HOTHREAT
CBRN

Food protection guidelines for hotels

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Document introduction

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Project consortium

Research, expertise, technology providers

End-users

Law enforcement agencies

The material for this publication was developed and reviewed by the HOTHREAT consortium:

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University of Lodz	PL
Dynamic Safety Corporation	PL
Polaris Hospitality Enterprises	PL
Hotel Boss	PL
Safety Core	PL
International Security and Emergency Management Institute	SK
National Institute of Aerospace Technology	ES
Atiram Hotels	ES
The Center for Security Studies	EL
Hellenic Police	EL
Konngruent	RO
Sigoria Security Solutions	PL
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The Nicosia Tourist Board	CY
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1. Introduction

Hotels, leisure, and conference facilities have historically been targets of terrorist attacks, and the threat level continues to rise. Due to its characteristics, this sector is vulnerable to attacks as during the last 25 years over 160 attacks were conducted[1]. Chemical, biological and radiological/nuclear (CBRN) threats are emerging risks that the European public must take into consideration. Notably, the use of those agents can be often combined with explosive devices, leading to CBRNe threats.

The HOTHREAT project aims to address the existing gap in the protection of hotels from CBRNe terrorist threats by bringing together a consortium composed of private and public entities, experts, end-users, security companies and law enforcement agencies (LEAs). Indeed, the Consortium is composed of 19 partners from 8 EU Member States.

The main objective of HOTHREAT is to increase the safety of EU Member States (MS) society from CBRNe threats by targeting hotels and conference centres. To do so, during the project cycle, comprehensive vulnerability and needs analysis will be conducted as well as best practices identification in order to elaborate tailor-made measures for CBRNe protection. The measures include recommendations for prevention, protection and response procedures. Moreover, CBRNe measures include recommendations for the adoption of protective equipment, multi-service communication models, programmes for VIP visits, cleaning services, food defence, epidemiology inquiries and CBRNe emergency application for mobile devices integrated with AR. Finally, training sessions will be delivered for hotel employees through a series of piloting and large-scale exercises to ensure the adoption of high-quality and well-addressed measures.

Specifically, Work Package (WP) 3 is the core of the HOTHREAT project with the aim of creating a comprehensive system supporting hotel and conference centres against CBRNe. This system is composed of 5 guidelines addressing CBNRe risks as follows:

- Recommendations for prevention, protection and response procedures to CBRNe terrorist acts
- Food protection guidelines
- Guidelines for epidemiological enquiry
- CBRNe VIP protection Programme
- Cleaning services recognition & reaction Programme

The document at hand represents a key project legacy thus contributing to the creation of a comprehensive system supporting hotels and conference centres against CBRNe risks by providing adequate guidelines.

[1] W. Michael Jr., S. Tibbles Hotels At Risk: The Legal Consequences Of Terrorist Attacks. https://vlex.com/vid/hotels-at-risk-the-650717569

2. Executive summary

Food safety / security in hotel restaurants is a key element for ensuring the health, safety and satisfaction of guests. It requires meticulous attention at every stage of food processing starting from the supply of raw materials and ending on to the serving of ready-to-eat food. This report covers the key aspects and challenges of ensuring high food safety standards, analyses the risk in hotel restaurants' food chain and provides the guidelines to mitigate the risk of intentional/unintentional food contamination by chemical, biological and radiological agents.

The first step in ensuring food safety is to control the quality of raw materials. Hotel restaurants should establish partnerships with trusted suppliers that adhere to appropriate hygiene and safety standards. Regular audits and inspections of supplies are essential to ensure that raw materials are fresh, free of contamination and properly stored.

Proper storage of raw materials plays a key role in preventing intentional/unintentional food poisoning. Hotel restaurants must observe proper storage temperatures, avoid cross-contamination, and follow the FIFO (First In, First Out) principle to ensure that older products are eaten before newer ones. In addition, care must be taken during the transportation of raw materials to ensure proper protection and temperature control to avoid spoilage.

Hotel restaurant staff should follow strict standards of personal hygiene. Regular hygiene training, including hand washing, CBRN threat awareness training, wearing appropriate protective clothing and keeping workstations clean, is essential to prevent the transmission of bacteria and other contaminants to food.

Proper cooking procedures, such as cooking temperature, frying and refrigeration, should be followed during whole food process preparation. Ensuring proper temperatures and cooking times is a key element to eliminate bacteria and other pathogens.

Hotel restaurants should conduct systematic monitoring and analysis of food safety risks. This includes tracking food poisoning incidents, monitoring refrigeration temperatures and monitoring staff hygiene. If an incident occurs, the restaurant should take immediate corrective action and inform the relevant sanitary and epidemiological services.

Food safety/security in hotel restaurants is not only a matter of compliance with sanitary regulations, and existing safety/ Hazard Analysis and Critical Control Points (HACCP) procedures but also a matter of concern for customer welfare and corporate reputation. Ensuring high food safety standards requires the involvement of all staff, close monitoring of processes and continuous improvement of procedures. Only in this way, the hotel restaurants gain the customers' trust and build a positive image in the food service and hotel market.

3. Introduction[2]

Chemical, Biological, Radiological and Nuclear (CBRN) agents are unique in their potential ability to inflict large numbers of casualties over a wide area with minimal logistical requirements and by means that can be virtually untraceable. Although wide area delivery may be technically challenging, the ease and low cost of producing an agent, the difficulty in detecting its presence and protecting (and treating) its intended victims, and the possibility to selectively target humans, animals, or plants conspire to make defence against this class of agents particularly difficult. As the economic gaps among nations grow and as some less advantaged nations seek a balance of power, there may be a tendency by these nations to overcome their disadvantage by choosing CBRN agents that can be produced easily and cheaply. The purely financial advantages of employing CBRN agents were clearly illustrated by a 1969 expert United Nations panel which estimated the minimum cost of attacking civilian populations at $1/km2 for biological weapons, versus $600/km2 for chemical, $800/km2 for nuclear, and $2,000/km2 for conventional armaments[3].

Dissemination is the process by which CBRN agents are dispersed to cause disease or intoxication. CBRN agents are most likely to be delivered covertly and through aerosols. The same routes of entry pertinent to the natural spread of diseases (that is, through inhalation, ingestion, or percutaneous inoculation) are also relevant when their etiological agents are delivered intentionally. Other routes of entry are thought to be less important than inhalation but are nonetheless potentially significant. CBRN agents can be delivered effectively by a wide range of platforms. The agent can be formulated as either a liquid or dry powder fill. The dissemination can be performed using simple or sophisticated spray devices, by an explosive charge, or simply packaged and delivered in regular mail. Depending on the efficiency of the delivery system used, some agents may be destroyed at the time of release, larger particles will fall to the ground producing local contamination and respirable particles generated will present predominantly as an inhalation hazard travelling long distances. Direct contamination of consumables, such as drinking water or foodstuffs, could be used to disseminate agents. Food CBRN incident is defined as an incident, which involves the threatened or deliberate release of a chemical, biological or radiological agent[4], while the food incident occurs, when concerns around the safety/security or quality of food may

[2] The chapter prepared on the basis of report 5.5 concerning Countermeasure procedures in case of food CBRN events – project Creation of CBRNE protection system for large area shopping malls IFS Grant Agreement No. 861643 – Mall – CBRN authored by University of Lodz.
[3] https://www.reachingcriticalwill.org/resources/fact-sheets/critical-issues/4579-biological-weapons
[4] Domestic Health Response Plan for Chemical, Biological, Radiological or Nuclear Incidents of National Significance.https://www.health.gov.au/sites/default/files/documents/2022/07/domestic-health-response-plan-for-chemical-biological-radiological-or-nuclear-incidents-of-national-significance-cbrn-plan.docx

require action to protect consumers[5]. Some foodstuffs, for example chocolate, can allow organisms to survive for long periods, and significantly reduce the number of organisms required to cause disease in case of biological agent[6]. This method of attack would be most suitable for sabotage activities and might be used against limited targets such as water or food supplies.

September 11, 2001, changed the global approach in the whole field of crisis management and in the management of food CBRN incidents. The largest investigation was initiated by the European Commission in the frame of SecuFood - Security of European Food supply chain. The results of the conducted project pointing that, in all tested cases (450), most of all food incidents cases happened in North America (mainly in USA – over 150 cases) and Asia – see. Figure 1, clearly points out the fact that food incidents appeared globally.

