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A model of hazard and risk analysis for bread production and the awareness of food safety

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RESEARCH ARTICLE

Abstract

A physical, chemical, biological or allergenic substance associated with a food commodity from harvesting to the consumer's hand could contaminate food processing. Hazard analysis and critical control points (HACCP) ensures product protection. Though many manufacturers obtain a HACCP certificate easily, they may not apply the systematic food screening programs during all stages of the process. The purpose of this study was to evaluate the HACCP implementation for the roll bread production line and determine the education level of food safety and legal requirements in Samsun, Turkey. Verification procedures, record keeping and workflow in the roll bread manufacturing plant was screened and hence the HACCP chart was revised, by the HACCP team. The critical control points (CCPs) were determined by going through the decision tree of the method specified in ISO 22000:2005. The level of awareness of staff for good hygiene practices and food safety was determined via face-to-face method questionnaire. Within all stages of the process, cooling (stage 10) was considered as CCP in the manufacturing plant. The control and preventive activities created including pre-requisite programmes for the other processing steps. In addition, label information of the product was re-evaluated according to the present production conditions and was revised. Regarding the education level of the food hygiene practices and quality control applications was determined to be inadequate; personnel need to be informed and technical support is required to ensure internal control.

Keywords: HACCP, food law, food safety, bread production

1. Introduction

Many of the inconvenience identified in the safety of the final product are due to the inadequacy of general and specific hygiene requirements of the plant (Karaman *et al.*, 2012; Marques *et al.*, 2012). In manufacturing of bakery products sector, there are inadequacies becoming industrial scale due to finding employment, inability of qualified technical staff, opening cost of bakery places and frequent changing in ownership or closing in short time. (Yapp and Fairman, 2006). Among the bacterial pathogens, coliforms and enterococci, are widely used as an indicator of inadequate hygiene and sanitation for cereal and cereal products. Besides, some spore-forming bacteria, which are not affected by heat process, can be found in grains, yeast and other ingredients could cause food spoilage in bread (Var and Zorlugenç, 2001). Physical, chemical and biological hazards can be prevented by performing pre-requisite programmes (PRPs) such as good hygiene practices (GHP) and good manufacturing practices (GMP) and operational pre-request programs (OPRPs) such as hazards linked to food safety in products or in the environment of manufacturing (Baş *et al.*, 2004; FAO, 1997). ISO 22000: 2005 (HACCP) is a science-based, systematic and dynamic system certification that evaluates and controls hazards that are important for food safety (CAC, 2003). With ISO 22000 standard, it is ensured that consumers receive reliable, healthy and high quality food products in compliance with international standards. Some PRPs must be complete before the HACCP system could be implemented (Scott and Stevenson, 2006). PRPs include general and specific hygiene requirements. A food manager has to ensure the hygiene requirements specified in the Food Hygiene Regulation in order to protect consumer health from

primary production to the final consumer. For example, the location, design, construction, size and drainage system of a food manufacturer must be convenient and adequate for all processes. All of the food contact surfaces, equipment and materials in the food processing area must be suitable to good hygiene practices, they must be easily cleanable, corrosion resistant, suitable for food contact, not absorb water and natural or mechanical ventilation systems should be present (Anonymous, 2010, 2011).

In this study, the current situation of good hygiene practices of the bakery has been evaluated in place. A face-to-face questionnaire about food hygiene practices was conducted to the staff. After the evaluation of the bakeries about HACCP certification it was determined that only one bakery has HACCP certificate. However, it was seen that both the management and the staff have some problems about ensuring the continuity of the HACCP system, documentation and recording data, filling important forms such as good hygiene manufacture procedures. Therefore, the conformity of the HACCP system was evaluated and then a HACCP model for hazard analysis and critical control points was generated for the industrial bread producing.

2. Materials and methods

Study area (demographic knowledge)

Based on the principle of volunteerism, the survey was performed in various bakeries. A total of one hundred and ten people attended the survey from 23 bakeries in Samsun, Turkey. The survey was carried out in three months. All the producing conditions was observed, including the behaviour of staff in bakeries in order to perform any quality control procedures and/or food safety management system. Food hygiene applications and the behaviour of staff in bakery plant were examined. Control and preventive actions against hazards and also control methods of critical limits was observed in the company which has forty-one local sales offices.

