



Implementation of traceability and food safety systems (HACCP) under the ISO 22000:2005 standard in North Africa: The case study of an ice cream company in Algeria



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ABSTRACT

Our study aims at establishing and implementing the HACCP and traceability system, in an integrated approach, of ice cream processing in order to control food borne safety hazards, to minimize the production and distribution of unsafe or poor quality products, thereby the potential food safety risks and associated food recalls. Internal information capture points were identified in ice cream process and the corresponding traceability information to be recorded were determined. Biological, physical, chemical and allergens hazards that could emerge at each stage of the production were identified. After hazards identification, the critical control points (CCPs) and operational prerequisites programs (oPRPs) were selected using a decision tree. Results showed that cleaning-in-place, filtration, pasteurization, cooling storage and transport stages were the critical control points identified. Critical limits, monitoring methods and frequency, responsibilities and corrective actions of the processes are also presented. Finally, the impact of implementation of food safety system (HACCP) on aerobic plate count (APC) and coliforms in vanilla, strawberry and chocolate flavoured ice cream was investigated. The results of HACCP adoption showed the reduction of APC in all flavours of the ice cream samples tested, being higher for the strawberry from 4.18 ± 3.03 till 3.80 ± 2.71 log CFU/g. Besides, a significant decrease of coliforms from 2.39 ± 1.76 till 2.11 ± 1.42 and 2.54 ± 1.62 till 2.02 ± 1.15 log CFU/g was observed in ice cream samples with a chocolate and strawberry flavour, respectively. In conclusion, the implementation of traceability and HACCP system, under the ISO 22000 standard has allowed tracking and tracing of ice cream products improving the microbiological quality of the ice creams.

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1. Introduction

Ice cream is a frozen dairy dessert obtained by freezing the ice cream mix with continuous agitation (Deosarkar, Kalyankar, Pawshe, & Khedkar, 2016, pp. 385–390). Considered as nutritive foods (Balthazar et al., 2017), due to its composition, which includes milk proteins, fat and lactose, as well as other compounds, the ice-cream might be functional by its supplementation with prebiotic ingredients or probiotic bacteria (Cruz, Antunes, Sousa, Faria, & Saad, 2009). Commonly enjoyed by people of all ages (Karaman et al., 2014), the production and consumption of ice cream continue to increase year on year (Smith, 2015, pp. 271–284). In

Algeria, the ice cream production raised up to 30 million litres in 2015 (Anonymous, 2015).

Dairy products pose a major concern to the dairy industry and public health authorities (Melo, Andrew, & Faleiro, 2015), as they can be important sources of foodborne pathogens (Oliver, Jayarao, & Almeida, 2005). Several authors have reported the outbreaks or incidents of foodborne illnesses associated with dairy products (Garcell et al., 2016; Gould, Mungai, & Barton Behravesh, 2014; Heuvelink et al., 2009; Honish et al., 2005; Johler et al., 2015; Lindström, Myllykoski, Sivelä, & Korkeala, 2010; Motarjemi, Moy, Jooste, & Anelich, 2014; Papademas & Bintsis, 2010). In industrialized countries, milk and dairy products are involved in 2–6% of outbreaks of foodborne illnesses (Claeys et al., 2013).

Ice cream, as other dairy product, the possibility of acquiring food-borne diseases by children, elderly people and immunosuppressed patients from this product should not be neglected (Daniels

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et al., 2002; De Farias et al., 2006; El-Sharef, Ghenghesh, Abognah, Gnan, & Rahouma, 2006; Kanbakan, Con, & Ayar, 2004; M-E-Elahi et al., 2002; Warke, Kamat, Kamat, & Thomas, 2000).

A study on food-borne disease outbreaks in a number of countries in Europe and North America (Buvens et al., 2011; CDC, 2015; Daniels et al., 2002; De Schrijver et al., 2008; Fetsch et al., 2014; Pouillot et al., 2016) reported outbreaks associated with the consumption of ice cream (El-Sharef et al., 2006).

Classical quality control methods only emphasized on hygienic quality of final products are inadequate to control hazards occurring at early stages of the process. To provide safe food and prevent food-borne illness outbreaks, Hazard Analysis Critical Control Point (HACCP) programs are recommended (Wang et al., 2010).

The HACCP concept is a scientific approach to assess hazards associated with food production and establish control systems to ensure food safety (FAO, 1997). It is a preventive system, that takes the whole chain of food production into consideration before biological, chemical and/or physical hazards affect the safety of food products (Food Product Association (FPA), 2006).

