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Case Report

The implementation of HACCP management system in a chocolate ice cream plant

Junchao Lu^{a,b}, Xiao-Hui Pua^a, Chi-Te Liu^c, Che-Lang Chang^d,
Kuan-Chen Cheng^{a,c,*}

^a Graduate Institute of Food Science and Technology, National Taiwan University, Number 1, Section 4, Roosevelt Road, Taipei, Taiwan

^b Department of Nutrition and Food Science, University of Maryland, College Park, MD 20742, USA

^c Institute of Biotechnology, National Taiwan University, Number 1, Section 4, Roosevelt Road, Taipei, Taiwan

^d Great Wall Enterprise Company, Ltd, 8F, Number 20, Wenhua Street, Neihu District, Taipei 11445, Taiwan

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ABSTRACT

To guarantee the safety of chocolate ice cream production, the Hazard Analysis Critical Control Points (HACCP) system was applied to the production process. The biological, chemical, and physical hazards that may exist in every step of chocolate ice cream production were identified. In addition, the critical control points were selected and the critical limits, monitoring, corrective measures, records, and verifications were established. The critical control points, which include pasteurization and freezing, were identified. Implementing the HACCP system in food manufacturing can effectively ensure food safety and quality, expand the market, and improve the manufacturers' management level.

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1. Introduction

HACCP, which stands for Hazard Analysis and Critical Control Point, is defined as a "Food Safety Control System" in Taiwan's food hygiene legislative system [1]. It stresses on—through critical hazard control—reducing or eliminating hazards to the lowest level during the processing steps, while establishing critical limits, monitoring procedures, corrective measures, records, and verifications. HACCP is a further feature of the

presented quality guarantee method based on standard operating procedures, Good Manufacturing Practice, and Good Hygiene Practice in Taiwan [2]. It has two major components: hazard analysis and critical control. Hazard analysis is primarily about systematically identifying and assessing the food production process, and selecting any "biological", "chemical", and "physical" characters or factors that may render the food unsafe. Critical control is mainly about basing on the results of hazard analysis, and formulating and managing the

* Corresponding author. Graduate Institute of Food Science and Technology, National Taiwan University, Number 1, Section 4, Roosevelt Road, Taipei, Taiwan.

E-mail address: kccheng@ntu.edu.tw (K.-C. Cheng).

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controllable points or procedures during the process to minimize the safety hazard of final products (Table 1) [3].

HACCP is a world-recognized, effective, and preventive food hygiene management system. At present, the HACCP system has been widely adopted by many countries such as the United States, Japan, the United Kingdom, and member states of the European Union, as well as international organizations such as the World Health Organization, Food and Agriculture Organization, and Codex Alimentarius Commission (CAC) [4]. In Taiwan, exported products were obliged to meet the requirements established by American regulations on fish and fishery products; thus, fish and fishery products became the first food industry that was required to perform mandatory HACCP practices [5]. In consideration of the booming development of the catering industry and the increasing number of food poisoning incidents, the Department of Health, Executive Yuan started to promote the development of HACCP practices stage by stage—from encouraging voluntary application to mandatory implementation [6]. Nowadays, fish and fishery products, meat products, meal box, and dairy products are required to perform mandatory HACCP practices; meanwhile, an increasing number of food processing manufacturers are voluntarily applying for HACCP certification.

Because of the plasticizer addition scandal in 2011 and the maleic acid incident in 2013, the Taiwan food industry encountered a serious crisis that shook the consumers' confidence toward food corporations and government regulatory bodies, resulting in remarkable reputation damage and financial losses [7]. Traditional quality ensuring methods, which simply require inspecting the final products, can no longer satisfy the consumers' needs. Implementing HACCP is helpful in gaining consumers' trust and establishing a good corporate image. Moreover, many countries such as the United States, member nations of the European Union, and Japan have strict requirements regarding food imports [8]. The application of HACCP enables corporations in Taiwan to break down trade barriers and participate in international business, thereby effectively expanding their markets and increasing profits. Additionally, a logical and applicable HACCP plan can help food factories improve their management level and enhance their staff's safety consciousness.

Chocolate ice cream is a frozen food that uses dairy products, cocoa powder, and chocolate chips as main ingredients, mixing them with sugar or syrup, egg products, emulsifier, stabilizer flavors, and colors, produced through a series of processing steps. In Taiwan, ice cream is a huge industry that accounts for a market share of approximately NTD 1688 million, representing 2115 tons of products sold for the year 2012 [9]. Chocolate is the second favorite ice cream flavor in Taiwan, after vanilla [10]. Chocolate ice cream is a good microbial growth medium because of its nutrients (lactose, protein, carbohydrate, etc.) and neutral pH profile [6,7]; however, its quality is difficult to determine solely by appearance. Therefore, preventing microbial contamination has been crucial for its safety control. HACCP has been proven to be effective in inhibiting the growth of *Staphylococcus aureus*, *Escherichia coli*, and other human pathogens in chocolate ice cream production [11]. The quality and safety of the final product can be effectively guaranteed through the application of the HACCP system (Table 2)[13].

2. Materials and methods

2.1. Study object

The entire production process of chocolate ice cream was evaluated including the plant layout, structure of each facility, technical standards, facility cleansing method, staff assignment, safety control method, condition of storage, and distribution (Fig. 1). The potential biological, chemical, and physical hazards that may exist in every step of the production process were identified, and then critical control points (CCPs) were selected.

2.2. Methods

Based on the Department of Health, Executive Yuan's regulations revised in 2008: *Food Safety Control System*, United Nations Codex Alimentarius Commission's *HACCP and guidelines for its application* (revision of 2003), the overall technical process of chocolate ice cream production was drawn, and a hazards analysis was performed. CCPs were subsequently selected. Based on government regulations and industry standards, critical limits were established, as well as monitoring procedures, corrective measures, records, documentations, and verifications. The decision tree method was implemented to select the CCPs. This method is a visual, easy-to-understand alternative to the numerical charts and statistical probabilities in other decision analysis methods, such as hazard analysis scheduling and spreadsheets.

3. Results and discussion

The overall flow diagram of the chocolate ice cream technical process is summarized in Fig. 2, including receiving of raw materials, weighing and mixing (liquid and solid), sifting, homogenization, pasteurization, cooling, aging, freezing (following chocolate chip addition), packaging, hardening, and storage/distribution.

3.1. Hazard analysis and prevention measures establishment

From the receipt of materials to the delivery of the final products to every retailer, hazard analysis was performed at every technical procedure to define any biological, chemical, and physical factors that may affect food safety. The severity and risk will determine the significance of each hazard.

3.1.1. Acceptance of raw material

Milk and other dairy products can provide ice cream with fat content and nonfat solids, giving ice cream its distinctive flavor, soft mouth feel, and rich nutritional materials. Additionally, fresh cream offers various kinds of fine lipid, which enhances the smooth mouth feel of the final product [12]. Each type of dairy products should meet the requirement of the *Chinese National Standards* (CNS), for example, standard CNS NO.2343 for milk powder and CNS NO.2878 for milk cream. General dairy products must meet the requirement of

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