Research method – determination of awareness of food safety

In this study, the current situation of good hygiene practices of the bakery plants was evaluated in place. Personal interval survey was conducted according to the face-to-face method (Sincero, 2012).

A questionnaire about their production technology, production areas, and quality control system, regulation about bread and bread varieties and food safety was applied face to face. Data was collected and evaluated according to the frequency distribution. Quantity data was collected by a survey form. In addition by interviewing the staff involved in each plant and self-observation information regarding good hygiene practices was gathered by the researcher.

Evaluation of HACCP implementation

A plant that having a HACCP certificate was chosen for the HACCP implementation among all of the surveyed bread producing plant. A HACCP team was established with the administrator, the team coordinator and the head of production of the plant. The roll bread line was evaluated for HACCP implementation during three months in the selected plant. The production stages were followed-up and re-evaluated on-site. Hazard analysis was performed by answering the questions in a decision tree specified in ISO 22000:2005 which includes the determination, monitoring, review and improvement of critical control points in the food chain. ISO 22000:2005 administers the Codex Alimentary Commission's seven principles of HACCP including PRPs (CAC, 2004), product description, list of product ingredients and incoming materials, process flow diagram, hazard identification, critical control points determination and HACCP control chart (ISO, 2005; TSE, 2006; Varzakas, 2011). For the PRPs and OPRPs, the buildings, workspace, employee facilities, water management, equipment, transportation, storage conditions and waste management were evaluated by HACCP team (Anonymous, 2011; CAC, 2004; Catlin, 2014; FAO and WHO, 2002; Sulieman *et al.*, 2013). Control and Preventive actions (CPA) were expressed to be implemented for each concerning step. The CPA includes limits for critical control points, monitoring, verification and corrective actions for CCP stage. This plan provides the protection in order to prevent physical-chemical-biological hazards, determination of critical limits, control method, control frequency, corrective action, registration forms, verification activities and who's responsible (Mohd Bakri *et al.*, 2017; TSE, 2006). Recordkeeping procedures and verification procedures were obtained by the HACCP plan (FAO, 1997). At the end of the study, all the HACCP procedures was documented and recorded. Reviewed activities were applied according to the HACCP-based plan.

3. Results

The results of awareness of food safety

The questionnaire contained demographic information, risk assessment of bread production and the food safety profile level of the staff in bakery sector. It was found that 65.46% of the personnel were trained for Turkish Food Codex (TFC) Notification No. 2017/23 on bread and various bread types. Building conditions were not enough to prevent cross contamination. Most of the manufactures didn't have any technical staff having a food science and processing technology degree. According to the given answers for food

safety and food control, it was determined that although most of the staff had a hygiene education certificate, the application of the general and special rules and the awareness of food safety and food control were insufficient (Table 1). For example, when considering the answers on the quality control system, only 13.46% of the respondents answered that they had heard the phrase 'from farm to fork food safety' and the rest did not hear it before.

At the end of this study, it was found that the staff did not have enough competence to apply GMP and GHP, although they had a food hygiene certificate. The staff working in the industrial bread producing plant needed to be informed about good hygiene practices and quality control. Some recent studies reported that education and awareness of the food chain was important to success for the implementation of HACCP (Cruz *et al.*, 2006; Jianu end Chis, 2012; Taylor, 2001).

The results of HACCP implementation study

Because the daily production capacity of roll bread was the highest amount, the HACCP plan of this production line was evaluated. During review of the HACCP implementation in the bakery, all of the staff participated with strong sense of responsibility.

After reviewing the flow chart, on-site conformation was conducted and the flow diagram was corrected. The HACCP team observed the quality control procedures

Table 1. Knowledge of staff about food safety and food control [n=110].