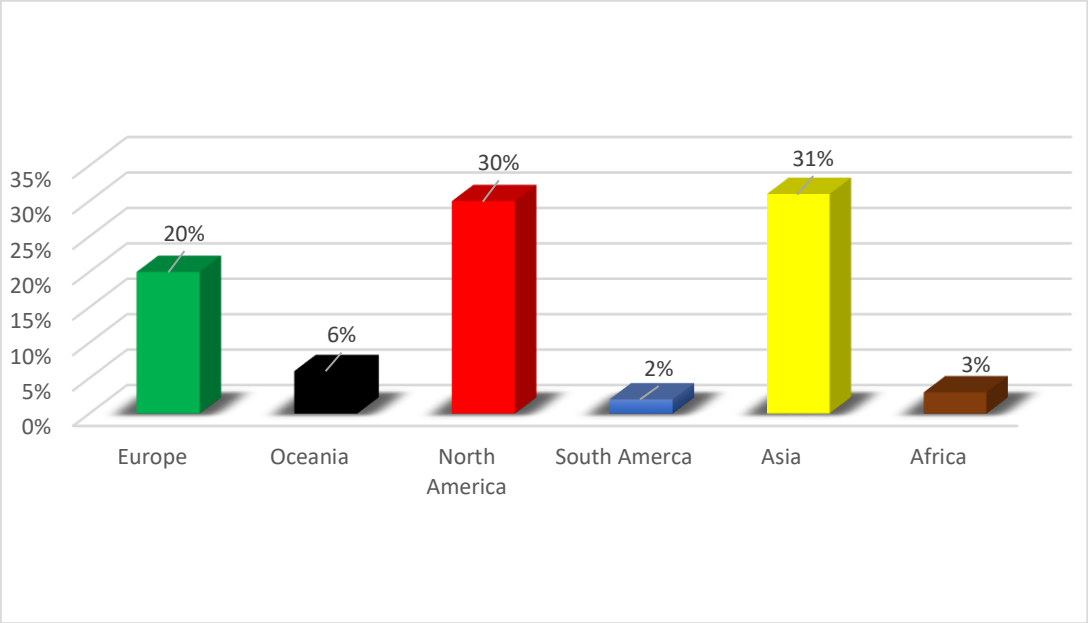

Figure 1 Distribution of food related incidents 7

The increasing risk of food incidents and food CBRN incidents are mainly due to the changes observed in the last decades. Mainly due to expansion and development of food supply chain, diversity of food and food related products, free trade food market, cross border food trading, problems related with global unemployment, human

[5] https://www.food.gov.uk/business-guidance/food-incidents-product-withdrawals-and-recalls

[6] Microbiological safety of chocolate confectionery products. https://www.newfoodmagazine.com/article/189/microbiological-safety-of-chocolate-confectionery-products/

[7] "SecuFood - Security of European Food supply chain". project co-funded by the European Commission in the framework of the European Programme on Critical Infrastructure Protection (CIPs), addressing the program theme "Prevention, Preparedness and Consequence Management of Terrorism and other Security-related Risks"

migration and globalization of world economy.

The analysis of the available literature data concerning the food incidents[8] - see Fig. 2, (averaged mean – developed and developing countries), suggests that the main factor responsible for food incidents belongs to the other category. The other category includes mislabelling, adulteration, misuse of additives and consumption or serving of expired food (food past its expiration date).

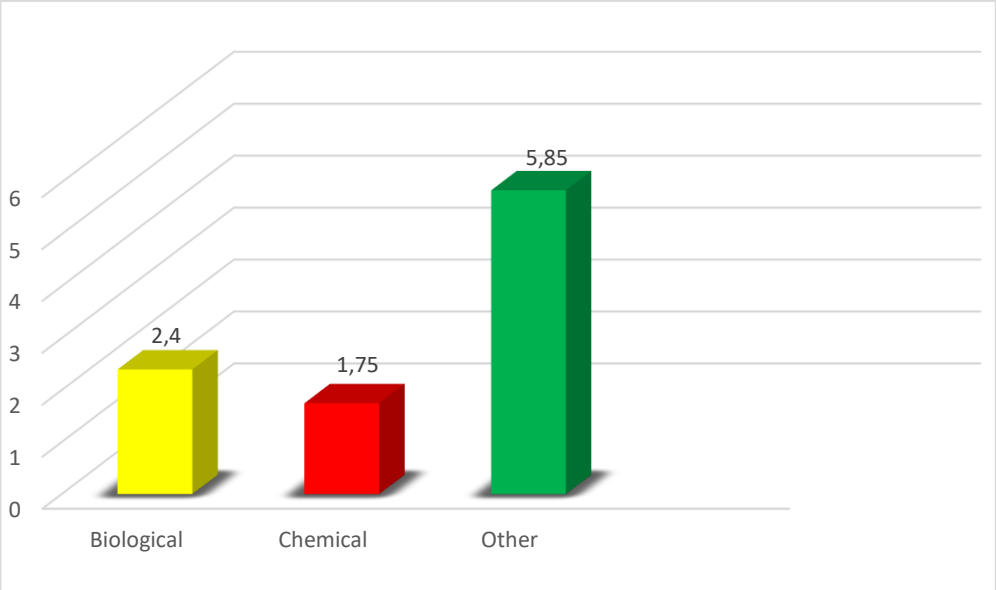

Figure 2 Reported food incidents9

Concerning the biological contamination - 6 major pathogens (Norovirus, Clostridium perfringens, Campylobacter spp., Salmonella spp., Bacillus cereus and Listeria) are causing the most food incidents. In case of chemical agents: four chemicals (aflatoxin, dioxin, cyanide and peanut allergen)[10].

3.1. Mislabelling of food products

One of the major risks for public health is associated with the food product market. The performed studies concerning mislabelling revealed that substantial proportion of food samples collected from food stores, supermarkets, restaurant and catering points,

[8] Zemichael Gizaw. Public health risks related to food safety issues in the food market: a systematic literature review. Environmental Health and Preventive Medicine volume 24, Article number: 68 (2019).
[9] Zemichael Gizaw. Public health risks related to food safety issues in the food market: a systematic literature review. Environmental Health and Preventive Medicine volume 24, Article number: 68 (2019).
[10] https://ccnse.ca/sites/default/files/2015-12-17_EH_Seminar_Foodborne_Chemicals-Afshari.pdf

which were genetically tested contained entirely different composition from that, which were presented on food product labels. It should be underlined that; the most common mislabelled food product were products contained seafood[11].

3.2. Misuse of additives

The misuse of food additives was also reported as a serious threat for public health related to food markets. Some food colorants and sweeteners are allowed to be used in food industry; however, their concentration exceeds the permissible limit. It was also reported the usage of non-permitted colorants and sweeteners[12].

3.3. Adulteration

Food adulteration is also considered as one of the major threats for public health related to the food chain. Most of the food products accessible in the market are adulterated to different degrees. Usage of the chemicals (e.g. hydrogen peroxide, caustic soda) or others, which are not declared food component (e.g. sugar in honey) are commonly used techniques to improve food products[13].

3.4. Serving expired food (food past expiration date)

There is substantial data concerning selling/serving outdated food in food stores and restaurants. This action largely contributes not only to public health but also to the environment[14]. The World Health Organization (WHO) estimates that annually approx. 600 million cases of foodborne illness appear globally. Among them, 360 million cases are due to bacterial infections, 125 million cases due to viral infections and 220 thousand due to chemical intoxication see Fig 3[15].

[11] Miller DD, Mariani S. Smoke, mirrors, and mislabeled cod: poor transparency in the European seafood industry. Front Ecol Environ. 2010;8(10):517–21

[12] Dixit S, Purshottam S, Khanna S, Das M. Usage pattern of synthetic food colours in different states of India and exposure assessment through commodities preferentially consumed by children. Food Addit Contam Part A Chem Anal Control Expo Risk Assess. 2011;28(8):996–1005.

[13] Peng G-J, Chang M-H, Fang M, Liao C-D, Tsai C-F, Tseng S-H, et al. Incidents of major food adulteration in Taiwan between 2011 and 2015. Food Control. 2017;72:145–52.

[14] Freedman DA, Bell BA. Access to healthful foods among an urban food insecure population: perceptions versus reality. J Urban Health. 2009;86(6):825–38.

