

## A Flexible Approach to the HACCP Principles for the Ready-to-Eat Food Enterprises

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doi: 10.71168/NAB.03.02.145

**Received:** January 30- 2026**Accepted:** March 05- 2026**Published Online:** March 16- 2026

**Abstract:** The Codex Alimentarius Commission (CAC) defines ready-to-eat (RTE) foods as raw or processed foods that are prepared, handled, or cooked and intended for consumption without any further processing. However, RTE providers that are in a class of Small and Medium Sized Enterprises (SMEs) could pose a risk for bacterial spoilage on manufacture line, especially when it comes to spoilage and contamination, because of many different types of raw material in the processing, such as poultry, beef, dairy, etc., and their own microbiological risks. According to data from the Food Safety Information System in Turkey, the number of RTE meal enterprises has increased markedly, from 2275 in 2019 to 17417 as of January 26th, 2026, surpassing the growth observed in catering establishments, which rose from 377 in 2019 to 4013 as of January 26th, 2026. The rapidly increasing role of RTE meal providers in the food supply chain emphasizes public health implications associated with this sector. Therefore, food safety management practices in RTE meal providers, particularly through the effective implementation of fundamental HACCP principles, are essential to ensure consumer health protection and prevent foodborne illness risks. The objective of this study was to present food safety management system practices related to the hazard analysis flexibility approach to the Codex HACCP principles for the RTE providers. For this purpose, regulatory requirements and audit-based observations, common non-conformities have been identified according to the EU Regulations and Guidelines for Food Safety Control Measures, CAC Notices for food retail activities, and the 5996 Law on Veterinary Services, Plant Health, Food, and Feed. Prerequisite programs and a flexibility approach based on HACCP principles were evaluated and practices for controlling PRP and foodborne hazards in ready-to-eat food establishments have been presented. It is expected to be a useful tool for SMEs, especially RTE food enterprises.

**Keywords:** Ready-to-eat foods, Small and Medium Sized Enterprises, Food safety management system, Prerequisite programs, Flexible approach, the Codex HACCP principles.

### Introduction

The COVID-19 pandemic has led to a significant shift in food consumption habits; in particular, there has been an increase in demand for small-scale businesses operating locally, which produce and distribute food within their regions. Disruptions in global supply chains during the pandemic have led consumers to place greater emphasis on reliability, continuity, and traceability in accessing food, bringing local production and distribution models to the forefront [1]. However, this increased demand has also made it increasingly important to assess the adequacy of these businesses in terms of food safety practices, hygiene standards, and official food safety controls [2]. The number of ready-to-eat food (RTE) enterprises has increased from 2287 in 2019 to 14,935 in 2025, higher than the number of catering establishments in Turkey (from 374 in 2019 to 3571 in 2025) [3]. The total number of RTE enterprises (where food is prepared in a central facility and distributed) and the catering sector has increased, and the number of RTE enterprises has also increased significantly [4].

Foodborne pathogens have caused many diseases in humans, leading to significant health problems and economic burdens globally. The World Health Organization (WHO) reports that approximately 600 million people (almost 1 in 10) contract foodborne illnesses each year, with 420,000 deaths.

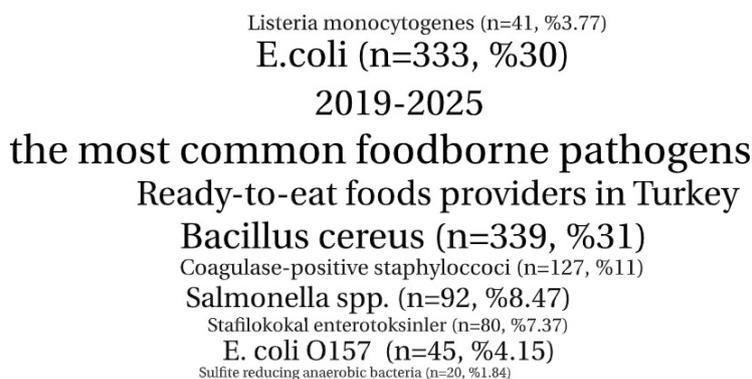
Contaminated foods lead to physical, chemical, microbiological, and allergic reactions to more than 200 diseases. Most microbiological foodborne outbreaks are reported due to *Clostridium perfringens*, *C. botulinum*, *Brucella* spp., *Staphylococcus aureus*, *Listeria monocytogenes*, *Salmonella* spp., *Yersinia enterocolitica*, Pathogenic *E. coli* strains, *Campylobacter jejuni*, *Vibrio cholerae*, *V. parahaemolyticus*, *Mycobacter tuberculosis*, *M. bovis*, *Shigella* dysenteriae, parasites, viral agents, and microbial toxins such as mycotoxins, histamine etc. [5,6,7].