Questions	Answers	%
Is there any quality control application in your plant?	Yes	78.2
	No	21.80
Do you need a control of provided firm?	Yes	67.28
	No	26.26
	No answer	6.36
Have you heard the phrase 'from farm to fork food safety'?	Yes	29.09
	No	67.27
	No answer	3.64
If yes, indicate what it mean.	True answer	0.91
	Wrong answer	11.82
	No answer	87.27
Which of the sentence describes food safety?	It is the production, storage and sale of foods in healthy conditions.	47.27
	It is take necessary precautions in order to avoid any hazard in foods.	14.55
	It means that the consumers reach the food in a packaged-labeled manner.	12.73
	Food production in accordance with hygiene regulations.	9.1
	Food that does not cause health problems.	2.72
	Not spoilage foods.	0.91
	No answer	12.72
Do you have a checklist form for implementing the procedure?	Yes	20.00
	No	30.91
	No answer	49.09
What is your opinion about the use of additives in bread and bread varieties that are offered to the market unpacked?	It can't be used	42.73
	I have no idea	37.27
	It can be added at a level that ensures good production conditions.	11.82
	It can be used	4.55
	No answer	3.64
When did you receive your health report [porter] latest?	Before one year	33.6
	Before three months	17.3
	I did not take it because it was not compulsory	17.3
	Empty	16.4
	Before six months	4.5
Do you apply HACCP [hazard and risk analysis] management system?	Yes	0.9
	No	92.7
	No answer	6.4

considered as critical control points. It was found that the aims of the production stages were not documented in accordance with the flow of production steps. (CAC, 2003; Konecka-Matyjek *et al.*, 2005).

The HACCP team re-identified a complete description of each food product including all components/packaging materials used in the product formulation, determined any potential hazards to the product, and identified the intended consumer group (Schmidt and Newslow, 2007). The evaluations were made based on the TFC Notification on bread and bread various (TFC, 2017) and TFC Regulation on Substances and Materials in Contact with Food (TFC, 2011). Within this study, the lack of product label information has been corrected. The roll bread product may show an allergic effect for gluten sensitive people due to the ingredients in the formulation. Foods containing any ingredient or process aid derived from a substance causing allergies or intolerance should be clearly distinguishable from other ingredients on the label of food and consumer information (TFC, 2017). Allergen effect causing some ingredients must be stated on the food label after this study.

Identification of all hazards, conduction of hazard analysis, control measures were re-examined. Then CCPs were determined according to the roll bread production (Table 2).

Cooling step was accepted as a CCP after HACCP assessment for roll bread production. Establishment CCP limits, a monitoring system for each CCP, corrective actions, verification procedures and documentation and record keeping were performed. It was revealed that by providing requirements based on GHP, PRPs and OPRPs conditions, high microbiological quality and limited hazardous tolerance could be obtained successfully.

4. Discussion and conclusion

In this survey, we confirmed that although most of the staff had a hygiene education certificate, the application of the general and special rules and the awareness of food safety and food control were insufficient. Only 13.46% of the respondents answered that they had heard the phrase 'from farm to fork food safety' and the rest had not heard it before. This also shows that the effect of training was not as it should be. The staff working in the bread producing plant need to be educated on good hygiene practices and quality control. Bakery products are affected by insufficient hygienic conditions that are usually cause of inadequate food contact materials (containers, machinery, packing materials), inadequate cleaning and disinfection of equipment, insufficiency of personnel hygiene practices, inadequate ventilation and preventive measures (Aplevicz *et al.*, 2014; Jianu and Chis, 2012; Marques *et al.*, 2012). If good manufacture practices, good hygiene practices were to be performed well in a plant, the number of critical control points will be decreased and also all of the processing stages will be controlled easily (Varzakas, 2011; Wallace and Williams, 2001).

When the HACCP system is not implemented by the food business management by involving all personnel, there are problems in the implementation of hazard and risk analysis. When reviewing the flow chart prepared previously, quality control stages rather than CCPs were used and also there were some insufficiencies the evaluation of hazard and risk analysis. It was found that the aims of the production stages weren't documented in accordance with the flow of production steps. Hence, the aim of each steps were explained and documented.

ISO 22000:2005 integrates the Codex Alimentary Commission's seven principles of HACCP including PRPs, product description, list of product ingredients and incoming materials, process flow diagram, hazard identification, critical control points determination and HACCP control chart. PRPs were crucial to assure general and specific hygienic conditions, good manufacturing practices (GMP), personnel training about food hygiene in a bakery sector (CAC, 2004; FAO, 1997; Wallace and Williams, 2001).

