involved is also within its competences.

The head of production (Pastry and Administrator assigned to the bakery sector) is responsible for coordinating the laboring products, as the name implies. It is essential to proper planning of the production process to ensure that everything is normal. The coordination and instruction of production workers is under his control. Where necessary he should start and proceed to amends of the self-control program.

Product description and intended use

The HACCP plan is directed solely at bakery products. As there is a wide variety of products in this area, a generic framework was developed for the description of only one product (Table 1).

Although the plan is directed to a product, it is important to note that the HACCP plan to be implemented, applies equally to all other bakery products, with the same manufacturing process.

TABLE 1. Product description and intended use.

PRODUCT DESCRIPTION	
Trade name	**Traditional bread "bola"**
Characterization summary	Bread Mix
Product description	**Organoleptic Characteristics:** Physical state: Solid Color: Light Brown Scent: Typical Flavour: Typical **Microbiological Characteristics:** Total microorganisms (30 °C): ≤ 10^5 UFC/g *Enterobacteriaceae spp*: ≤ 10^2 UFC/g *Staphylococcus aureus*: ≤ 10^2 UFC/g *Salmonella spp*: Absence in 25g *Listeria monocytogenes*: Absence in 25g Fungi (Molds) and Yeasts: ≤ 10^2 UFC/g Units of 30 gr. and 48 gr.
Ingredients	Wheat Flour, Water, Rye Flour, Prepared Powder [Rye Flour], Gluten Flour, Salt, Malt Flour, Acidity Regulator: Citric Acid (E170), Wheat Flour, Emulsifier (E472e), Agent Flour Treatment: L-Ascorbic Acid (E300) and Enzymes], Yeast, Salt and Improver
Terms of Use	Conservation in a cool dry place Shelf life: Product of the day Ready to spend
Conditions of Carriage / Packaging	**Product not packed:** Transport of goods in passenger car with closed box, adapted for this purpose and provided with ventilation by indirect process. Packaging in white trays with background closed and barred sides
PRODUCT USE	
The product mentioned is for the general population, except for sensitive groups (Coeliacs)	
Place of Sale	Bakery, pastry and home delivery
Applicable Law	Regulation (EC) No 852/2004 of 29 April and Regulation (EC) No 1441/2007 of 5 December

Description of productive process

A flowchart was produced from the analysis of the production process (Figure 1).

HAZARDS ANALYSIS AND IDENTIFICATION OF CCP'S AND PROP (PRE-REQUIREMENTS OPERATIONAL PROGRAM)

The hazard analysis provides the identification of potential hazards associated with all phases of the process from receipt of raw materials to final consumer.

The risk assessment is done based on the hazard analysis, according to the probability of occurrence and severity

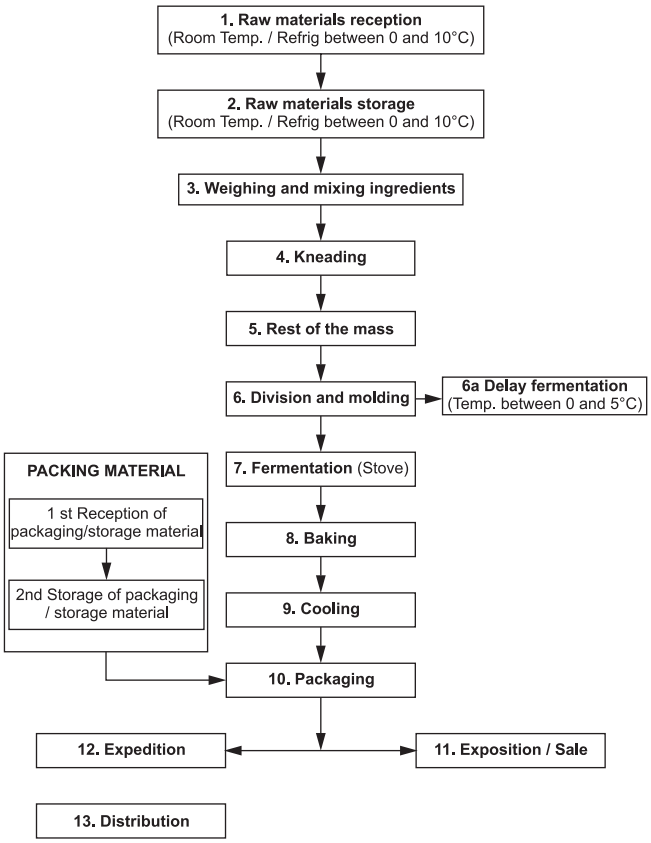

FIGURE 1. Flowchart of the production process.