Due to limited general and special hygienic necessities in RTE enterprises, such as inadequate manufacture area, non-hygienic building design, insufficient personnel hygiene applications, unappropriated cold chain conditions, inadequate handling and post-cooking storage, a improper heating of foods, difficulties in serving large quantities of food at safe temperature and time combination, cross-contamination while preparing raw materials, and catering operators bring to the risk of foodborne diseases. RTE foods have also been implicated in food-borne diseases. *Bacillus cereus*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Salmonella* spp., *Shigella* spp., *Escherichia coli*, *Clostridium* spp., *Campylobacter* spp., and *Vibrio* spp., common bacteria that cause food-related illness, were the most frequently detected contaminants within the category of the ‘ready-to-eat’ food [8,9,10,11,12,13,14,15,16]. *Salmonella* spp. and *Campylobacter* spp. were the most frequently isolated from foodborne outbreaks in EU Member States for 2015-2019 (Figure 1) [17].



**Figure 1:** The number of foodborne pathogens in EU Member States in 2015-2019 by a word cloud generator (www.wordart.com , accessed on 24 January 2026).

*Bacillus cereus*, *E. coli*, and Coagulase-positive staphylococci were the major foodborne pathogens in ready-to-eat food meals produced in RTE enterprises and the catering sector between 2019 and 2025 in Turkey (Figure 2) [18].



**Figure 2:** The number of foodborne pathogens in Turkey in 2019-2025 by a word cloud generator (www.wordart.com , accessed on 24 January 2026).

The ready-to-eat food sector, where food prepared in a central facility is distributed, is in the category of small businesses where it is not possible to define critical control points [19].

In small and medium-scale enterprises (SMEs) where it is not possible to define critical control points, a flexible approach is applied in the implementation of a system based on HACCP principles. In small businesses where it is not possible to define critical control points, a flexible approach is applied in the implementation of a system based on HACCP principles [20,21,22,23]. Instead of monitoring critical control points, these businesses can perform the first stage of the HACCP procedure, the hazard analysis, by implementing good hygiene practices (prerequisite programs) and ensuring the control of food hazards [11,19].

The Commission Declaration on the implementation of food safety management systems, including Prerequisite Programs (PRPs) and procedures based on HACCP principles, adopted in 2016 (including ease/flexibility of implementation in some food businesses), provides practical guidance on how to implement PRPs that should result in an integrated Food Safety Management System for every food business [24,25,26,22,27].

The nature and the size of the food business must be considered when verifying compliance with the procedures based on the HACCP principles in accordance with Regulation (EC) No 852/2004. The regulation refers to the need for flexibility for the application of procedures based on the HACCP principles in the case of SMEs. It is necessary to recognize that in certain food businesses, it is not possible to identify critical control points (CCPs) and that, in some cases, GHP or PRPs in general can replace the monitoring of CCPs [28,29,30].

It has been observed that there is a lack of adequate guidance on technical and regulatory requirements regarding the control of PRPs and foodborne hazards in RTE (Refrigerated Equipment Manufacturer) facilities. Therefore, this study aims to improve the prevention of foodborne hazards, conduct a SWOT analysis in terms of food safety requirements, and provide a simplified and flexible approach to HACCP principles.

This study is designed as an applied, practice-focused assessment of PRP/HACCP flexibility implementation in RTE catering establishments and aimed to simplify HACCP principles in preventing foodborne hazards in businesses in the ready-to-eat food enterprises. This article presents examples of best practices for controlling foodborne hazards according to a flexible approach, considering EU directives.

### **A Swot Analysis in Terms of Food Safety for Ready-To-Eat Food Enterprises**

RTE food providers represent one of the most critical categories of the food supply chain in terms of food safety. Due to large-scale production, holding times, and service to vulnerable consumer groups, this sector requires robust, practical, and risk-based food safety management systems. In this section of the study attempt is made to analyze the strengths, weaknesses, opportunities, and threats of the RTE food enterprises. On one side, strengths and weaknesses reflect the internal factors, and on the other hand, opportunities and threats throw light on the external factors. Identification of SWOT is necessary as it will help in achieving subsequent steps in planning the development and growth of the sector [31].

According to international reports, food service and mass catering are among the food sectors most frequently associated with foodborne outbreaks, particularly those of microbiological origin. Preparing and serving food for large population groups, such as in schools, universities, dormitories, hospitals, and workplace canteens, increases the potential consequences of food safety breaches. Foodborne poisonings also lead to the loss of healthy life years and can affect the health of future generations. In addition, they strain health systems and have negative impacts on national economies, tourism, and trade [32].

