

THE SPECIFICS OF THE INSURANCE SYSTEM TO PROTECT FOOD FROM INTENTIONAL CONTAMINATION IN THE PRODUCTION OF POWDERED FOOD PRODUCTS

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Abstract

Problems relating to the presence of contaminated food on the market that is available to consumers an entirely new dimension when taking into account the possible cases of intentional contamination. Overall aspiration towards food chain of intentional contamination of food is especially supported by the standards for food safety approved by Global Food Safety Initiative (GFSI) that presents a requirement for all food processing companies that are certified according to any one of the standards authorized on the GFSI.

This paper presents a system for assessing the risk of intentional contamination, as well as measures taken to reduce risk in the production and packaging of powdered food products. The established system of protection against intentional contamination is fully effective and integrated into the existing quality management and food safety system. The methodology used is risk assessment in terms of identifying potential threats, estimates the probability of events of potential threats and the impact of potential threats if they occurred in the general business activities and food safety. Effectiveness of the established system is verified through simulation scenarios of possible incidents and internal audit of quality management and food safety system.

Based on the results obtained in this study, it is evident that for a comprehensive approach to ensuring food safety required to take into account the possible hazards and risks of intentional contamination of food, when implement food safety management system, in order to reduce the possibility that contaminated food reaches the consumer.

Key words: Food defense, Intentional contamination, Food safety, Risk assessment.

1. Introduction

One of the key challenges today facing the food industry is to ensure the safety of food products. Over the past few years, with the application of Hazard Analysis and Critical Control Points (HACCP) in processes related to the storage, processing and transport of food products and also retailing and serving food in catering facilities, food business operators are taking measures to reduce the risks of incidents related to food safety.

However, in recent years, the growing focus of the food industry has been transferred to ensuring food safety from intentional contamination.

On 18 May 2002, the Fifty-fifth World Health Assembly adopted a resolution (WHA 55.16) which expressed serious concern about threats against civilian populations by deliberate use of biological, chemical or radioactive agents. It noted that such agents can be disseminated via food and requested the Director-General to provide tools and support to Member States, particularly developing countries, in strengthening their national systems (WHO, [1]).

Food safety addresses the unintentional contamination of food products during processing or storage by microbial, chemical, or physical hazards (foreign objects). This accidental contamination of food products can be reasonably anticipated based on the type of

processing. Food defense, on the other hand, focuses on protecting the food supply from intentional and unanticipated contamination with various chemical and biological agents or other harmful substances by people who want to do harm. These agents could include materials that do not occur naturally or are not part of routine food product testing. Intentional acts are hard to predict (WHO, [1]).

Viewed through history, several cases of intentional contamination of foods have been recorded that have resulted in the poisoning of people who consumed that food.

In 1984 in USA was recorded case of intentional contamination of food. This outbreak of salmonellosis, affecting at least 751 persons, was caused by intentional contamination of restaurant salad bars by members of a religious commune. It was the largest outbreak of foodborne disease reported to Centers for Disease Control in the United States in 1984 (Török *et al.*, [2]).

In 2004, Italian officials were alerted to several incidents of illness following the ingestion of bottled mineral water. The perpetrator was using a syringe to inject bleach, acetone, and ammonia into the water bottles. 14 individuals were hospitalized with stomach irritation due to the adulteration. While a perpetrator was never named, officials believed that there was an anti-capitalist or an environmentalist involved and therefore had political motives to contaminate the water [3].

At present, there are no legal obligations in Bosnia and Herzegovina regarding the implementation of a food defense system against intentional contamination. Companies that are oriented to the production of products under the trademark of EU trade companies and certified according to the requirements of the standards approved by the Global Food Safety Initiative (GFSI) have implemented requirements related to food defense.

A food defense hazard analysis and assessment of associated risks shall have been performed and documented. Based on this assessment, and based on the legal requirements, areas critical to security shall be identified. Food defense hazard analysis and assessment of associated risks shall be conducted annually or upon changes that affect food integrity. An appropriate alert system shall be defined and periodically tested for effectiveness (IFS Food, [4]).

2. Materials and Methods

The process of implementation a system for preventing intentional food contamination consists of several phases.

In the preliminary phase, a team for Threat Assessment and Critical Control Points (TACCP) has been set

up whose primary task is to carry out risk assessment related to the purpose of contamination of powdered products, powder mixtures for the preparation of pudding and whipped cream manufactured in the factory from Bosnia and Herzegovina and to define priority preventive measures by which the risks of intentional contamination of the powdered products can be controlled.