of identified hazards. It is also evaluated the preventive measure established for its control. In risk assessment, the following data are considered [Batista *et al.*, 2003]:

- Review of customer complaints;
- Return of lots or shipments;
- Results of laboratory tests;
- Data from monitoring programs of agents of foodborne illness.

Thus the hazards can be divided into four groups according to their severity to human health [Batista *et al.*, 2003; Ribeiro, 2002]:

A – High (4): Severe consequences for consumer health;

M – Medium (3): Serious consequences for consumer health;

B – Low (2): Zero or very small effects for consumer health;

D – Neglectable (1): Without consequences for consumer health.

Concerning its probability of occurrence, the risk is divided as follows [Batista *et al.*, 2003; Ribeiro, 2002]:

A – High (4);

M – Medium (3);

B – Low (2);

D – Neglectable (1).

The combination of the severity with the probability results in the following table (Table 2). In this, there are combinations that reproduce risks with the greatest impact on consumer health.

The analysis matrix allows us to estimate a level of risk across the two levels (Probability *vs*. Severity). Thus, the Risk

TABLE 2. Analysis Matrix. Severity *vs* Probability (Adapted from: [Batista *et al*., 2003]; [Ribeiro, 2002]).

PROBABILITY					
	A (4)	RS	RMe	RMa	RC
	M (3)	RS	RMe	RMa	RMa
	B (2)	RS	RMe	RMe	RMe
	D (1)	RS	RS	RS	RS
		D (1)	B (2)	M (3)	A (4)
		SEVERITY			

RS –Satisfatory Risk; **RMe** – Lower Risk; **RMa** – Increased Risk; **RC** – Critical Risk.

Index (RI) of each step of the manufacturing process is defined taking into account the following [Ribeiro, 2002]:

IR = Probability x Severity

Based on the calculations of the matrix (Table 2), it appears that for this study, the IR varies between 1 (Satisfactory Risk) and 16 (Critical Risk). The calculated Risk Index can be seen in Table 3.

According to Tables 2 and 3, where the RI is higher than 8, a CCP is identified and managed by the HACCP plan, defining the critical limits, parameters to be monitored and corrective actions to implement on each step. If there was no CCP (IR ≤8), the results should be handled by PROP, acting on the basis of good manufacturing practices and which aim to implement corrective actions for improvement of each step. The RI contributes to the analysis and identification of CCP's and PROP (Table 4).

ANALYSIS OF RESULTS

It was not identified a CCP for the production of the traditional bread "bola". None of the steps undermine food security and pose greater risk to public health.

The absence of a CCP does not require the creation of a HACCP plan. Thus, throughout the manufacturing processes that pose a lower risk (IR ≤8) to the health of the consumer, the system is managed by the PROP, who selects and evaluates the control measures in a specific stage, contributing to its improvement.

TABLE 3. Likelihood of danger.

IR	RISK INDEX (RI)	CONCLUSION
IR ≤ 4	Satisfactory Risk	Risk managed by PROP[2]
4 ≥ IR ≤ 8	Lower Risk	
8 ≥ IR ≤ 12	Increased Risk	Risk managed by HACCP [3] plan
12 ≥ IR ≤ 16	Critical Risk	

Pre-Requisites Operational Program (PROP) – Selection and evaluation of control measures, previously obtained from the analysis of hazards and determination of critical control points. In PROP and opposing to what happens in a CCP, failures in the production process does not directly affect the product, and is therefore an essential difference between them [Cruz *et al.*, 2006].

HACCP Plan – Document prepared in accordance with the principles of the HACCP system.

TABLE 4. Hazards analysis and identification of CCPs and PROP.