[15] https://apps.who.int/iris/bitstream/handle/10665/199350/9789241565165_eng.pdf

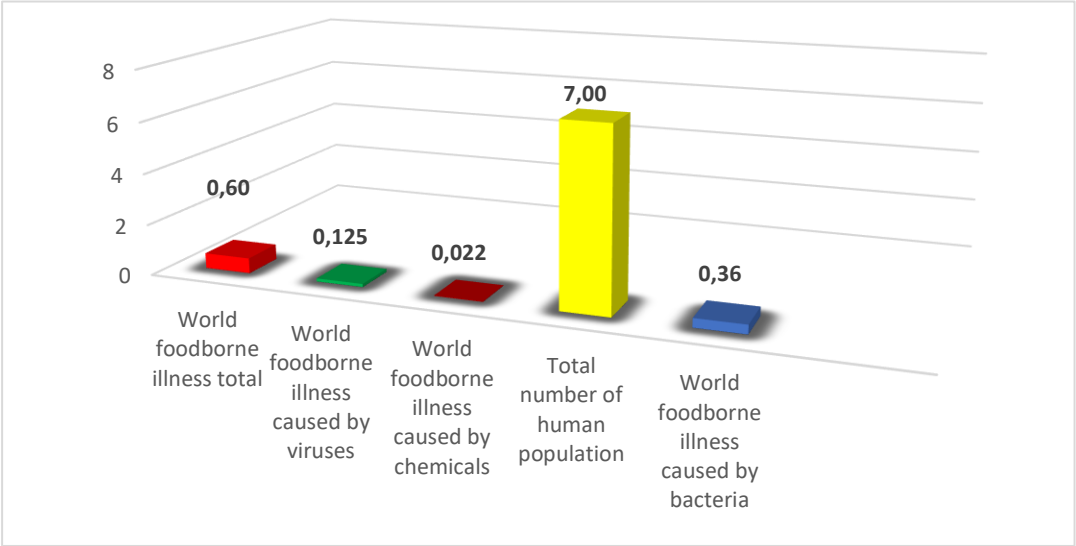

Figure 3 The number of foodborne illness vs total number of human population

Furthermore, foodborne illness will cause not only deaths but also place employees out of commission, resulting in a general employee shortage within the market, consequently influencing the overall economy see Fig. 4.

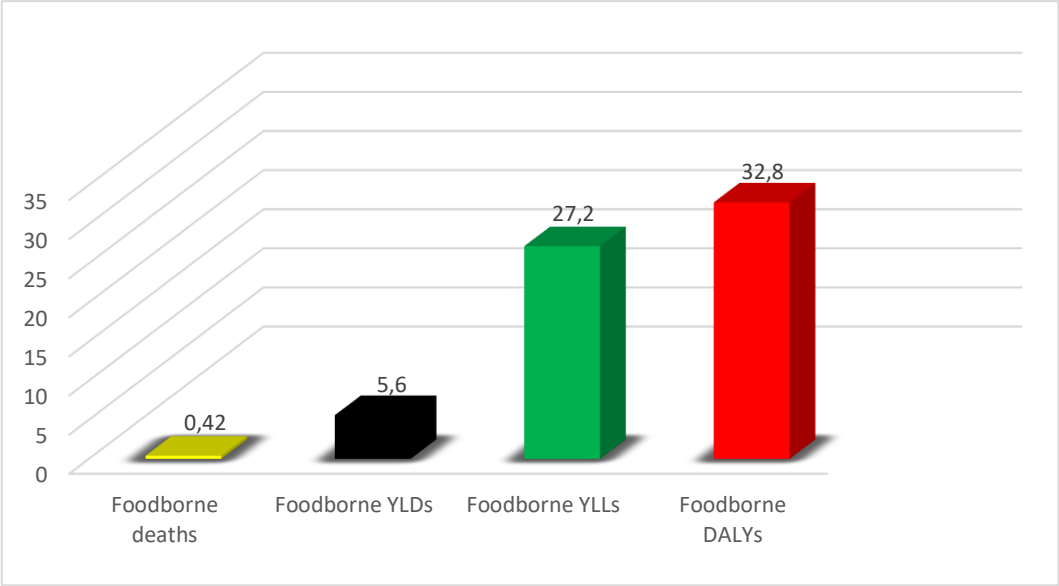

Figure 4 The global number of foodborne illnesses, deaths, Years Lived with Disability (YLDs),Years of Life Lost (YLLs) and Disability Adjusted Life Years (DALYs)16

In most cases, the responsible agent of foodborne illness are bacteria and parasites see Fig 5. The figure below compares causative agents of foodborne illness.

[16] https://apps.who.int/iris/bitstream/handle/10665/199350/9789241565165_eng.pdf

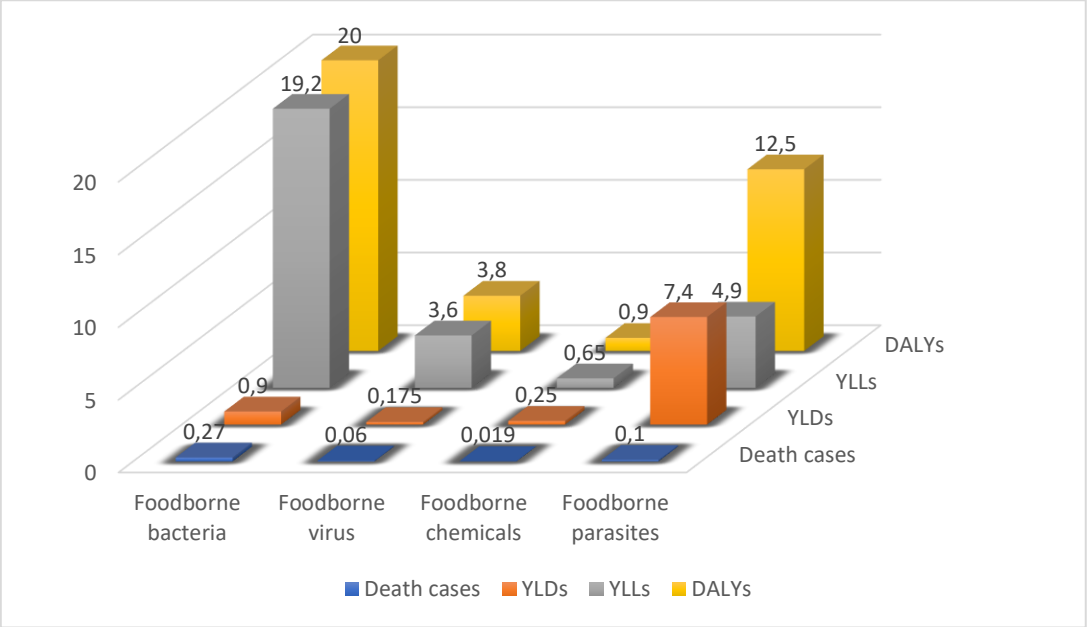

Figure 5 The causative agents of foodborne illness

4. History of CBRN incidents in the food chain[17]

CBRN agents pose a daily threat to humans, animals, and plants in Europe. The history of usage of CBRN agents dates to ancient times. However, usage of food as a carrier for CBRN agents is dated later. The first mention dated back to the 15th century. In 1495, during the war in the Southern part of Italy[18] against the French forces, the Spanish Armed Forces contaminated the wine with leprosy patients' blood. In 1978, five Dutch children suffered after eating the mercury-contaminated oranges originating from Israel. The Palestine Liberation Organization was responsible for this action. They tried to influence Israel's economy by targeting their export[19]. In 1984, over 700 residents of Dalles Wasco County in Oregon, USA, suffered from food poisoning caused by Salmonellae enteritidis. Over 40 of them were hospitalized. There were no death cases caused by this outbreak. The incident was caused by local members of the Rajneeshee religious cult. They contaminated 10 salad bars in the county with Salmonellae enteritidis. The intention was to prevent the residents from voting and thereby affecting the local elections in Wasco County at which they wanted to gain political control. Two members of this group were convicted and sentenced to 29 months in prison. The source of the strain that was used is believed that was obtained from commercial sources. Besides the victims, nine of the restaurants went out of business. This attack clearly pointing on the fact of relative easiness of executing this kind of attack and pointing out on particularly vulnerable part of the food chain[20]. Other recent reported incidents include food poisoning and blackmail. As an example: the incident in Friedrichshafen in Germany in 2017, where terrorists demanded 10 million euro from supermarkets while threatening to poison 20 different kinds of food products[21]. Another example is the attempt to extort a million euro from the candy maker Haribo and two supermarket chains by German citizens threatening to poison their products[22]. In 2003, over 90 people got sick after eating ground beef that had been intentionally contaminated with a nicotine-containing pesticide at a Michigan supermarket. A person employed by the store was charged of putting banned Black Leaf 40 into the meat[23]. In the UK in 2005, Sudan I (dye used as food colorants, azo compounds, carcinogenic – banned in 2005 by EU) was detected in a Worcester

[17] The chapter prepared on the basis of report 5.4 concerning Best practices for prevention of food CBRN incidents – project Creation of CBRNE protection system for large area shopping malls IFS Grant Agreement No. 861643 – Mall – CBRN authored by University of Lodz.
[18] Jeffery K. Smart. History of Chemical and Biological Warfare: An American Perspective. Chapter 2 History of Chemical and Biological Warfare: An American Perspective
[19] Phil Gurski. Borealis Threat & Risk Consulting.
[20] Carl Abbott. Utopia and Bureaucracy: The Fall of Rajneeshpuram, Oregon. Pacific Historical Review Vol. 59, No. 1 (Feb., 1990), pp. 77-103
[21] https://www.dw.com/en/poisoned-food-german-police-searching-for-blackmailer-near-lake-constance/a-40727214
[22] https://www.dw.com/en/german-pensioner-blackmails-haribo-gets-years-in-prison/a-39631673
[23] Nicotine poisoning after ingestion of contaminated ground beef--Michigan, 2003. MMWR Morb Mortal Wkly Rep. 2003 May 9;52(18):413-6.

sauce, which was used to make a wide variety of foods. As a result, close to 500 food products were recalled, making it the largest recall in UK history[24].