A significant source of foodborne illnesses and foodborne spoilage is a reason for insufficient hygiene conditions at businesses at any stage in the food chain. A kitchen management system that prevents foodborne hazards and ensures the supply of safe food to consumers plays a critical role. Common deficiencies frequently identified in relation to the causes of foodborne illnesses in cafeterias and mass consumption areas are related to pre-service kitchen management (PRPs) and oPRP.

The Strengths, Weaknesses, Opportunities, and Threats (SWOT) perspectives of the RTE sector were below:

#### **Strengths**

- 1. Standardized workflow plan, processing steps, predefined recipes:** This repetition enhances process predictability, facilitates hazard identification, and supports the implementation of preventive controls, particularly for critical steps such as cooking, cooling, storage, and distribution.
- 2. The widespread application of thermal processing constitutes:** Most RTE meals undergo a cooking step capable of effectively inactivating vegetative pathogens such as *Salmonella* spp. and *Escherichia coli*.
- 3. More frequent inspections and controls in educational and health institutions:** When RTE providers serve the Educational and health institutions, they are controlled by competent authorities more frequently, so managerial awareness of food safety obligations increases.
- 4. Concern about protecting trade names:** At the managerial level, there is typically a strong awareness that food safety failures may lead to severe legal, reputational, and contractual consequences, especially in public procurement and branded catering services.

#### **Weaknesses**

- 1. Inadequate PRP conditions, the risk of cross-contamination:** The following factors contribute to the unsatisfactory conditions of the facility: inadequate infrastructure, design, location, and layout (e.g., dishwashing and pre-processing areas being intertwined), insufficient compliance checks of raw materials, auxiliary materials, or components with legal regulations, inadequate label literacy, lack of a unique workflow plan, insufficient personnel hygiene practices and training, lack of organization in supply chain traceability records, deficiencies in label information for products prepared and stored in different grammages (e.g., failure to specify the expiration date as determined by the facility), inadequate checks of the potable quality of the water used in the facility, failure to consider compliance checks with the temperature conditions,

specified on the labels of raw materials, components, intermediate and final products, storage of unreliable products without appropriate identification such as “destruction or return labels,” inadequate checks of the suitability of the heat treatment conditions under which food is served, and failure to perform appropriate thawing procedures for frozen foods.

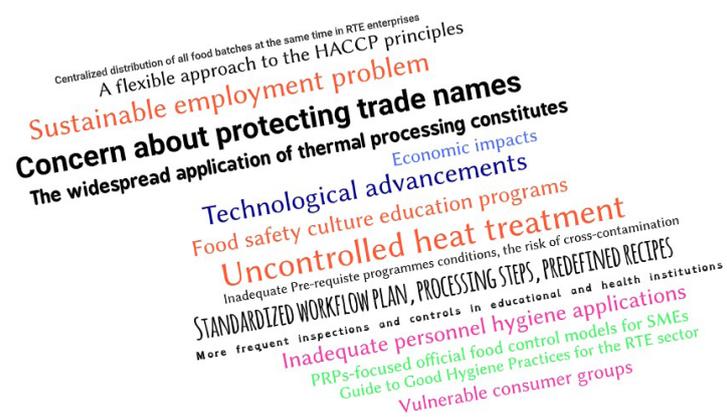
2. **Uncontrolled heat treatment:** Weakness of the RTE providers to regularly control the relevant essential parameters, especially temperature, pressure, sealing, and microbiology, results in foodborne hazards. The workflow steps in RTE manufacturing are crucial for foodborne hazards. Heat treatments in purchasing, storage, preparation, cooking, cooling, keeping warm in safe conditions, and serving hot and cold food affect foodborne hazards. Sometimes reheating applications cause ideal conditions for the growth of spore-forming pathogens such as *Clostridium perfringens* and *Bacillus cereus* if temperature control is inadequate.
3. **Inadequate personnel hygiene applications:** Failure of employees in workplaces to comply with cleaning and hygiene rules, failure to use appropriate, clean work clothes and protective clothing (hairnet, mask, shoe covers, gloves, etc.), lack of hand hygiene, workplace behavioral errors, lack of knowledge about legislation, the training certificate being deemed sufficient by the public authority- failure to ensure continuity in training, and the workplace authority not regularly checking whether employees comply with workplace instructions are all contributing factors. These conditions increase the risk of poor personal hygiene practices and contamination by pathogens such as *Staphylococcus aureus* and fecal coliform bacteria.
4. **Sustainable employment problem:** RTE enterprises, in the SME enterprises group, often employ staff at low wages. Therefore, frequent staff turnover can occur, leading to disruptions in standard food safety practices.
5. **Regulatory knowledge:** There is a lack of both regulatory and technical knowledge regarding the simplified HACCP flexibility approach.