STAGE	RISK	ACCEPTANCE LEVEL ON THE FINISHED PRODUCT	RISK EFFECT	RISK EVALUATION			PROBABLE CAUSES	CONTROL MEASURES	DECISION TREE				REMARKS	CCP	PRP	PROP
				P	S	IR			Q1	Q2	Q3	Q4				
1. Reception of raw materials (Room Temp.)	**Biological:** Microbial contamination	As product datasheet	With consequences	1	4	4	Damaged packaging. Incorrect hygiene practices	Check cleanliness of transport vehicles and personnel. Control of integrity of the packaging, labeling and shelf life. HACCP certificate from the supplier. Maintain facilities and equipment for the operation properly sanitized.	Yes	No	No	---	Given the control carried out at the reception for transport vehicles and package integrity, this step is not considered a CCP	---	x	---
	Physical: Contamination by foreign objects (hair, insects)	Absence	Without consequences	1	1	1	Damaged packaging	HACCP certificate from the supplier. Control of package integrity.	Yes	No	No	---	Given the control carried out at the reception for transport vehicles and package integrity, this step is not considered a CCP	---	x	---
	Chemical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1. Reception of raw materials (refrigerated between 0 and 10ºC)	**Biological:** Microbial contamination and multiplication	As product datasheet	With consequences	1	1	4	Inadequate transport temperature. Incorrect hygiene practices	Control the product temperature. Check transport vehicles hygiene and personal hygiene. Controlling the integrity of the packaging, labeling and shelf life. HACCP certificate from the supplier. Keep facilities, equipment and utensils for the operation properly sanitized. Perform task in a fast, hygienic and seamless way.	Yes	No	No	---	Given the control carried out at the reception for transport vehicles and package integrity, this step is not considered a CCP	---	x	---
	Physical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Chemical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1a Reception of packaging/storing material	**Biological:** Microbian contamination	Absence	With consequences	1	4	4	Incorrect hygiene practices	Check cleanliness of transport vehicles and personnel. Control of integrity of packaging during transport.	Yes	No	No	---	Given the control carried out at the reception for transport vehicles and package integrity, this step is not considered a CCP	---	x	---
	Physical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Chemical: Presence of undesirable substances	Absence	With consequences	1	2	2	Inadequate packaging material	Confirm suitability of material for food use (presence of food symbol)	Yes	No	No	---	Given the control carried out at the reception for transport vehicles and package integrity, this step is not considered a CCP	---	x	---

2. Storage of raw materials (Room Temp.)	**Biological:** Microbial contamination (*Salmonella*, *Staphylococcus aureus* and *Escherichia coli*; Pests – *Leptospira*)	Absence	With consequences	1	4	4	Traces of pests. Incorrect hygiene practices	Pest control plan. Keep containers closed and secured in proper place. Compliance with good personal hygiene practices. Keep facilities, equipment and utensils for the operation properly sanitized. Perform FIFO (first in, first out) stock rotation.	Yes	No	No	---	Given the existence of a Company Pest Control Plan and the fulfillment of good hygiene practices, this step is not considered a CCP	---	x	---
	Physical: Contamination by foreign objects (hair, decorations, pieces of packaging, insects)	Absence	Without consequences	2	1	2	Incorrect hygiene practices	Keep containers securely closed and placed in proper location. Controlling the integrity of packaging. Compliance with good personal hygiene practices.	Yes	No	No	---	Given the control carried out during storage and compliance with good hygiene practices, this step is not considered a CCP	---	x	---
	Chemical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2. Storage of raw materials (refrigerated between 0 and 10 ºC)	**Biological:** Microbial contamination	As product datasheet	With consequences	1	4	4	Inadequate storage temperature	Control storage temperature. Keep containers securely closed and placed in proper location. Keep facilities, equipment and utensils for the operation properly sanitized. Perform FIFO (first in, first out) stock rotation.	Yes	No	No		Verifying compliance with good manufacturing and hygiene practices, this step is not considered a CCP	---	x	---
	Physical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Chemical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2a Storage of packaging/storage material	**Biological:** Microbial contamination (Pests – *Leptospira*)	Absence	With consequences	1	4	4	Traces of pests. Incorrect hygiene practices	Keep containers properly closed and secured in proper place, protected from contamination. Maintain facilities and equipment for the operation properly sanitized. Pest Control Plan.	Yes	No	No	---	Given the existence of a Company Pest Control Plan and the fulfillment of good hygiene practices, this step is not considered a CCP	---	x	---
	Physical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Chemical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3. Weighing and mixing ingredients	**Biological:** Microbial contamination (*Salmonella*, *Staphylococcus aureus* and *Escherichia coli*)	As product datasheet	With consequences	1	4	4	Incorrect hygiene practices	Perform the task quickly, hygienically and without interruptions. Compliance with good personal hygiene practices. Keep facilities, equipment and utensils for the operation properly sanitized	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---