In 2009 also in UK, the incident of contamination of food and wine by feces mix with urine in Tesco resulted in loss over 700 thousand of British pounds due to the necessity of destruction of products[25].

[24] Susie Genualdi, Shaun MacMahon, Katherine Robbins, Samantha Farris, Nicole Shyong, and Lowri DeJager. Method development and survey of Sudan I–IV in palm oil and chilli spices in the Washington, DC, area. Food Addit Contam Part A Chem Anal Control Expo Risk Assess. 2016 Apr; 33(4): 583–591.
[25] Man sprayed urine on Tesco food. Metrowebukmetro Tuesday 14 Apr 2009

5. Description of the most common bacterial food borne pathogens[26]

5.1. Bacillus cereus

Bacillus cereus is a bacterium occurring naturally in the environment (dust, soil, etc.). It can form spores and produce toxins, which can survive high temperatures in cooking or boiling process. Starchy foods like potato, pasta, rice and cereals, and pre-cooked mixed dishes (especially spiced dishes) are products at the highest risk of contamination. Bacillus cereus can cause two types of illness – emetic and diarrheal.

Symptoms of poisoning start between 1 and 16 hours after consumption of contaminated food. The most common symptoms are vomiting, nausea and watery diarrhoea. Symptoms usually are mild and recovery occurs within 24h without any specific treatment. The high risk for pregnant women, young children, elderly people (as they are susceptible to dehydration) or patients with weak immune systems.

Risk reduction of contamination and poisoning is possible by: thoroughly cooking and serving food immediately, keeping cooked food hot (60°C or higher) before serving, quickly cooling and storing cooked food at 5°C (or lower) if will be used later, not eating cooked food older than 3-4 days, washing your hands with soap and drying them before preparing and eating food, keeping your kitchen and equipment clean[27].

5.2. Bacillus anthracis (gastrointestinal form)

Bacillus anthracis - bacteria naturally occurring in the environment (dust, soil, wild animals, etc.). It can form spores and produce toxins, which can survive high temperature during the cooking or boiling process. Food products with highest risk are: undercooked or raw meat and milk (from infected animals), water and other products contaminated by spores. The gastrointestinal form of anthrax incubation period ranges from 1 to 7 days.

Symptoms include severe gastrointestinal disorders and fever. They may occur in the oesophagus area (tongue base, sore throat, fever, enlarged lymph nodes) or mainly in

[26] The chapter prepared on the basis of report 5.4 concerning Best practices for prevention of food CBRN incidents – project Creation of CBRNE protection system for large area shopping malls IFS Grant Agreement No. 861643 – Mall – CBRN authored by University of Lodz.
[27] Richard Dietrich, Nadja Jessberger, Monika Ehling-Schulz, Erwin Märtlbauer, Per Einar Granum. The Food Poisoning Toxins of Bacillus cereus. Toxins (Basel). 2021 Jan 28;13(2):98. doi: 10.3390/toxins13020098.

the intestines (nausea, loss of appetite, vomiting and fever, followed by abdominal pain, bloody vomiting and diarrhoea). Mortality ranges from 25 to 60%.

Risk reduction of contamination and poisoning is possible by: not purchasing/eating meat or milk from unauthorized sources, thorough cooking and serving food immediately, keeping cooked food hot (60°C or higher) before serving, quickly cooling and storing cooked food in 5°C (or lower) if will be used later. Do not eat cooked food older than 3-4 days, wash your hands with soap or disinfectant and dry them before preparing and eating food. Keep the kitchen and equipment clean[28].

5.3. Campylobacter

Campylobacter is a type of bacteria that can be found naturally in the intestines of pets (cats, dogs), livestock (poultry, swine, cattle), rodents and wild birds. Contamination of food and water usually follows from faeces or cross-contamination in technological processes. Campylobacter can cause a severe type of gastro disorder called campylobacteriosis. Campylobacter is the most common bacterial cause of diarrheal illness. Over 10,000 cases are reported each year (6 cases per 100,000 persons). Many more cases go undiagnosed or unreported, and campylobacteriosis is estimated to affect over 2 million persons every year, or 1% of the population. Campylobacter is found in seafood and chicken. Some reports claim that all chicken is contaminated by Campylobacter. If the chicken is well cooked the Campylobacter bacteria are destroyed. Campylobacter is the bacterium implicated with the highest numbers of diarrheal diseases and the most common reason for food-borne illness, although most cases are sporadic and large outbreaks are not common.

Symptoms of campylobacteriosis start at 2 to 5 days after eating contaminated food, and usually involve fever, diarrhoea(often bloody and watery), abdominal pain, nausea, vomiting and tiredness. The illness duration up to ten days, and most people recover without any treatment in two weeks.

Risk reduction of contamination and poisoning is possible by cooking food thoroughly, especially poultry meat and liver, storing cooked food separately from raw foods, thoroughly reheating cooked food (to 75°C), drinking only treated or boiled water, wash fruit and vegetables with clean running water, avoid consuming unpasteurized milk and raw seafood, wash and dry your hands before handling and eating food, keep the kitchen and equipment clean (counters, cutting boards, knives and other utensils). Use separate cutting boards and knives for raw poultry and ready-to-eat food, keep the pets away from food storage and preparation areas[29].

[28] Ghodratollah Maddah, Abbas Abdollahi, Mehrdad Katebi. Gastrointestinal anthrax: clinical experience in 5 cases. Caspian J Intern Med. 2013 Spring; 4(2): 672–676.
[29] Sharon V. R. Epps, Roger B. Harvey, Michael E. Hume, Timothy D. Phillips, Robin C. Anderson, David J. Nisbet. Foodborne Campylobacter: Infections, Metabolism, Pathogenesis and Reservoirs. Int

5.4. Clostridium botulinum

Clostridium botulinum is a type of anaerobic bacteria, which can be found in soil, water, plants and in the intestines of animals. Clostridium botulinum bacteria similar to Bacillus cereus and Bacillus anthracis can form spores and produce a heat resistant toxin. Toxin ingestion can cause a very serious illness called botulism, in the case of very young children (under 12 months old) can cause infant botulism. Transmitted by improperly canned foods, garlic in oil, vacuum-packed and tightly wrapped food products.

Symptoms: toxin affects the nervous system. Symptoms usually appear within 18 - 36 hours and manifest as double vision, droopy eyelids, trouble in speaking and swallowing, and difficulty breathing. Can be fatal in 3 - 10 days, if not treated. Food-borne botulism is caused by eating foods that contain the botulism toxin. Infant botulism is caused by consuming the spores of the botulinum bacterium, which then grow in the intestine and release the toxin. Honey can contain spores of Clostridium botulinum and has been a source of infection for infants. Wound botulism is caused by toxins released in wounds infected by Clostridium botulinum. One hundred ten cases of botulism are reported each year – 72% infant, 25% food-borne. Clostridium botulinum can be found often in improperly canned food - a warning sign for possible botulinum contamination in canned food is when the can is bulging. This bulge resulted from the gas produced by the microbe. This toxin affects the nervous system, which begins with double vision and droopy eyelids. Then it starts to migrate through the body, eventually hitting the lungs and the diaphragm, shutting them down and asphyxiating the infected person. There are three mechanisms to be poisoned by botulinum toxin: the toxin is in the food that is eaten, the bacterium is ingested and produces the toxin in the gut, and the toxin is produced in an infected wound. This latter form was common during WWI and a major cause of morbidity and mortality.

Risk reduction of contamination and poisoning is possible by: home-canned and bottled food should be stored only in new sterilized bottles and jars. Food products should be kept at the correct temperature. Do not eat or serve food from damaged, bulging or leaking cans. Baked or cooked food should be kept hot until served. Do not feed infants under 1 year with honey. Wash hands and kitchen equipment thoroughly before food preparation and eating[30].

J Environ Res Public Health. 2013 Dec; 10(12): 6292–6304. doi: 10.3390/ijerph10126292

[30] Yiman Lin, Yixiang Jiang, Zelong Gong, Yanli Wang, Min Jiang, Qiongcheng Chen, Chunlian Li, Qinghua Hu, Xiaolu Shi. Investigation and Identification of Food Poisoning Caused by Clostridium botulinum Type B1 in Shenzhen, China. Foodborne Pathogens and DiseaseVol. 19, No. 3. doi.org/10.1089/fpd.2021.0060

5.5. Clostridium perfringens

Clostridium perfringens is a spore-forming bacteria widespread in the environment. It can be found in soil, dust, sewage, and human and animal intestines. The spores and toxins of Clostridium perfringens are high-temperature resistant. It can survive at a boiling temperature of up to one hour.