The successful application of HACCP system ensures food safety from physical, chemical and biological hazards. A systematic and dynamic system based on science should be established for food safety that identifies, evaluates and controls the hazards throughout the food chain from farm to fork. Thus, respond quickly to food safety-related events and to protect consumers' health and prevent food-borne poisonings. The application of HACCP management system should be considered as an obligation and throughout the food chain from the first stage to final consumption. Its practice aid inspection by regulatory authorities and by increasing confidence in food safety and food quality, promote international trade. A liveable HACCP food safety management system ensures that the products comply with both food safety and legal regulations. In the HACCP internal audit inspections carried out by the government, the results provide evaluation of the system operation. The present study carried out for a roll bread production line to improve the safety and quality of products could be exemplified to similar production bakery sector.

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Table 2. Hazard and risk analysis for type of roll bread.

Process step	Hazards	Type of hazard[1]	Decision tree (Yes:Y, No: N)				Control/preventive actions[2]
			Q1	Q2	Q3	Q4	
Storage [room temperature]	Contamination of insects, dust, etc., insufficient hygienic conditions	P C,B	Y	–	–	–	PRP: Provide pest control process for storage and silo, proper storage condition setting, personal hygiene, food storage control, quality water supply.
Acceptance of raw and auxiliary materials	Damaged packaging, insufficient hygiene practices	P,C,B	Y	–	–	–	PRP: Not used raw materials in damaged packaging, proper food hygiene and personal hygiene conditions. Storage at hygienic conditions and keep away direct sunlight. Provide personal hygiene and handling. Control HACCP certificate from the supplier.
Transferring and elimination flour from silo	Contamination with the piece of equipment, poor hygienic conditions inside transferring and eliminating line.	P C B	N – Y	N – –	– – –	– – –	OP PRP: Provide quality filters, proper personal hygiene and handling. PRP: Ensure porter examinations once in three months, microbiological qualified product supply.
Preparation of the ingredients and mixing	Contamination of a piece of the package material, hair, nails, etc., chemical residues of cleaning products	P C,B	N Y	N –	 –	– –	OP PRP: Perform regular maintenance of the mixing machine. Provide equipment good hygienic condition; keep facilities for the water purifier, proper personal hygiene and handling. PRP: Provide good hygiene practices for the equipment.
Cutting and rolling	Insufficient hygienic conditions	P,C,B	Y	–	–	–	PRP: Provide good hygiene practices for the equipment, personal hygiene and handling, setting good hygienic conditions into cutting-rolling machine.
Bench rest	Contamination of metal, paint, hair, fibre, wood chips, chemical matters	P,C,B	Y	–	–	–	PRP: Provide suitable equipment for food contact materials setting good hygienic conditions for the manufacture area, all of the equipment's and personal hygiene.
Final fermentation	Contamination of insect, dust, etc.	P,B	Y	–	–	–	PRP: Setting good hygienic conditions for the fermentation room, all of the equipment's and personal hygiene.
Addition of sesame	Insufficient hygienic conditions	P B	N Y	N –	N –	– –	PRP: Qualified product supply, provide personal hygiene and handling.
Cooking	In sufficient cooking time or temperature, insufficient hygienic conditions	P B	N Y	N –	N –	– –	OP OGP: Ensure the suitability of equipment for heat treatment, setting 10-12 minutes at 200-220 °C for internal temperature being 72 °C. PRP: Provide good personal and equipment practices.
Cooling	In sufficient cooling time or temperature, insufficient hygienic conditions	P C,B	Y N	– N	– Y	– N	PRP: Provide good hygiene practices, ensure hygiene of food contact materials CCP: Perform the suitable final temperature and pH value combination. Application of cleaning and disinfection procedures.
Package and printing of last consumption date	Improper packaging material and dye	P,C,B	Y	–	–	–	PRP: Provide suitable dye for using contact to foods that is suitable for food packaging material, good hygiene practices.
Storage	Dirtiness, dust-loaded air	P,C,B	Y	–	–	–	PRP: Provide good hygiene practices in storage department, ensuring pest control procedure.
Transportation	Environmental contamination, insanitary distribution condition	P	Y	–	–	–	PRP: Protect environmental contamination and provide good hygiene practices.

[1] P = physical; C = chemical; B = biological.

[2] PRP = prerequisite programmes; OP PRP = operational prerequisite programmes; CCP = critical control point.

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