The TACCP team consisted of the following members: quality manager, HACCP team leader, production manager, security manager and purchasing manager.

Threat Assessment and Critical Control Points (TACCP) aims to (PAS 96:2014, [5]):

- identifying specific threats to the company's business;
- assessing the likelihood of an attack by considering the motivation of the prospective attacker, the vulnerability of the process, the opportunity and the capability they have of carrying out the attack;
- assessing the potential impact by considering the consequences of a successful attack;
- judging the priority to be given to different threats by comparing their likelihood and impact;
- deciding upon proportionate controls needed to discourage the attacker and give early notification of an attack; and
- maintaining information and intelligence systems to enable revision of priorities.

TACCP team has conducted a procedure related to the analysis of threats and critical control points (Figure 1).

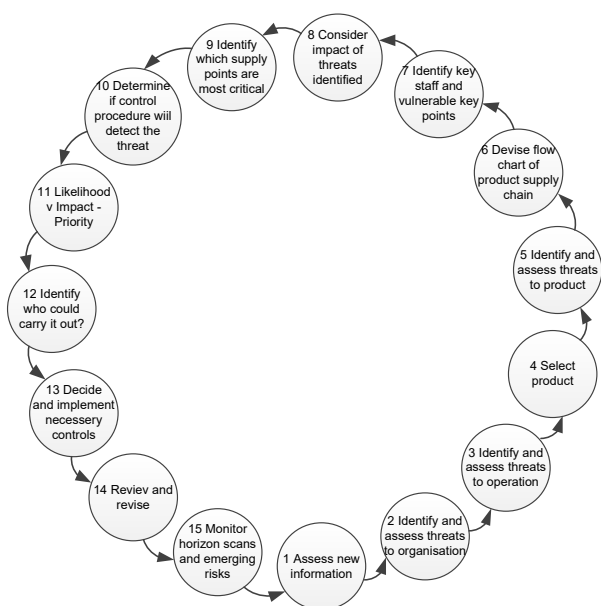


Figure 1. Steps in TACCP process (PAS 96:2014, [5])

The vulnerability to the threat has been broken down into motivation and opportunity. In order for the business to be vulnerable to the threat there has to be a motivation for the attacker to cause harm or damage and also the opportunity for them to actually be able to carry out the act. For a successful attack, the attacker must have the opportunity to carry out the act. This is generally dependent on whether the attacker has access to the target product or raw material and whether they can do this undetected (Adams and Marsh, [6]).

The threat assessment methodology is based on the fact that the TACCP team assesses each threat from the point of view of its likelihood of occurrence and the harmfulness of its impact on the company's business and the health and safety of consumers, as shown in Table 1.

The risk score presented by each threat can be shown on a simple chart presented on Figure 2.

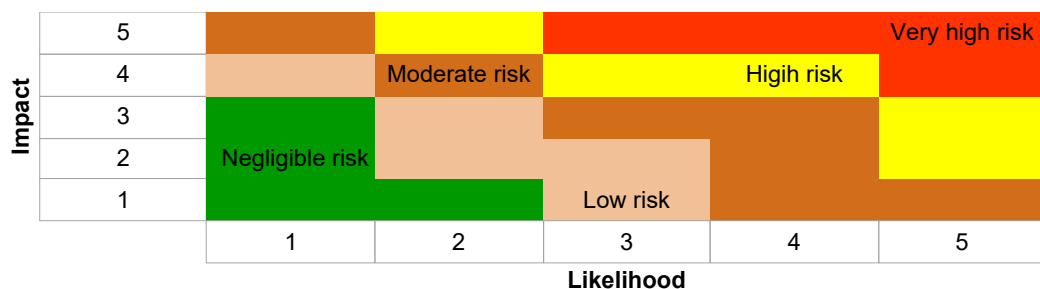
3. Results and Discussion

The company in which the food defense system has been implemented produces a powder mixture for the preparation of pudding and whipped cream. The company is located in the northwestern part of Bosnia and Herzegovina. In addition to the above mentioned products, the company also produces mixtures of spices, teas and ketchup.

In the first step, the TACCP team collected information on potential threats and classified them as general threats to the company, the image of the company, the brand (table 1) and potential threats to the location of the company and products (Table 2).