Transmission: "the cafeteria germ" because many outbreaks have resulted from food left for long periods on steam tables or at room temperature.

Intoxication **symptoms** include diarrhoea and gas pains, which may appear 8 to 24 hours after eating. Usually lasts about 1 day, but less severe symptoms can be observed for 1 - 2 weeks. In many cases, symptoms are mild within and disappear in 24h. In rare cases, they can last for up to two weeks. **Common symptoms** include: abdominal pain, stomach cramps, loss of appetite, fatigue, nausea, vomiting, watery diarrhoea and fever. Clostridium perfringens is destroyed by heat, but the spores are relatively heat resistant and can survive and germinate once the food is cooling down. Thus, clostridium perfringens enterotoxin food poisoning occurs, where there is improper food holding temperatures, especially in items like gravy. Clostridium-based food poisoning is a classic problem in military bases, if the cafeteria lines are not handled well enough. The identified source of poisoning is food products, which are high in starch or proteins (cooked meat products, cooked beans, thick gravy or soups).

Risk reduction of contamination and poisoning is possible by: thoroughly food cooking and serving immediately or keeping it in 60°C or hotter before serving. Refrigerate quickly cooked food, if it will be stored and used later. Divide large amounts of food to cool faster, keep food in the fridge at 4°C or lower. Cooked food from the fridge should be eaten within 3-4 days. Cooked food should be reheated quickly to a minimum of 75°C. Wash hands and kitchen equipment thoroughly before preparing and eating food[31].

5.6. Escherichia coli

Escherichia coli is a bacterium naturally found in the intestines of people and other mammals. It is also widespread in the environment, in soil and water, where they go with secretions and faeces. Most Escherichia coli strains are harmless and are a part of the normal intestinal microbiota. Some strains of Escherichia coli are beneficial by producing vitamins B and K or preventing intestines before colonization by pathogenic

[31] Bhattacharya A, Shantikumar S, Beaufoy D, Allman A, Fenelon D, Reynolds K, Normington A, Afza M, Todkill D (2020). Outbreak of Clostridium perfringens food poisoning linked to leeks in cheese sauce: an unusual source. Epidemiology and Infection 148, e43, 1–7. https://doi.org/10.1017/S095026882000031X

bacteria. Pathogenic Escherichia coli strains are grouped into six pathotypes: Shiga toxin-producing Escherichia coli (STEC, VTEC, EHEC), Enterotoxigenic Escherichia coli (ETEC), Enteropathogenic Escherichia coli (EPEC), Enteroaggregative Escherichia coli (EAEC), Enteroinvasive Escherichia coli (EIEC), and Diffusely adherent Escherichia coli (DAEC).

5.6.1. Enterohemorrhagic Escherichia coli (EHEC)

EHEC is a strain with the ability to produce Shiga toxin (or verotoxin). EHEC is the major cause of foodborne illness. Symptoms of illness begin 2 to 10 days after exposure. EHEC are resistant to stomach acids and colonize of the human large intestine causing gastroenteritis, enterocolitis, and bloody diarrhoea. In some cases, a severe complication called hemolytic-uremic syndrome (HUS) is observed. The **general symptoms** include bloody diarrhoea, nausea, vomiting and cramping stomach pain. The natural reservoirs of EHEC are cattle and other livestock animals, as well as pets (cats, dogs) and wild animals. EHEC is also found in environments contaminated by the faeces of infected animals (soil, water, plants). People get infected by eating raw or undercooked beef meat, raw milk or dairy products, unwashed fresh fruits and vegetables, contaminated ready-to-eat food with fresh fruits or vegetables. Escherichia coli 0157:H7 is one of the strains of the bacteria Escherichia coli that cause illness in humans. It causes an estimated 60 deaths and 73,000 illnesses annually. Most reported outbreaks are due to contaminated food or water. However, direct transmission of Escherichia coli 0157 H7 from animals and their environment to humans is a growing concern. Escherichia coli 0157:H7 can be found in most dairies, in water troughs, wet feeds, and flush alleys, especially during warmer months. However, the bacteria present an insignificant disease problem for cattle and only a few animals shed the bacteria in their manure at any one time. Healthy cattle are the main recognized animal reservoir and may harbour the organism as part of the bowel flora. It is most easily found in weaned calves, but market cattle can shed significant amounts in their feces which can lead to the contamination of beef during slaughter. Most infections of Escherichia coli 0157:H7 come from eating undercooked, contaminated ground beef often from spent dairy cows, or those animals that have surpassed their prime producing years and are sent to slaughter. Meat becomes contaminated in the slaughterhouse, and the bacteria are easily spread when meat is ground in the processing plant. The bacteria cause human disease by producing toxins and some of the clinical signs include diarrhoea, cramping, vomiting, urinary problems, and is currently the most significant cause of kidney disease in children (Hemolytic Uremic Syndrome). It begins 2 - 5 days after food is eaten, lasting about 8 days. Escherichia coli 0157:H7 can survive in the environment for months and thus pose an ongoing source of infection in humans. It is estimated 10,000 to 20,000 cases of infection occur each year. First recognized as a cause of illness in 1982 during an

outbreak of severe bloody diarrhoea. The outbreak was traced to contaminated hamburgers[32].

5.6.2. Enterotoxigenic Escherichia coli (ETEC)

ETEC strains can produce two toxins: heat-stable (ST toxin) and heat-labile (LT toxin). Different strains can produce one or both toxins. The **symptoms** of infection begin in 12-72 hours after eating or drinking contaminated food products and include profuse, watery diarrhoea with no blood and cramping abdominal pain. Other symptoms, like fever, nausea, vomiting, headache and muscles pain can also occur. The disease is usually self-limiting, and diarrhoea lasts for 3 days[33].

5.6.3. Enteropathogenic Escherichia coli (EPEC)

EPEC strains are not able to produce toxins, but possess many other virulence factors, which are similar to Shigella. EPEC colonizes the small intestine and changes cell structure due to "attachment and effacement". Natural reservoirs are humans and wild, livestock and pets (rabbits, dogs, cats and horses). People get sick after eating food products or drinking water contaminated by faeces of infected humans or animals. **Symptoms** usually begin in 1-2 days and include watery diarrhoea with mucus (without blood), fever, vomiting and dehydration. The disease is usually self-limiting, and diarrhoea lasts in 5 to 15 days[34].

5.6.4. Enteroinvasive Escherichia coli (EIEC)

EIEC strains do not produce toxins. To colonize small intestine bacteria are using adhesion proteins, like an EPEC strains. The infection syndromes are very similar to shigellosis. The natural host is only the human intestine, and people get sick within 12-

[32] Kashima, K., Sato, M., Osaka, Y., Sakakida, N., Kando, S., Ohtsuka, K., . . . Honda, A. (2021). An outbreak of food poisoning due to Escherichia coli serotype O7:H4 carrying astA for enteroaggregative E. coli heat-stable enterotoxin1 (EAST1). Epidemiology & Infection, 149, E244. doi:10.1017/S0950268821002338

[33] James M. Fleckenstein and F. Matthew Kuhlmann. Enterotoxigenic Escherichia coli Infections. Curr Infect Dis Rep. 2019 Mar 4; 21(3): 9. doi: 10.1007/s11908-019-0665

[34] Min-A Lim, Ji-Yeong Kim, Dilaram Acharya, Bishnu Bahadur Bajgain, Ji-Hyuk Park, Seok-Ju Yoo, and Kwan Lee3. A Diarrhoeagenic Enteropathogenic Escherichia coli (EPEC) Infection Outbreak That Occurred among Elementary School Children in Gyeongsangbuk-Do Province of South Korea Was Associated with Consumption of Water-Contaminated Food Items. Int J Environ Res Public Health. 2020 May; 17(9): 3149. doi: 10.3390/ijerph17093149

72 hours after ingestion of food or water contaminated by faeces of infected humans. The **initial symptoms** include: watery secretory diarrhoea from the small intestine, then severe colitis develops. Symptoms of colitis include fever, abdominal pain, painful tenesmus and frequent passing of scanty stools with mucus, blood and pus[35].

The risk reduction of contamination and poisoning is possible by: cooking thoroughly raw minced meat (burgers, sausages etc.). Wash thoroughly raw fruit and vegetables under running water. Wash your hands with soap and running water before preparing or eating food and after using the bathroom. Use separate knives and cutting boards for raw meat and ready-to-eat food. Store raw meats and ready-to-eat food separately in the fridge. Avoid unpasteurized milk and dairy products.