### Opportunities

1. **Food safety culture education programs:** Behavior-based training, increasing staff’s sense of responsibility regarding food safety.
2. **A flexible approach to the HACCP principles:** The HACCP flexibility approach is an important way to ensure food safety for SMEs. This approach allows businesses to focus resources on the most relevant hazards and control measures without compromising food safety objectives. Emphasizing critical PRPs such as time & temperature control, hygiene practices, and cleaning effectiveness can yield greater risk reduction than rigid adherence to complex HACCP documentation.
3. **PRPs-focused official food control models for SMEs:** In the official controls of SMEs, audits consider the HACCP Flexibility Approach, which includes PRPs and the control of foodborne hazards, as the basis, rather than a full HACCP system audit. Inspections that prioritize actual practices rather than the mere presence of documents can drive meaningful improvements in hygiene performance.
4. **Technological advancements:** Digital temperature monitoring systems, simple sensors, automated alarms, and electronic traceability tools reduce reliance on manual records and improve real-time control over critical parameters, and support food safety enhancement.
5. **Guide to Good Hygiene Practices for the RTE sector:** Guidelines for the development of Community guides to good practice have been prepared together with the EU countries. Guides to good practice have the potential to play an important role in supporting effective application of the new EC hygiene regulations, and the Commission encourages the EU feed and food business sectors to take the initiative to develop such guides.

### Threats

1. **Vulnerable consumer groups:** The most significant external threat is their service to vulnerable consumer groups, including children, the elderly, and hospitalized individuals. For these populations, even low levels of pathogens such as *Listeria monocytogenes* may result in severe or fatal outcomes.
2. **Centralized distribution of all food batches at the same time in RTE enterprises:** A mistake at the center kitchen of RTE enterprises has the potential for a foodborne outbreak. Furthermore, certain hazards are not eliminated by standard heat treatments, including heat-stable toxins produced by *Bacillus cereus* and staphylococci, as well as biogenic amines such as histamine.
3. **Economic impacts:** Supply chain disruptions and food-price inflation have put economic pressure on SMEs. Local vendors have been facing significantly rising input costs and find it increasingly difficult to maintain profitability in the current landscape. Moreover, the SME manufacturers. Decreasing economic inflation may lead to insufficient hygiene infrastructure, monitoring equipment, or staff training. In such contexts, food safety may become unsustainable [21].



**Figure 3:** SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis of the Ready-to-Eat Food enterprises.

The SWOT analysis clearly demonstrates that food safety in the RTE food sector is determined less by the complex HACCP plans and needs more effective PRPs, periodic time-temperature control, the management of human behavior, and is supported by a strong food safety culture. Food safety culture was observed to be procedural rather than behavioral. Furthermore, the findings indicate that food safety culture remains insufficiently embedded in key operational areas such as food preparation, material handling, cold chain control, and the controlled application of heat treatment. Sustainable food safety requires not only documented procedures but also long-term commitment, awareness, and accountability across all levels of personnel. Inadequate implementation of PRPs and operational PRPs (oPRPs) may significantly increase microbiological risks and the likelihood of foodborne illness.

### A Flexible Application of Haccp Principles for RTE Enterprises

Recital 15 of Regulation (EC) No 852/2004 clearly recognizes that CCPs might not be identified in certain FBOs. In such a business, hazard analysis, which is the first principle, could be enough for the application of procedures based on the HACCP principles [33].