Table 1. Risk assessment scoring

Likelihood of threat happening	Score	Impact
Common occurrence	5	Catastrophic
It's already happened in our practice	4	Major
It's not already happened in our practice but it's possible	3	Significant
It's not probably	2	Some
Not possible	1	Not significant



Very high risk	Stopping business activities / fatalities in case of food contamination
High risk	Serious business disruption / serious illness in case of food contamination
Moderate risk	Difficult business operations / product withdrawal
Low risk	Little impact on the conduct of business activities / complaints from the customers
Negligible risk	Without impact on the business activities / without affecting consumers

Figure 2. Risk score matrix (adopted from PAS 96:2014, [5])

Table 1. List of potential threats to company

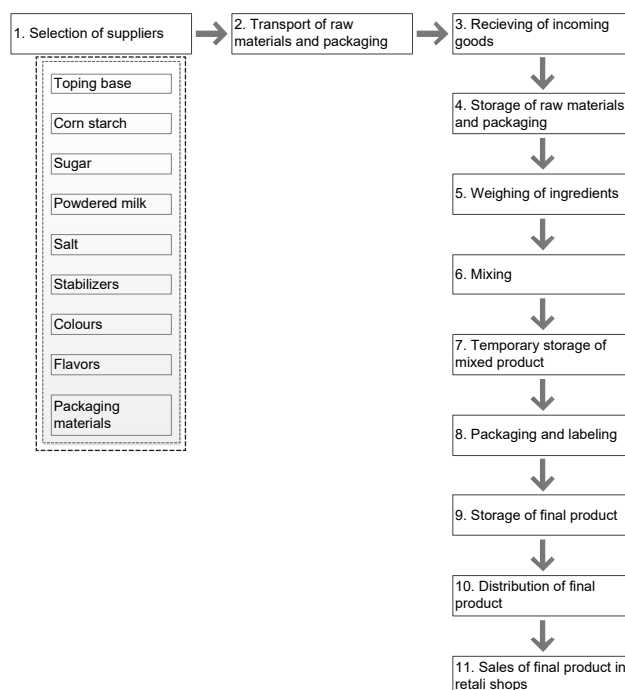
No.	Threats from	Possible method of operation
	Hackers	• Attack on the company's website
	Competition	• Negative advertising campaign, damage to products in retail
	Criminal groups	• Counterfeiting products, misuse of packaging
	Ideologically motivated groups (terrorist groups)	• Recruiting company staff for terrorist acts in connection with intentional contamination of food

Table 2. List of potential threats to company location and product

No.	Threats to location and product	Possible method of operation
	Production staff (first line)	<ul style="list-style-type: none"> • Possible intentional product contamination • Theft • Deal with customers and alienation of products
	Temporarily employed workers	<ul style="list-style-type: none"> • Possible intentional product contamination • Theft • Deal with customers and alienation of products • Cooperation with ideologically motivated groups (terrorists) • Cooperation with criminal groups
	Fired workers (ex-workers)	<ul style="list-style-type: none"> • Cooperation with ideologically motivated groups (terrorists) • Cooperation with criminal groups • Attack on company location and company staff
	Workers of service companies	<ul style="list-style-type: none"> • Theft • Possible intentional product contamination
	Workers of the supplying company food for workers in the production	<ul style="list-style-type: none"> • Contaminated food for workers lead to the halt of the work process due to workers' diseases
	Ideologically motivated groups (terrorist groups)	<ul style="list-style-type: none"> • Intentional contamination of products or certain raw materials that are embedded in products
	Drivers for delivery vehicles for raw materials and packaging	<ul style="list-style-type: none"> • Theft • Transport of hazardous chemicals with raw materials and packaging material can lead to contamination
	Suppliers of raw materials	<ul style="list-style-type: none"> • The presence of undeclared allergens in raw materials • Inadequate warehouse insurance system at suppliers location
	Suppliers of packaging materials	<ul style="list-style-type: none"> • Presence of forbidden ingredients in foil for basic packaging of products • Inadequate warehouse insurance system at suppliers location

In the next step, the identification and graphic representation of the production chain of powder mixtures for the preparation of pudding and cream was performed (Figure 3), taking into account all raw materials

and packaging materials used in the process. The existing process flow diagrams that were developed in the HACCP study, but with some specifics and clear identification of the supply chain by suppliers were used.

**Figure 3. Flow diagram of process**

For each process step identified in the flowchart, identification of threats and vulnerability assessments was performed (Table 3).

After vulnerability assessment TACCP team perform threat assessment with methodology that is describe above (Table 4). In this step TACCP team identify preventive actions necessary to take in order to reduce risk of the threat.