	Physical: Contamination by foreign objects (hair, decorations, pieces of packaging, stones – salt)	Absence	Without consequences	1	1	1	Incorrect hygiene practices	Greetings from good personal hygiene practices. Visual inspection of salt	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
	Chemical: Detergent residue	Absence	Without consequences	1	1	1	Incorrect hygiene practices	Keep the sites, equipment and fixtures for the operation properly sanitized	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
4. Kneading	**Biological:** Microbial contamination (*Salmonella*, *Staphylococcus aureus* and *Escherichia coli*)	As product datasheet	With consequences	1	4	4	Incorrect hygiene practices	Perform the task quickly, hygienically and without interruptions. Compliance with good personal hygiene practices. Keep facilities, equipment and utensils for the operation properly sanitized	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
	Physical: Contamination by foreign objects (hair, decorations, pieces of packaging, stones – salt)	Absence	Without consequences	1	1	1	Incorrect hygiene practices	Compliance with good personal hygiene practices. Visual inspection of salt	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
	Physical: pieces of metal contamination	Absence	With consequences	1	4	4	- Incorrect hygiene practices – Mixer spiral damaged	- Check the integrity of the mixer spiral after each mixing cycle	Yes	No	Yes	No	The existence of pieces of metal can be fatal to the health of consumers. Nevertheless, since for this step RT ≤ 8, then it is not a CCP	---	---	X
	Chemical: Detergent residues	Absence	Without consequences	1	1	1	Incorrect hygiene practices	Keep the sites, equipment and fixtures for the operation properly sanitized	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
5. Rest	**Biological:** Microbial contamination (*Salmonella*, *Staphylococcus aureus* and *Escherichia coli*)	As product datasheet	With consequences	1	4	4	Incorrect hygiene practices	Keep product well packed in proper places, protected from contamination. Compliance with good personal hygiene practices. Maintain facilities and equipment for the operation properly sanitized	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---

	Physical: Contamination by foreign objects (hair insects)	As product datasheet	Without consequences	1	1	1	Incorrect hygiene practices	Compliance with good personal hygiene practices. Keep product well packed in proper place, protected from contamination.	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
	Chemical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6. Division and Molding	**Biological:** Microbial contamination (*Salmonella*, *Staphylococcus aureus* and *Escherichia coli*)	As product datasheet	With consequences	1	4	4	Incorrect hygiene practices	Perform the task quickly, hygienically and without interruptions. Compliance with good personal hygiene practices. Keep facilities, equipment and utensils for the operation properly sanitized	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
	Physical: Contamination by foreign objects (hair, decorations)	Absence	Without consequences	1	1	1	Incorrect hygiene practices	Compliance with good personal hygiene practices	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
	Chemical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6a. Retardation of fermentation	**Biological:** Microbial contamination (*Salmonella*, *Staphylococcus aureus* and *Escherichia coli*)	As product datasheet	With consequences	1	4	4	Incorrect hygiene practices Inadequate refrigeration temperatures	Temperature control of the refrigerated space. Compliance with good personal hygiene practices	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
	Physical: Contamination by foreign objects (hair, decorations)	Absence	Without consequences	1	1	1	Incorrect hygiene practices	Compliance with good personal hygiene practices	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
	Chemical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
7. Fermentation (Stove)	**Biological:** Microbial contamination (*Salmonella*, *Staphylococcus aureus* and *Escherichia coli*)	As product datasheet	With consequences	1	4	4	Incorrect hygiene practices	Compliance with good personal hygiene practices. Keep facilities, equipment and utensils for the operation properly sanitized	Yes	No	Yes	Yes	The subsequent stage of cooking eliminates any microbial load that can be developed in the product, so this step is not considered a CCP	---	x	---