Several reports indicated the effects of implementing HACCP on microbiological quality of food products (El-Hofi, El-Tanboly, & Ismail, 2010; Kassem, Salem, Ahwal, Saddik, & Gomaa, 2002; Kokkinakis, Kokkinaki, Kyriakidis, Markaki, & Fragkiadakis, 2011, 2008; Nada, Ilija, Igor, Jelena, & Ruzica, 2012; Soriano, Rico, Molto, & Manes, 2002; Wang et al., 2010).

Moreover, HACCP is recognized in the international food safety community as a worldwide guideline for controlling food-borne safety hazards (Kafetzopoulos, Psomas, & Kafetzopoulos, 2013; Meng et al., 2011). Its principles, detailed in the *Codex Alimentarius* guidelines, are integrated in International Standard ISO 22000:2005 (ISO 22000, 2005) and have been incorporated in the Algerian food legislations in 2010, through the Executive Decree No. 10–90 laying down the conditions and procedures for sanitary accreditation of institutions whose business is related to animals, animal products and products of animal origin and to their transport (JORA, 2010; Art. 3.).

Nevertheless, the application of HACCP systems does not imply the existence of a traceability system as a direct consequence of the documentation procedures. Although one of the HACCP principles (principle No. 7) states the need to establish documentation and record-keeping procedures, and although these procedures can provide useful information for a traceability system, the aims and scope of documentation in HACCP are different. In the latter, the aim is to document that the system is under control, and corrective actions are always taken when pre-defined critical limits are exceeded (Caporale, Giovannini, Di Francesco, & Calistri, 2001).

A traceability system provides a set of data about the location of food and food ingredients along the supply chain. They are useful to identify and track products from origin to consumption while providing the ability to quickly trace back products at any point in the food chain (Thompson, Sylvia, & Morrissey, 2005).

There are numerous studies on the implementation of HACCP system in ice cream factories (Arvanitoyannis, Varzakas, & Koukiliaroglou-van Houwelingen, 2009; Hung et al., 2015; Lu, Pua, Liu, Chang, & Cheng, 2014; Papademas & Bintsis, 2002, pp. 213–260), however, traceability systems were not successfully integrated. In addition, to the best of our knowledge, there is not any study investigating the implementation of such food safety and hygiene procedures in the Algerian ice cream industry. The key issue to add values on food safety is to integrate the traceability system with HACCP system and use the traceability data to manage the production process and improve its performance.

The aim of this work was to install the traceability and food safety systems (HACCP) under the ISO 22000:2005 standard through conducting a hazard analysis on the ice cream production

line in an Algerian food industry and to identify Critical Control Points (CCPs) thus setting up an effective preventive system which will lead to a safer and more efficient production of ice cream.

2. Materials and methods

2.1. Company description

This study was carried out in a food industry, MAZAFROID, located in north Algeria. The main reason for its selection lies on being the first ice cream Algerian company which aims at obtaining the ISO 22000:2005 certification. Besides, implementation and follow-up of ISO 22000:2005 was agreed with the company director and food quality staff. Management commitment (ISO 22000, Section 5.) was materialized by communicating to the organization the importance of meeting this International Standard, statutory and regulatory requirements as well as customer requirements relating to food safety and by ensuring the availability of financial, material and human resources (ISO 22000, Section 6.) for the establishment of the necessary work environment. This company, founded in 2000 and composed by three production units with staff of 80 employees, produces cookies, chocolate and ice creams. The products are directed exclusively to the internal market. This company has implemented ISO 9001:2008 and ISO 22000:2005 to improve the quality and safety of its products, customer expectations and product image in the market. Procedures were established in order to identify and monitor CCPs, correct the process and verify the HACCP plan's effectiveness.

Although the ISO 22000 standard has been completely implemented in all production lines, this work explains only the implementation of prerequisites programs (PRPs), Hazard Analysis Critical Control Point (HACCP) principles and traceability system according to the standard requirements for ice cream processing line.

2.2. Implementation steps of the HACCP

The tasks outlined in section 7 of ISO 22000: 2005 were followed to develop a HACCP plan that includes the following seven principles:

- Conduct hazard analysis (HA)
- Identify critical control points (CCP)
- Establish critical limits (CL)
- Monitor each CCP
- Establish corrective action
- Establish verification procedures
- Establish record keeping

In this study, prerequisites programs (PRPs) are included in the HACCP study. Therefore, procedures related to the prerequisite programs are firstly presented (Wang et al., 2010).

2.3. Principle of traceability

In order to develop a traceability system and to achieve a fully traceable ice cream chain, a traceability procedure was established for the elaboration process and information flow at every step in the chain was collected. Traceability systems require the identification of all the physical entities (and locations) from which the product originates, but also where it is processed, packaged, and stored. To do so, the HACCP team of the studied food company carried out a stepwise inspection of the production facilities; structured interviews with staff; and scrutiny of relevant company documentation. For an efficient execution of traceability in the

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