5.7. Listeria monocytogenes

Listeria can be found throughout nature in animals and water. Infected soil from cattle manure used as fertilizer can contaminate crops with the bacteria. Dairy cattle may become infected with Listeria from sources in their environment. The literature suggests Listeria monocytogenes in dairy cattle may originate from consumption of poorly fermented silages and/or by inadequate cleaning of animal areas and milking equipment. Listeria monocytogenes is one of the causes of circling disease in cattle. Infected cattle often display generalized illness with abnormal behaviour and posture. Common sources of human infections are raw milk, soft cheeses, or meats as well as foods contaminated during processing or food preparation. In humans, this bacterium causes flu-like illness including nausea, vomiting, and diarrhoea. In severe cases, neurological signs, and abortions. While less widely known than other human food-borne pathogens like Salmonella or Escherichia coli, it is far deadlier. Listeria is fatal in nearly 20% of all cases. It is estimated, that 2,500 people become seriously ill from Listeria each year with infections often leading to blood poisoning or meningitis. Most at risk from this pathogen are pregnant women, new-born children, and people with weakened immune systems. In the past, Listeriosis in cheese has caused dozens of deaths. As a precaution, pregnant women are warned not to consume unpasteurized soft cheeses, particularly from Latin America. A major public health concern for the Listeria monocytogenes is that it can survive and continue to multiply in post pasteurizing processing environments and may lead to the recontamination of dairy products such as milk and cheese. The bacteria readily grow at refrigerator temperatures. Therefore, a small amount of contamination may become an infective dose as the food is stored in the refrigerator. Literature suggests the development of drug resistance in Listeria from antibiotic use in farm animals is less of concern that in

[35] Sophie Newitt, Vanessa MacGregor, Vivienne Robbins, Laura Bayliss, Marie Anne Chattaway, Tim Dallman, Derren Ready, Heather Aird, Richard Puleston, and Jeremy Hawker. Two Linked Enteroinvasive Escherichia coli Outbreaks, Nottingham, UK, June 2014. Emerg Infect Dis. 2016 Jul; 22(7): 1178–1184. doi: 10.3201/eid2207.152080

other food and water borne pathogens. It is believed that the Listeria found in the intestines of food animals are often not the same that ultimately contaminates ready to eat food products. In addition, Listeria is a poor competitor against other human pathogens such as Escherichia coli or Campylobacter.

The **symptoms** can start as early as 3 days, but in severe cases may appear up to 70 days after exposure. Early symptoms include: fever, head and muscle aches, constipation, cramps, nausea, vomiting, diarrhoea. Severe listeriosis symptoms include: confusion, loss of balance, stiff neck, sepsis, meningitis, encephalitis, corneal ulcer, pneumonia, myocarditis, and in pregnant women intrauterine or cervical infections, which may cause spontaneous abortion (second to third trimester), prematurely or stillbirth. Mortality ranges may reach over 70%, from sepsis 50%, and from perinatal/neonatal infections greater than 80%[36].

Risk reduction of contamination and poisoning is possible by: do not serve foods over their date to use. Cook and/or reheat food thoroughly (Listeria died at high temperature). Refrigerated food should be eaten within 3-4 days. Cooked food should be stored at 5°C or lower, separately from raw foods. Wash raw fruit and vegetables thoroughly under clean running water. Use separate cutting boards and knives for raw and ready-to-eat food. Wash hands and kitchen equipment before preparing food and eating.

5.8. Salmonella spp.

Salmonella bacteria are ubiquitous in nature and are found in the gastrointestinal tracts of animals and humans. There are over 2000 serotypes of Salmonella, most of which do not cause illness in humans. There are three types of salmonellosis: gastroenteritis, typhoid fever, and bacteraemia (bacteria in the blood), which are most caused by the consumption of contaminated food and water tainted with animal faeces. Studies performed, showed that there are an estimated 1,412,498 human illnesses, 16,430 hospitalizations, and 582 deaths annually caused by food producing animals such as cattle who are the main reservoir of non-typhi serotypes of Salmonella enterica[37]. Salmonella can be found on dairy farms, especially in flush alleys and on milking equipment. The bacteria present significant disease of cattle with symptoms of diarrhoea, decreased milk production, abortion and sometimes death. Cows infected with Salmonella can spread the bacteria in their manure, wherever they go on the dairy farm, especially during times of stress, like calving. As a result, dairy cattle destined

[36] J M Farber and P I Peterkin. Listeria monocytogenes, a food-borne pathogen. Microbiol Rev. 1991 Sep; 55(3): 476–511. doi: 10.1128/mr.55.3.476-511.1991

[37] Michael Barza, Karin Travers. Excess Infections Due to Antimicrobial Resistance: The “Attributable Fraction”. Clinical Infectious Diseases, Volume 34, Issue Supplement_3, June 2002, Pages S126–S130, https://doi.org/10.1086/340250.

for culling may readily bring it into the slaughterhouse. The literature[38] suggests animal feed may serve as a vehicle to infect cattle with Salmonella. The conducted surveys of food ingredients and animal feed were executed. In a particular survey where 101 animal protein-based samples were taken, contamination with Salmonella enterica was detected in over 50 percent of the samples. Although this was only one study, it supported that animal protein-based animal feed could be contaminated with the pathogen. As a result, the contaminated animal feed can cause infection or colonization of food animals, which may lead to human food-borne illness. In humans, Salmonellae can cause a broad range of infections, including gastroenteritis, enteric fever, bacteraemia, endovascular infections, and focal infections such as osteomyelitis and abscesses. An infective dose can vary, with as few as 1 to 15 cells causing illness, depending on the age and health status of the recipient. The health care community is concerned about the emergence of drug – resistant strains of Salmonella. There have been high rates of drug-resistance including multi resistant bacteria documented in meat destined for human consumption. It has the transmission potential of drug resistant pathogens from animals to people. A particular strain of Salmonella is now resistant to five important antibiotics used in human medicine. In recent years Salmonella contamination in the food supply has dropped but the prevalence of multidrug-resistant isolates has increased from less than 1 percent in 1980 to 34 percent in 1996[39].

5.8.1. Salmonella enteritidis

Salmonella enteritidis can be found in intestinal tract and faeces of animals. Salmonella enteritidis is mostly presence in raw eggs. It is transmitted by consumption of raw or undercooked eggs, poultry, and meat; raw milk and dairy products; seafood and by food handlers.

The **symptoms**: stomach pain, diarrhoea, nausea, chills, fever, and headache usually appear 8 to 72 hours after eating; may last 1 to 2 days. May produce arthritic conditions 3-4 weeks after acute symptoms appeared[40].

Risk reduction of contamination and poisoning is possible by: cook thoroughly poultry meat and eggs. Do not eat dirty or cracked eggs. Wash hands and kitchen equipment before preparing and eating food, especially after handling raw poultry meat

[38] R H Davies, A D Wales. Salmonella contamination of cereal ingredients for animal feeds. Vet Microbiol. 2013 Oct 25;166(3-4):543-9. doi: 10.1016/j.vetmic.2013.07.003. Epub 2013 Jul 12.
[39] Olugbenga Ehuwa, Amit K. Jaiswal and Swarna Jaiswal. Salmonella, Food Safety and Food Handling Practices. Foods 2021, 10(5), 907; https://doi.org/10.3390/foods10050907
[40] Surendran Deepanjali, Mandal Jharna, Bammigatti Chanaveerappa, Dhandapani Sarumathi, Pallam Gopichand, and Kaliyappan Anupriya. An outbreak of Salmonella Enteritidis food poisoning following consumption of chicken shawarma: A brief epidemiological investigation. F1000Res. 2021; 10: 851. doi: 10.12688/f1000research.54410.4

and eggs. Never wash raw chicken. Wash thoroughly raw vegetables and fruits in clean running water. Use separate cutting boards and knives for raw chicken and other food products. Store separately cooked food from raw foods. Keep raw or cooked food in fridge (temperature 5°C or lower), before serving keep cooked food hot (60°C or hotter).

5.9. Shigella spp.

Shigella is another bacterium that may cause food-borne disease. Shigella is usually found in the human intestinal tract. It is the cause of bacillary dysentery. Poor personal hygiene of people handling food is a major reason for contaminations. Shigella-induced diarrhoea typically contains blood. Shigella can also produce a toxin (an Escherichia coli type of toxin).

Shigella is a pathogenic bacterium, which can be found in the intestines of humans and animals. The four pathogenic species of Shigella are known - Shigella sonnei, Shigella flexneri, Shigella boydii and Shigella dysenteriae. Infection by Shigella dysenteriae type 1 can be deadly. Food can become contaminated by: infected people, contact with contaminated surfaces or water, vectors (e.g. flies), which can spread Shigella from faeces to uncovered food. Food products at higher risk include: unpasteurized milk, raw oysters and shellfish, raw unwashed fruits and vegetables, ready-to-eat sandwiches and salads with raw vegetables or fruits. Shigella infection is called shigellosis, which symptoms start usually 1-2 days after exposure and last approx. 7 days.