	Physical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Chemical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
8.Baking	**Biological:** Microbial contamination (*Salmonella*, *Staphylococcus aureus* and *Escherichia coli*)	As product datasheet	With consequences	1	4	4	Incorrect hygiene practices. Insufficient cooking time and / or cooking temperature	Compliance with good personal hygiene practices. Meet binomial time / temperature set (10–12 minutes at 200–220ºC) for the process so that at the interior is reached at least a temperature of 70 ° C	Yes	No	Yes	No	This step is critical because at this stage is that the microorganisms in the product will be deleted. If RI ≤ 8 this step is not a CCP	---	---	x
	Physical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Chemical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9. Cooling	**Biological:** Microbial contamination (*Staphylococcus aureus*)	As product datasheet	With consequences	1	4	4	Incorrect hygiene practices.	Compliance with good personal hygiene practices. Keep facilities, equipment and utensils for the operation properly sanitized	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
	Physical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Chemical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10. Packaging / Storing	**Biological:** Microbial contamination (*Salmonella*, *Staphylococcus aureus* and *Escherichia coli*)	As product datasheet	With consequences	1	4	4	Incorrect hygiene practices.	Compliance with good personal hygiene practices. Perform the task quickly, hygienically and without interruptions. Keep facilities, equipment and fixtures for the operation properly sanitized.	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
	Physical: Contamination by foreign objects (hair, decoration)	Absence	Without consequences	1	1	1	Incorrect hygiene practices.	Compliance with good personal hygiene practices. Perform the task quickly, hygienically and without interruptions.	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
	Chemical: Detergent residue, migration of undesirable substances into the food	Absence	Without consequences	1	2	2	Incorrect hygiene practices. Inadequate packaging material	Keep facilities, equipment and fixtures for the operation properly sanitized. Confirm suitability of the packaging material for food use (presence of food symbol).	Yes	No	No	---	Verifying compliance with good hygiene practices and the adequacy of the packaging material to food use, this step is not considered a CCP	---	x	---

11. Exposition / Sell	**Biological:** Microbial contamination (*Salmonella*, *Staphylococcus aureus* and *Escherichia coli*)	As product datasheet	With consequences	1	4	4	Incorrect hygiene practices.	Compliance with good personal hygiene practices. Keep product well packed in proper place, protected from contamination. Keep facilities, equipment and fixtures for the operation properly sanitized	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
	Physical: Contamination by foreign objects (hair, decoration)	Absence	Without consequences	1	1	1	Incorrect hygiene practices.	Compliance with good personal hygiene practices. Keep product well packed in own place, protected from contamination.	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
	Chemical: Detergent residues.	Absence	Without consequences	1	2	2	Incorrect hygiene practices.	Keep local and utensils for the operation properly sanitized	Yes	No	No	---	Verifying compliance with good hygiene practices and the adequacy of the packaging material to food use, this step is not considered a CCP	---	x	---
12. Expedition	**Biological:** Microbial contamination (*Staphylococcus aureus*)	As sampling plan for analysis	With consequences	1	4	4	Incorrect hygiene practices.	Compliance with good personal hygiene practices. Keep facilities, equipment and fixtures for the operation properly sanitized	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
	Physical: Contamination by foreign objects (hair, decoration)	Absence	Without consequences	1	1	1	Incorrect hygiene practices.	Compliance with good personal hygiene practices. Keep product well packed in own place, protected from contamination.	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
	Chemical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
13. Distribution	**Biological:** Microbial contamination (*Salmonella*, *Staphylococcus aureus* and *Escherichia coli*)	As product datasheet	With consequences	1	4	4	Incorrect hygiene practices.	Compliance with good personal hygiene practices. Protect the product from direct contact with customers and environmental contamination.	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
	Physical: Contamination by foreign objects (hair, decoration)	Absence	Without consequences	1	1	1	Incorrect hygiene practices.	Compliance with good personal hygiene practices. Protect the product from direct contact with customers and environmental contamination.	Yes	No	No	---	Verifying compliance with good hygiene practices, this step is not considered a CCP	---	x	---
	Chemical: Unidentifyed	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

TABLE 5. Pre-Requisites Operating Plan.