Food safety is primarily ensured through effective PRPs, supported by simplified hazard analysis and exception-based documentation, rather than complex Critical Control Points (CCPs-focused systems for SMEs. Foodborne hazard analysis provides comprehensive monitoring that integrates food processing stages for effective control of foodborne hazards, such as in the ready-to-eat food sector, where food prepared in a central facility is distributed, and in establishments where on-site food is handled. Hazard analysis involves collecting and evaluating information on hazards identified in raw materials and other ingredients, the environment, the process, or the food, and the conditions that lead to their presence to determine whether they are significant hazards [25,34]. The HACCP requirements should take account of the principles contained in the Codex Alimentarius (-Commission Staff Working Document on the Understanding of certain provisions on flexibility provided in the Hygiene Regulations Frequently Asked Questions Guidelines for Food business operators Accompanying the document Regulations (EC) No 852/2004 of the European Parliament and of the Council on the hygiene of foodstuffs and Regulation (EC) No 853/2004 of the European Parliament and of the Council laying down specific hygiene rules for food of animal origin, Regulation (EC) No 853/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific hygiene rules for food of animal origin,- Guidelines for the Validation of Food Safety Control Measures (CAC GL 69-2008), Commission Notice providing guidance on food safety management systems for food retail activities, including food donations (2020/C 199/01) on the implementation of safety management systems covering Good Hygiene Practices and procedures based on the HACCP principles, including the facilitation/flexibility of the implementation in certain food businesses (2022/C 355/01), European Commission Notice on the implementation of food safety management systems covering prerequisite programs (PRPs) and procedures based on the HACCP principles, including the facilitation/flexibility of the implementation in certain food businesses (2016/C 278/01) [33,35,36,22,37,27,38]. They should provide sufficient flexibility to be applicable in all situations, including in small businesses.

This part of the study provides support for RTE enterprises in applying HACCP principles using a flexible approach in accordance with EU food hygiene legislation EC 852/2004, EC 853/2004, and EC guidance documents. Food safety management practices in the RTE enterprises with a flexible approach were presented in this section. The methodology is also based on direct observation throughout by official food control. The obtained information and detection were adjusted into the simplified form of a food safety management system for RTEs based on PRPs and hazard analysis.

The following section was presented to reveal practical HACCP-based procedures for RTE sector:

## Preliminary Activities

### 1. Assembly of a HACCP team

The RTE Food Safety Management Team is assembled to ensure the effective implementation, maintenance, and verification of the food safety management system. The team is composed of personnel with appropriate knowledge of RTE food production, hygiene practices, HACCP principles, and regulatory requirements. The team is responsible for: Conducting hazard analysis specific to RTE products; Developing, implementing, and reviewing PRPs and the HACCP plan; Defining foodborne hazards, food safety criteria, and monitoring procedures, ensuring staff training and food safety awareness, managing corrective actions, verification, and documentation, ensuring compliance with applicable food safety legislation, management provides the team with the necessary authority, resources, and training to fulfil its responsibilities effectively.

### 2. Description of the product (s) at the end of the process (called hereafter 'end product')

A full description of the end product should be drawn up, including relevant safety information (origin of ingredients, origin of ingredients/raw materials, processing, packaging, storage and distribution conditions, including transport and handling, required shelf life, instructions for use, any microbiological or chemical criteria applicable).

**For example, dry beans with meat meal were described as follows:**

**Ingredients:** Dry beans (44%), marrowbone water, beef (4%), onion, tomato paste, vegetable oil (sunflower oil), tomato, butter, wheat (gluten), salt, sugar, spice mixture.

**Allergen hazards:** It could be an allergic reaction cause of including wheat (gluten).

**Origin of ingredients:** Domestic.

**Processing:** The dried beans are soaked in hot water overnight. The onion is chopped and sautéed in a pressure cooker with oil. Diced meat is added and lightly sautéed. Tomato pastes and spices are added, then the dried beans are added. Enough hot water is added to cover the beans, and they are cooked for 30-40 minutes.

**Storage and/or service:** Cooked dry beans with meat will be served hot, and keep safety temperature of at least 72°C, holding max 2 hours.

**Distribution conditions:** The meal is distributed in thermobox containers that maintain the temperature for at least 3 hours.

**Shelf life:** Max 2 days in cold storage conditions.

**Instructions for use:** Directly to the consumer.

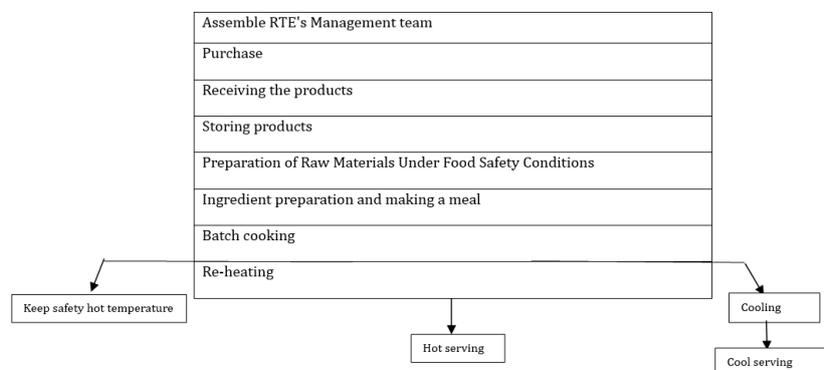
**Microbiological and/or chemical criteria applicable:** Unique consistency, color, smell, texture, taste.