Symptoms of shigellosis include diarrhoea (sometimes bloody and prolonged), fever, nausea, vomiting, stomach pain and abdominal cramping. Group of people at higher risk of severe infection are young children (under 5 years old), elder (over 60 years old) and people with weakness immune systems. Shigella spread very easily, disease can be cause by small number of bacteria. People infected by Shigella can shed the bacteria for up 2 weeks after the symptoms finished[41].

Risk reduction of contamination and poisoning is possible by: carefully washing hands with soap and clean running water, especially before preparing and eating food, or after going to the bathroom. Drink only bottled water. Avoid preparing food with using untreated water.

[41] Shuai Zhi, Brendon D. Parsons, Jonas Szelewicki, Yue T. K. Yuen, Patrick Fach, Sabine Delannoy, Vincent Li, Christina Ferrato, Stephen B. Freedman, Bonita E. Lee, Xiao-Li Pang and Linda Chui. Identification of Shiga-Toxin-Producing Shigella Infections in Travel and Non-Travel Related Cases in Alberta, Canada. Toxins 2021, 13(11), 755; https://doi.org/10.3390/toxins13110755

5.10. Staphylococcus aureus

Staphylococcus food poisoning. Staphylococcus aureus can be found on humans: skin, infected cuts, noses, and throats. Transmitted by people to food through improper food handling. Multiply rapidly at room temperature and produce a toxin that causes illness. When it is ingested, it causes food-related symptoms that start very rapidly and are due to staphylococcal enterotoxin, not due to the bacterium itself, i.e. it's a food poisoning, not foodborne infection. Staphylococcus aureus is a bacterium commonly occurring on skin and in the upper respiratory tract of people and animals. In healthy people it does not cause any illness. Bacteria produce a toxin (staphylococcal enterotoxin B, SEB), which is heat resistant and can cause food poisoning. The gastrointestinal illness, called Staph food poisoning, is caused by eating foods or drinking water contaminated with SEB. Severe illness is very rare, usually symptoms like vomiting, nausea, stomach cramps and diarrhoea start after 30 minutes to 8 hours after eating or drinking contaminated food products. The **symptoms** last no longer than 1-2 days. Foods products at higher risk of contamination with toxins include: sliced meats, meat dishes, milk and milk products, creams, puddings, halves, ice creams, pastries and ready-to-eat salads and sandwiches, especially foods, which are not cooked after handling. Enterotoxin present in the food products usually does not change their taste or smell and foods do not look spoiled[42].

Risk reduction of contamination and poisoning is possible by: preventing ready-to-eat food from being stored in unsafe temperature (between 5°C and 60°C) for more than 2 hours. Thoroughly cook foods. Keep hot foods hot (60°C or hotter) and cold foods cold (5°C or colder) before serving. Put cooked food in fridge within 2 hours (or 1 hour if it's hotter than 30°C outside). Wash hands carefully with soap and clean running water before preparing and eating food. Keep your kitchen and equipment clean (counters, cutting boards, knives and other utensils). Do not allow preparing the food by ill personnel, especially with diarrhoea or vomiting symptoms. Wear gloves if you have skin wounds or infections on your hands.

5.11. Vibrio spp.

Vibrio cholerae is a bacterium naturally occurring in brackish and marine water, on the surfaces of chitin shells of crabs, shrimps and other shellfish. Diarrhoeal illness is called cholera, and cause by toxigenic strains of Vibrio cholerae serogroups O1 or O139. Non-toxigenic strains (non-O1 and non-O139) may cause the illness named

[42] María Ángeles Argudín, María Carmen Mendoza, and María Rosario Rodicio. Food Poisoning and Staphylococcus aureus Enterotoxins. Toxins (Basel). 2010 Jul; 2(7): 1751–1773. doi: 10.3390/toxins2071751

"cholera-like illness". People get the Vibrio cholerae by drinking contaminated water or eating undercooked or raw shellfish. In epidemic areas the source of infection is water contaminated by faeces of sick people.

Symptoms of infection appear in few hours to 5 days after ingestions (usually 2-3 days) and in many cases are mild or not occur at all. In rare cases (approx. 1 in 10 people) severe symptoms will develop and include: watery diarrhoea, vomiting, and legs cramps. In these people rapid loss of body fluids leads to severe dehydration, shock and without treatment to death within hours[43].

Risk reduction of contamination and poisoning is possible by: drinking only bottled boiled or treated water and bottled or canned drinks - make sure the seal has not been broken. Carbonated drinks are safer than non-carbonated. Wash hands carefully using soap and clean running water (if not available, use minimum 60% alcohol sanitation solution) before preparing and eating food or after using the bathroom. Eat packaged ready-to-eat foods or foods freshly cooked and served hot. Do not eat raw or undercooked fruits, vegetables, meats and seafood. Clean kitchen surfaces, equipment and dishes under clean running water and using chemical cleaning supplies.

5.12. Cronobacter sakazakii

Cronobacter sakazakii is a bacteria widely present in the natural environment in water, soil and sewage. It is resistant to dry conditions of life. They also appear in a wide range of food products, which consuming are the general source of people infection. Cronobacter may also produce heat resistant enterotoxin (stable in 90°C by 30 minutes) and proteolysis enzymes. Groups of people at high risk of severe illness are infants (less than 2 months old and born prematurely), elderly people (over 65 years old) and people with weak immune systems.

Products at higher risk of contamination include: milk (raw and powdered), powdered infant formula, cheese, vegetables, meat, sausages, fish, rice, tea and various spices. Cronobacter illness in healthy people is very rare, but in people from risk group may be severe and deadly. In infants and newborn babies, it can cause meningitis, sepsis and severe intestinal infection with necrosis of enterocolitis[44].

Risk reduction of contamination and poisoning is possible by: cleaning baby's feeding bottles in a dishwasher. Consider using a bottle sterilizer.

[43] Dipanjan Dutta, Anupam Kaushik, Dhirendra Kumar, and Satyabrata Bag. Foodborne Pathogenic Vibrios: Antimicrobial Resistance. Front Microbiol. 2021; 12: 638331. doi: 10.3389/fmicb.2021.638331

[44] Wei Yong, Baofu Guo, Xiaochao Shi, Tingting Cheng, Mingming Chen, Xiao Jiang, Yanhua Ye, Junning Wang, Guoxiang Xie, and Jie Ding. An Investigation of an Acute Gastroenteritis Outbreak: Cronobacter sakazakii, a Potential Cause of Food-Borne Illness. Front Microbiol. 2018; 9: 2549. doi: 10.3389/fmicb.2018.02549

5.13. Yersinia enterocolitica

Yersinia enterocolitica is a bacteria widespread in nature. It can be found in intestinal of pets (cats, dogs), livestock (mammals and birds) and wild animals (rodents). Yersinia enterocolitica was also isolated from water, soil and food contaminated by faeces of infected animals and people. Strains of Yersinia enterocolitica was classified into 6 biotypes and over than 57 serogroups. However, only some of these serogroups are pathogenic for humans and animals. Isolates from environment are avirulent. Pathogenic for humans strains was generally isolated from pigs, sheep, dogs, cats and wild rodents. People get sick for yersiniosis usually after eaten raw or undercooked pork. The rare sources of infection are also unpasteurized milk, raw fruits and vegetables and untreated water.

Symptoms of yersiniosis depend on the age of infected person and starts typically 4 to 7 days after exposure and last in 1-3 weeks. In young children symptoms include: fever, watery or bloody diarrhoea and abdominal pain. In older children and adults, the predominant symptoms are: fever and right-side abdominal pain, which can be confused with appendicitis. In some cases, the joint pain and rashes occur[45].

Risk reduction of contamination and poisoning is possible by: carefully hand washing with soap and clean running water before preparing foods or after using bathroom. Thoroughly cooking or baking pork. Washing fruits and vegetables under running water. Storing meat in fridge in temperature 4°C or lower, separately from ready-to-eat food. Use separate knives and cutting boards for raw pork and other food products and keeping kitchen clean.