STAGE	RISK	CONTROL MEASURES	MONITORIZATION				ACTIONS TO IMPLEMENT		RESPONSIBILITIES AND AUTHORITIES	REGISTRY
			WHAT?	HOW?	WHEN?	WHO?	CORRECTIONS	CORRECTIVE ACTIONS		
4. Kneading	Physical: Contamination by metal pieces	-- Check the integrity of the mixer spiral after each mixing cycle	Mixer spiral	Visual observation	Every kneading cycle	Employee making the kneading	- Location and removal of scrap metal; *(If the pieces of metal are not located, the entire batch of product should be discarded, placed in proper place, properly identified as a not compliant product)*	Replacement of the kneader spiral	Monitoring – Employee making the kneading Correction and Corrective Actions – Director of Quality	MOD.18 – Corrective action MOD.34 – Kneader spiral integrity record MOD.30 – Not conformal product zone MOD.32 – Not conformal product
8. Baking	**Biological:** Microbial multiplication (*Salmonella, Staphylococcus aureus* and *Escherichia coli*)	Compliance with good personal hygiene practices. Meet binomial time / temperature set for the process . The goal is to reach inside the product temperature at or above 70 ° C.	Binomial time / temperature. Internal temperature of the product.	Clock ovens / Penetration Thermometer.	Weekly	Responsible employee / director of quality.	Extend or shorten the cooking time to achieve the desired end product and that inside the product is achieved a temperature above 70°C. If the product is not fit for human consumption, must be rejected, put in place, duly identified as nonconforming product.	Reset the binomial time / temperature.	Oven operator or employee responsible for firing. Director of Quality. Administration.	Corrective action. Record internal temperature of the product.

In this study, the step of cooking is the largest contributor to the proliferation of microorganisms and therefore a specific PROP is directed to this step. Although there is no critical limit for the stage, the nonfulfillment of the manufacture plan (time, 10 to 12 min and temperature, 200 to 220°C for baking the "bola"), will lead to a product unfit for consumption. As such, there is a need to create a PROP for the stage (Table 5), which followed, contributed to its improvement and quality. Likewise, the step kneading has a physical risk (pieces of metal contamination) with consequences and there is also need to create a PROP for the stage (Table 5).

FINAL CONSIDERATIONS AND RECOMMENDATIONS

The HACCP system is complex and constantly evolving. To be implemented, all steps must be verified and implemented so that everything goes as planned.

It is essential that the flowchart is well planned, analyzed on the ground and that it contains as much information as possible. Only a well planned flowchart facilitates the control of the entire process, making it easier to detect possible deviations.

On the other hand, it is essential to establish verification procedures. The plan should be audited periodically, or whenever there are changes to it, not only in terms of manufacturing processes, but also whenever there is a new product. This entire process must be documented and filed in a proper place for this purpose. Finally, each quarter, the whole plan should be reviewed, discussed and validated by the team and responsible administration. Whenever a plan is validated, the former is obsolete, being in force always the latest.

When the objective is to produce safe foods that do not constitute any risk to public health, the use of preventive tools is the best way of achieving this.

The HACCP system is constantly evolving and is now recognized as one of the most effective control of food production. The implementation of this system in the food industry today is a legal obligation, stamping all workers and staff responsibilities. However, this does not depend on itself to be effective, depends crucially on the implementation of a set of prerequisites, where the application of good hygiene and safety is essential.

From the overview of the HACCP system implemented in the bakery, there was no reduction in quality of the final product during the manufacturing process, with particularly strong implementation of prerequisites and total commitment and sense of responsibility of all employees. Rather, there was a guarantee of product quality, as shown by several studies, demonstrating that the HACCP system has a positive effect of the quality of end products (*e.g.* [Trafiałek & Kołożyn-Krajewska, 2007, 2011; Sikora & Nowicki, 2007]).

Because it is a complex system it is recommended however, that the company regularly runs training in this area with the aim of instilling habits and make workers more receptive to the change of working methods. Only through education and awareness of all elements of the food chain it is possible to achieve the best performance and best results.

It is up to the HACCP team to make the entire management of the system. They must adopt a firm stance, persis-

tent and determined in carrying out their duties, in order to achieve all objectives.

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