### 3. Identification of intended use

Dry beans with meat meals are not suitable for consumers who may be allergic or have an intolerance to gluten.

### 4. Construction of a flow diagram (description of manufacturing process)

When in the 'classical approach', flow diagrams summarizing the different stages, from raw material to end-product, are represented systematically, the 'simplified approach' also uses flow diagrams to provide an overview of the stages/processes used in each retail establishment. Figure 4 shows a sample of a kitchen flowchart. The flowchart for SMEs takes into account the regulation (EC) No 852 and 853/2004 on the hygiene of foodstuffs, particularly requirements related to PRPs, staff training, hygienic practices, and hazard control requirements.



**Figure 4:** A sample of a kitchen flowchart.

This flow diagram describes the sequential stages of kitchen operations from material receipt to production management, focusing on the implementation of PRPs and the control of foodborne hazards. The diagram is designed in accordance with a flexible approach to the HACCP principles and is suitable for the Codex legislation. The simplified flexible approach did not require a detailed description of the activities at each stage, but instead used the flow diagrams to guide the development of an RTE enterprise's food safety management system.

## 5. On-site confirmation of flow diagram

After the flow diagram has been drawn up, the HACCP team or FBO should confirm it on site during operating hours. Any observed deviation must result in an amendment of the original flow diagram to make it accurate.

### Hazard analysis

The food business operator must identify biological, chemical, and physical hazards that may affect food safety in the production, processing, and distribution processes. RTE providers should put in place, implement, and maintain a permanent procedure with a flexible approach to the HACCP principles [22,27,38].

According to the flexibility approach, SMEs or low-risk FBOs are not expected to use complex risk matrices, quantitative assessment methods, or detailed decision trees in the hazard identification phase. Under the “simplified approach,” good hygiene practices guides and HACCP guidelines prepared for the relevant sector can be used as a basis, and the hazards defined in these guidelines can be adapted and applied to the business’s own operations. In this context, the food business operator does not need to conduct a risk analysis; adopting the hazards defined in sector-specific guidelines and applying them in a way that suits the business conditions is sufficient. For example, keeping raw and cooked meat in separate cabinets, regularly cleaning and disinfecting cutting boards, and using simpler methods such as “visual inspection” instead of continuous measurement and recording to monitor critical limits such as temperature are sufficient.

Traceability is a legal requirement EC directive in EU Member States and also Law No. 5996 in Turkey. According to the flexibility approach, keeping regular daily records is practically impossible for small businesses. However, the “Exception Record” approach can be applied for records kept in case of deviations from critical limits, within the framework of the HACCP flexibility approach [39,27,38]. Some of the traceability records include temperature records, personnel hygiene records, raw material acceptance records, delivery notes and invoice records, raw material input-output records, and product formulations. For example, a Veterinary Health (Slaughter) Report obtained from the butcher for food safety controls of red meat carcasses accepted into a canteen, the suitability of the temperature and hygiene requirements of the logistics conditions, visual inspections, and reports recorded only in case of deviations from critical limits can be considered sufficient for controlling foodborne hazards in the supply chain [39].

The following part contains how the RTE providers should assess to determine foodborne hazards, considering a flexible approach to the Codex HACCP principles (EC No 852 and 853/2004, EC2016/C 278/01, EC 2020/C 199/01, EC 2022/C 355/01, Hazard analysis approaches for certain small retail establishments in view of the application of their food safety management systems [39].

### 1. Purchase and receiving the raw materials, ingredients, and packaging materials

Purchasing activities are conducted based on predefined product specifications and intended use. Approved suppliers are selected through documented evaluation procedures. Raw material acceptance and verification are performed in compliance with Law No. 5996 on Veterinary Services, Plant Health, Food, and Feed [25]. (OG, 2010). This stage ensures traceability, legal compliance, and supplier control, thereby reducing upstream food safety risks. RTE enterprises should work with reputable suppliers who follow strict food safety standards; they should be verified their certifications and quality control measures. Controls include verification of delivery conditions, temperature compliance, packaging integrity, labeling accuracy, and shelf life. Non-compliant materials are rejected or placed under quarantine. Acceptance of raw material under food safety conditions prevents, eliminates, or reduces foodborne hazards to acceptable levels. Through the integration of PRPs, this step ensures that food safety risks are systematically managed before further processing or production.