Table 3. Threat identification and vulnerability assessment in process steps

Process step	Threat	Vulnerability	
		Opportunity for threat	Motivation for attack
Selection of suppliers	• Various	• Inadequate security protection of the supplier's facility	• Workers form production and storage, drivers
Transport of raw materials and packaging	• Unsecured trucks who deliver raw and packaging materials	• Inadequate transport vehicles	• Drivers
	• Transport of hazardous chemicals with raw materials and packaging material can lead to contamination		
Receiving of incoming goods	• Theft	• Inadequate security protection of company facilities	• Drivers • Storage workers
	• Unauthorized deliveries of raw materials and packaging materials	• Work with not approved suppliers	
Storage of raw materials and packaging	• Access to a warehouse to unauthorized persons	• Inadequate security protection of company facilities	• Storage workers • Drivers of deliver vehicles • Service company workers
	• Intentional contamination of product with poison chemicals (chemicals for pest treatment)		
Weighing of ingredients	• Intentional contamination of product with poison chemicals during weighing (chemicals for pest treatment, cleaning chemicals)	• Availability of chemicals for cleaning or poison chemicals for treatment of pests	• Worker on raw material weighing • Foreman • Lab technician
	• Intentional contamination of product with allergens	• Availability of allergen (gluten, sesame, soy, almond, celery)	
	• Weighing additive at a concentration higher than allowed	• Worker who perform weighing work alone	
Mixing	• Intentional contamination of semi-product with poison chemicals (chemicals for pest treatment, cleaning chemicals)	• Availability of chemicals for cleaning or poison chemicals for treatment of pests	• Workers on mixing final product
	• Intentional contamination of semi-product with physical contaminants (metal, glass)	• Inadequate control of material input into production area from workers	
Temporary storage of mixed product	• Intentional contamination of semi-product with poison chemicals (chemicals for pest treatment, cleaning chemicals) during temporary storage in a mobile silo	• Availability of chemicals for cleaning or poison chemicals for treatment of pests	• Worker on raw material weighing • Foreman • Lab technician • Maintenance workers • Temporarily hired workers
Packaging and labeling	• Intentional contamination of semi-product with physical contaminants (metal, glass) during packaging	• Inadequate control of material input into production area from workers	• Workers on packaging line
Storage of final product	• Access to the warehouse of finished products to unauthorized persons	• Inadequate security protection of company facilities	• Storage workers • Service company workers
	• Deliberately too long keeping the product in the warehouse before delivery	• Unsatisfactory company staff	
Distribution of final product	• Unauthorized access to company delivery vehicles	• Inadequate vehicle protection	• Ideologically motivated groups (terrorist groups) • Dismissed workers
Sales of final product in retail shops	• Intentional product contamination by packaging degradation by ideologically motivated groups	• The product is exposed in retail and easily accessible to people	• Ideologically motivated groups (terrorist groups) • Dismissed workers