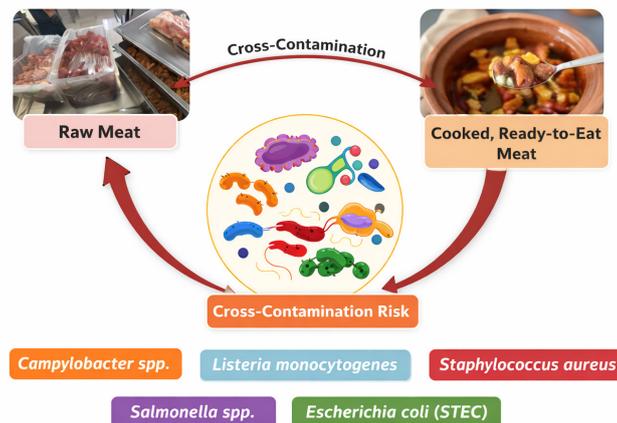
### 2. Storing products

Materials are stored under controlled conditions, considering temperature, humidity, and hygienic requirements. FIFO/FEFO principles are applied to ensure proper stock rotation. Allergenic, raw, ready-to-eat, and non-food materials are segregated to prevent cross-contamination. Non-conforming materials are promptly removed from storage areas. This stage supports the control of microbial growth and cross-contamination hazards.

### 3. Preparation of Raw Materials Under Food Safety Conditions

The preparation of raw materials is a critical step in food production where foodborne hazards may be introduced, survive, or increase if not properly controlled. This stage is therefore managed through PRPs and, where applicable, HACCP-based controls. During raw material preparation (washing, cutting, mixing, portioning), the following hazards are must be considered: Pathogenic microorganisms (e.g. *Salmonella* spp., *Listeria monocytogenes*, *E. coli*) originating from raw materials, equipment, hands of food handlers, or the environment (Biological hazard), Cleaning and disinfectant residues, pesticide residues, allergens due to cross-contact, or incorrect ingredient use (Chemical hazard), Foreign bodies such as metal fragments, plastic, glass, or stones introduced during handling or from damaged equipment (Physical hazard).

Most hazards at this stage are controlled through effective PRPs, including “Personnel hygiene and hand-washing procedures, Cleaning and sanitation of equipment and food-contact surfaces, Use of potable water for washing raw materials, Separation of raw and ready-to-eat foods, Allergen segregation and labeling, Controlled preparation areas and hygienic workflow”.



**Figure 5:** Sample of a common mistake, cross-contamination from raw meat to cooked, ready-to-eat meat.

#### 4. Ingredient preparation and making a meal

Ingredients are cleaned, cut, mixed, and prepared following established hygiene procedures. Personnel hygiene, sanitation of equipment, and appropriate use of food-contact surfaces are strictly enforced. Separation between raw and ready-to-eat preparation areas is maintained. This stage primarily controls microbiological contamination and physical hazards arising from handling activities. Food business operators can easily prevent hazards by meeting food hygiene requirements (PRPs) during the preparation phase.

#### 5. Batch cooking

Batch cooking is a critical processing step designed to eliminate or significantly reduce biological hazards through the application of controlled heat. Due to its direct impact on food safety, batch cooking is typically managed to control foodborne hazards. Batch cooking controls foodborne hazards through: Application of validated time-temperature combinations, stable heat distribution throughout the batch, use of calibrated cooking equipment, and controlled batch size to ensure adequate heat penetration. It should keep safety hot temperature. Control limits should be established and validated, for example: minimum internal temperature (e.g.  $\geq 75^{\circ}\text{C}$  at the coldest point), and minimum holding time (e.g.  $\geq 2$  minutes), or equivalent validated combinations. It should be proper monitoring, documentation, and verification guarantee that each batch meets established food safety criteria before proceeding to subsequent processing steps.

Re-heating is a critical food safety step intended to eliminate or reduce biological hazards that may have survived previous processing or developed during cooling and storage. When applied, re-heating must be strictly controlled and is generally managed as a control point. If reheating will be done, it will be performed under these conditions: Preventing cross-contamination after re-heating, food must be rapidly and uniformly re-heated to  $\geq 75^{\circ}\text{C}$  (or validated equivalent), monitored and recorded for each batch to control biological hazards, limiting re-heating to one cycle only, using equipment suitable for uniform heating, keeping food to a safe consumption temperature, ensuring homogeneous internal temperature throughout the product, and review of re-heating records. Reheating must be uniform and achieved at the coldest point of the food. Monitoring is carried out for every re-heating operation.