Table 4. Threat assessment

Description of threat	Likelihood	Impact	Risk	Preventive action
Attack on the company website	3	3	Moderate risk	• Protecting of company website according to protocol
Negative advertising campaign	3	3	Moderate risk	• Taken measures according to emergency procedure
Counterfeiting of the product, misuse of packaging produced by the packaging suppliers	2	4	Moderate risk	• Taken measures according to emergency procedure • Supplier audit and proposal of measures for improvement of protection our brand packaging by supplier
Uninsured vehicle trailers for delivery of raw materials and packaging materials	3	3	Moderate risk	• Audit of transport service providers • Defining the requirements for the transport of raw materials and packaging within the framework of the transport contract
Transport of raw materials and packaging materials together with non-food products	2	3	Low risk	• Defining the requirements for the transport of raw materials and packaging within the framework of the transport contract
Theft of raw materials and packaging materials	2	4	Moderate risk	• Accompany unauthorized persons (e.g., visitors, contractors, personnel) to restricted areas • Protection of a company with a security service 24 hours • CCTV surveillance of all facilities and factory circuits
Unauthorized deliveries of raw materials and packaging materials	4	3	Moderate risk	• Supplier evaluation and purchasing only with approved suppliers. • Scheduled delivery with all approved suppliers.
Access to a warehouse to unauthorized persons	4	4	High risk	• Accompany unauthorized persons (e.g., visitors, contractors, personnel) to restricted areas • Protection of a company with a security service 24 hours • CCTV surveillance of all facilities and factory circuits
Contamination of raw materials with cleaning chemicals or chemicals for pest treatment during storage	2	5	High risk	• Store potential contaminants (waste, chemicals, pesticides, cleaning supplies, laboratory cultures) in separate and secured location immediately upon receipt and after use • Regular inspection of all traps for pest by internal staff and authorized external company
Intentional contamination of products during weighing with chemicals for cleaning or chemicals for pest treatment	2	5	High risk	• Hiring workers in the workplace in contact with food only with a certificate of impunity for criminal offenses • Training of workers who work on weighing on food defense • CCTV surveillance of facilities for weighing • Organoleptic testing of all batches of final product
Intentional contamination of products with allergens during weighing	2	4	Moderate risk	• Separate storage of allergens • Daily mass balance testing for all allergens by foreman
Intentional contamination of semi-products with physical contaminants (metal, glass ...)	2	4	Moderate risk	• Visually inspect equipment, equipment components, and supplies prior to use and report anomalies. • Using metal detector for detection at all production lines • Checking integrity of all glass and brittle plastic according to register monthly
Intentional contamination of semi-products with chemicals for cleaning or chemicals for pest treatment during temporary storage in a mobile silo	1	5	Moderate risk	• Use tamper-evident devices (seals, covers, locks) to secure packaging and storage containers
Intentional contamination of semi-products with physical contaminants (metal, glass ...) during packaging	2	4	Moderate risk	• Visually inspect equipment, equipment components, and supplies prior to use and report anomalies. • Using metal detector for detection at all production lines • Checking integrity of all glass and brittle plastic according to register monthly
Access to the warehouse of finished products to unauthorized persons	2	4	Moderate risk	• Accompany unauthorized persons (e.g., visitors, contractors, personnel) to restricted areas • Protection of a company with a security service 24 hours • CCTV surveillance of all facilities and factory circuits
Deliberately keeping the product in the warehouse before delivery	3	2	Low risk	• Using bar code system in preparation product for delivery • Internal audit of process storage of final product according to program of internal auditing integrated management system
Unauthorized access to delivery vehicles while parked	2	4	Moderate risk	• Use an alarm system to monitor and detect suspect events • Locking the vehicle during parking and managing the keys according to the procedure • Protection of a company with a security service 24 hours • CCTV surveillance of all facilities and factory circuits
Intentional product contamination by packaging degradation by ideologically motivated groups (terrorist attack) in retail	2	5	High risk	• Recall of product according to procedure for recall

All preventive measures that are defined during the assessment of the threat are comprehensively part of the food defense plan. The key elements contained in the food defense plan relate to:

- Facility plan management.
- Contact information for emergency assistance.
- Personnel security procedures.
- Information technology security procedures.
- Outside facilities security.
- Inside facilities security.
- Processing areas security.
- Final product storage security.
- Chemical storage security.
- Shipping and receiving areas security.
- Evacuation plans.
- Medical emergency plan.
- Guard service security and training.
- Business continuity and recovery plans.

In addition to the food defense plan as very important elements of food protection against intentional contamination are the procedures defined in the food safety management system related to:

- Product recall and withdrawal.
- Procedures related to traceability.
- Testing plan (chemical analysis, microbiological analysis and organoleptic testing).
- Procedures for management with physical contaminants such as control of foreign metal bodies and management with glass and brittle plastic.

The effectiveness of the food defense plan is carried out in the framework of internal audit quality and food safety management system. The checks carried out during the internal audit relating to the verification of compliance with the defined food defense plan, the testing of alarm systems related to the security of the facility and the protection of the information system have shown that the system is fully operative and functional.

4. Conclusions

- The Food Defense Plan, together with food safety components, and the food quality, constitutes a complete integrated system of quality and food safety management system.
- The key identified advantages of the implemented system for the protection of food against intentional contamination are the higher level of protection of the health of consumers, protection of employees and the brand of the company, increasing the level of readiness for responding in emergencies and certainly increas-

ing the level of compliance of business with the legal regulations.

- Certainly, ensuring food safety against intentional contamination cannot be achieved in an adequate way only by the measures taken by food business operators. It is necessary to integrate the activities of food business operators, security agencies, police structures, inspection bodies and many others.

- In Bosnia and Herzegovina, the importance of adequate food protection against intentional contamination has not yet been recognized. Only companies that are certified according to the requirements of one of the standards approved by the Global Food Safety Initiative (GFSI), which contain requirements for the protection of food from intentional contamination, have implemented these measures.

- In the education system, elements relating to the food safety system against intentional contamination are not yet recognized and included. Educational institutions should incorporate food defense in their curricula. There are critical factors at all levels of the food chain so one cannot prevent intentional contamination and food fraud without regulated legal provisions and effectively written procedures (Bogadi *et al.*, [7]).

- In order to protect the food supply chain, the roles of all stakeholders must be clearly defined: (a) emergency planners, responders, and receivers; (b) food manufacturers, distributors, and other related fields; and (c) public health, laboratories, and government agencies at all levels (Feinman, [8]).

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