#### 6. Serving the food hot/cold forms

Serving is the final control step before consumption and is therefore critical for preventing time-temperature abuse and post-process contamination. General Hygiene rules (PRP Requirements) must be provided during serving; good personal hygiene of serving staff, use of cleaned and sanitized equipment, avoidance of hand contact with foods, protection against environmental contamination, allergen management, and declaration to the consumers. Food must be served under controlled hot or cold holding conditions to maintain safety until consumption. To prevent the growth of pathogenic microorganisms after cooking or re-heating, the meals must be kept hot at  $\geq 63^{\circ}\text{C}$  (or as defined by national legislation), use suitable hot-holding equipment (bain-marie, heated cabinets), minimize holding time, and protect food from contamination.

An accurate and verified process flow diagram is a prerequisite for effective hazard analysis. Without a realistic representation of the production process, hazard identification and control measures cannot be established.

## Results and Discussion

The main objective of this study is to examine HACCP Requirements Flexibility Approach” for the RTE food enterprises, where food is prepared in a central facility and distributed, and businesses handling food served on-site.

RTE food providers play an important role in public health. A food safety management system plays a crucial role in preventing contamination and foodborne illnesses at all stages of food production. The Hazard Analysis and Critical Control Points (HACCP) system is widely recognized as the most effective preventive approach to ensuring food safety. However, the classic and highly detailed application of HACCP can create practical challenges, particularly for small and medium-sized enterprises (SMEs), due to limitations in technical infrastructure, financial resources, and trained personnel. To overcome these challenges, regulatory authorities have introduced the concept of HACCP resilience, which enables the achievement of food safety objectives through alternative, risk-based measures, provided that the core principles of HACCP are not compromised [21,22,38]. Exception-based recording is effective only when supported by robust PRPs and routine visual verification. In line with the HACCP flexibility approach, the study supports the use of an “exception-based recording” system, whereby documentation focuses on deviations and corrective actions rather than routine, repetitive monitoring records. This approach reduces administrative burden while maintaining effective control, as long as key indicators such as equipment performance and temperature displays are regularly verified and corrective actions are promptly documented when deviations occur.

The most frequently observed deficiencies were related to PRPs, particularly cross-contamination control and personnel hygiene. Within this framework, food and beverage businesses are required to comply with general hygiene rules, maintain appropriate infrastructure and equipment, ensure personnel hygiene and training, and implement hazard analysis-based procedures.

National food legislation, harmonized with EU food law, sets out general and specific hygiene requirements for food businesses, defines the responsibilities of food business operators, and mandates the implementation of food safety management systems based on HACCP principles. The general and specific hygiene principles defined in the EC Directives (Food Hygiene Regulation, Regulation on Specific Hygiene Rules for Animal Foods, and requirements specified in Good Hygiene Practice Guidelines) ensure compliance with the PRPs requirements. Sustainable and successful PRP applications based on the first HACCP principles would be enough to provide food safety conditions for SMEs.

The results demonstrate that the HACCP flexibility approach provides a pragmatic and scientifically justified framework for managing food safety risks in catering operations. Rather than relying on complex hazard matrices or decision-tree models, a simplified, risk-based system, supported by sector-specific good hygiene practices, allows food business operators to focus on controlling hazard groups and high-risk process steps. In this context, the majority of foodborne hazards can be effectively managed through well-implemented PRPs, with targeted use of oPRPs where necessary.

## Conclusion

The findings of this study confirm that food safety challenges in ready-to-eat catering establishments, particularly small and medium-sized enterprises, are predominantly associated with weaknesses in Prerequisite Programs, including inadequate hygienic design, ineffective separation of raw and ready-to-eat foods, insufficient control of heat treatment processes, and inconsistent personnel hygiene practices. These deficiencies are further compounded by limitations in sustainable workforce management and gaps in regulatory and technical knowledge related to the practical implementation of HACCP flexibility.

The observed benefits of exception-based recording directly reflect the principles described in the 2016 Commission Declaration. This study also highlights the importance of aligning food safety management systems with the Commission Declaration adopted in 2016, which promotes flexibility in the application of PRPs and HACCP-based procedures according to the nature and size of the food business. The adoption of this guidance supports the development of integrated food safety management systems that are both compliant with EU legislation and operationally feasible for SMEs.

In conclusion, simplified HACCP implementation, grounded in strong PRPs, effective food safety culture, and proportionate documentation, would represent a robust strategy for improving microbiological food safety in ready-to-eat catering enterprises. Future research should prioritize quantitative evaluation of PRP effectiveness and the development of sector-specific guidance to further support food business operators and regulatory authorities in achieving sustainable food safety outcomes. There is a need for studies on sector-specific HACCP decision-tree alternatives, implementation guidelines, and official control data analysis of foodborne incident/outbreak data in the RTE (Refrigerated Transport and Infectious Diseases) sector.

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