[45] Md. Latiful Bari, M. Anwar Hossain, Kenji Isshiki, and Dike Ukuku. Behavior of Yersinia enterocolitica in Foods. J Pathog. 2011; 2011: 420732. doi: 10.4061/2011/420732

6. The most common food borne parasites[46]

6.1. Toxoplasmosis (Toxoplasma gondii)

Toxoplasma gondii is a species of pathogenic protozoan, which can cause an illness named toxoplasmosis in warm-blooded animals, especially cats but also pigs, sheep, boars and rodents. People get infected by eating raw or undercooked meat (pork, lamb, venison) or shellfish (oysters, mussels, etc.). Accidentally by eating fruits and vegetables or drinking water contaminated by faeces of infected animals. In many case people infected by Toxoplasma gondii have no symptoms. Rarely **symptoms** include swollen lymph glands or muscle pains, which last for weeks to months. Severe toxoplasmosis can develop from acute infection or reactivation of earlier no-symptoms infection, and cause damage to the brain, eyes or other organs.

Ocular toxoplasmosis **symptoms** include: reduced and blurred vision, redness of the eye, pain with bright light, and sometimes tearing[47].

Risk reduction of contamination and poisoning is possible by: cook or bake meat thoroughly. Do not eat raw or undercooked meat or shellfish. Rinse fruits and vegetables under running water before eating. Keep kitchen surfaces and equipment clean and wash them in hot water with cleaning products before and after using.

6.2. Cryptosporidium

Cryptosporidium is a genus of microscopic protozoan, which can cause humans and animals gastrointestinal illness named cryptosporidiosis. A number of Cryptosporidium species are pathogenic for mammals. In humans, cryptosporidiosis is caused by: Cryptosporidium parvum and Cryptosporidium hominis, but also Cryptosporidium canis, Cryptosporidium felis, Cryptosporidium meleagridis, and Cryptosporidium muris can cause disease. Cryptosporidium can be found in soil, food, water, or other surfaces contaminated by faeces of infected humans or animals. Cryptosporidium possesses a high tolerance to chlorine. For this reason, it can survive for a long time in chlorinated drinking and swimming pool water. The infection dose is very low and swallowing approx. ten Cryptosporidium oocysts can cause illness. People get infected by swallowing contaminated recreational water (swimming pool, fountain, lake, river),

[46] The chapter prepared on the basis of report 5.4 concerning Best practices for prevention of food CBRN incidents – project Creation of CBRNE protection system for large area shopping malls IFS Grant Agreement No. 861643 – Mall – CBRN authored by University of Lodz.
[47] Malik A. Hussain, Victoria Stitt, Elizabeth A. Szabo, and Bruce Nelan. Toxoplasma gondii in the Food Supply. Pathogens. 2017 Jun; 6(2): 21. doi: 10.3390/pathogens6020021

drinking untreated water, eating uncooked food or drinking unpasteurized milk or raw juice.

Symptoms of infections start generally 2 to 10 days after eating germs and last about 1-2 weeks. They include: watery diarrhoea, cramping stomach pain, nausea, vomiting, dehydration, weight loss, fatigue and in some cases low-grade fever[48].

Risk reduction of contamination and poisoning is possible by: good hygiene practices. Washing thoroughly hands with soap and running water before preparing and eating food or after using the bathroom. Hand sanitizers based on alcohol solution are not enough effective for Cryptosporidium. Rinse fruits and vegetables under running water before eating. Pasteurize raw milk and juice. Do not drink untreated water or use untreated ice.

6.3. Giardia

Giardia duodenalis is a microscopic parasite causing one of the most common parasitic diarrheal diseases in humans, dogs and cats named giardiasis. It can also infects other mammals species include: sheep, cattle and goats. Giardia cysts can survive outside the body for weeks or even months and over one hour in chlorinated water. Giardiasis can be spread by drinking untreated water or eating undercooked food products contaminated by faeces infected people or animals.

Symptoms begin 1 to 2 weeks after exposure and last in healthy people to 2-6 weeks. Symptoms generally start by having 2 to 5 loose stools per day and include: diarrhoea, cramping stomach pain, nausea, vomiting, progressively increasing fatigue, dehydration, weight loss, avitaminosis (vit A and B12)[49].

Risk reduction of contamination and poisoning is possible by: washing thoroughly hands with soap and running water before preparing and eating food or after using the bathroom. Avoid eating undercooked food or drinking untreated water. Rinse properly raw fruits and vegetables before eating.

[48] Damien Costa, Romy Razakandrainibe, Stéphane Valot, Margot Vannier, Marc Sautour, Louise Basmaciyan, Gilles Gargala, Venceslas Viller, Denis Lemeteil, Jean-Jacques Ballet, French National Network on Surveillance of Human Cryptosporidiosis,Frédéric Dalle and Loïc Favennec. Epidemiology of Cryptosporidiosis in France from 2017 to 2019. Microorganisms 2020, 8(9), 1358; https://doi.org/10.3390/microorganisms8091358

[49] Özlem Orunç Kılınç, Adnan Ayan, Burçak Aslan Çelik, Özgür Yaşar Çelik, Nazmi Yüksek, Gürkan Akyıldız and Fatma Ertaş Oğuz. The Investigation of Giardiasis (Foodborne and Waterborne Diseases) in Buffaloes in Van Region, Türkiye: First Molecular Report of Giardia duodenalis Assemblage B from Buffaloes. Pathogens 2023, 12(1), 106; https://doi.org/10.3390/pathogens12010106

6.4. Entamoeba histolytica

Entamoeba histolytica is an anaerobic parasite, causing disease in humans and other primates called amoebiasis. The infection can occur after ingestion of food or water contaminated by faeces of infected people. The cysts (eggs) of Entamoeba are readily killed at high (cooked, boiled) and low (freezing) temperatures. Under moist conditions, cysts can survive outside of the hosts for a few months. The trophozoite (active stage) of Entamoeba can exist only in the host or in fresh loose faeces. The amoeba can get into the intestinal wall and reach the blood stream. From there, it can reach to the other vital organs of the human body (liver, lungs, brain or spleen). Infection can be asymptomatic or mild (e.g. occasional loose stools, abdominal cramps, abdominal distension, loss of appetite and weight loss). In some cases, it can lead to severe amoebic dysentery or amoebic liver abscess.

Symptoms can include: bloody diarrhoea, weight loss, fatigue, abdominal pain, amoebic abscesses on liver (single or multiple), and ameboma (colon carcinoma-like lesion)[50].

Risk reduction of contamination and poisoning is possible by: drinking only bottled, filtrated, boiled or chemically treated water. Eat only cooked food. Rinse carefully fresh fruits or vegetables under clean running water. Avoid unpasteurized milk and dairy products.

6.5. Cyclospora cayetanensis

Cyclospora cayetanensis is a microscopic parasite, that causes an acute or chronic diarrheal disease in humans and other primates called cyclosporiasis. People get sick after consuming food or water contaminated by faeces of infected humans. Direct transmission from human to human is unlikely because oocysts excreted in the faeces need time for sporulation in the external environment, outside the host (one to several weeks). The incubation period is typically around 7 days after ingestion mature oocysts and illness can self-limit in 6 weeks. Infection can be asymptomatic, or mild symptoms can include chronic watery diarrhoea without blood and mucus, loss of appetite, weight loss, fatigue, cramping abdominal pain, increased flatulence, nausea, and low-grade fever[51].

[50] Andrea Servián, Elisa Helman, María del Rosario Iglesias, Jesús Alonso Panti-May, María Lorena Zonta and Graciela Teresa Navone. Prevalence of Human Intestinal Entamoeba spp. in the Americas: A Systematic Review and Meta-Analysis, 1990–2022. Pathogens 2022, 11(11), 1365; https://doi.org/10.3390/pathogens11111365

[51] Agni Hadjilouka and Dimitris Tsaltas. Cyclospora Cayetanensis—Major Outbreaks from Ready to Eat Fresh Fruits and Vegetables. Foods 2020, 9(11), 1703; https://doi.org/10.3390/foods9111703

Risk reduction of contamination and poisoning is possible by: washing hands with soap and warm, clean, running water before preparing and eating food. Wash fresh fruits and vegetables that will not be cooked before eating under warm water. Use separate knives, cutting boards and dishes for meat and fruits and vegetables. Store fruits and vegetables separately from raw meat, poultry or seafood.

6.6. Sarcocystis

Sarcocystis is a genus of protozoan parasites including over 130 species infecting mammals, reptiles and birds. Only Sarcocystis hominis and Sarcocystis suihominis use humans as definitive hosts and cause intestinal sarcocystosis in humans. After the accidental swallowing of oocysts of non-human Sarcocystis spp., people may also become end hosts. In cases of intestinal sarcocystosis, infections are often asymptomatic and clear spontaneously. Sometimes, low to mild fever, chills, diarrhoea, nausea, vomiting and respiratory problems may occur. When humans are the end host, the infection take muscular form. In these cases, may occur: myalgia, muscle weakness and transitory oedema.

Symptoms begins in 3-6 hours (intestinal form) or weeks to month (muscular form) and lasts in 36 hours (intestinal) or months to years (muscular)[52].

Risk reduction of contamination and poisoning is possible by: cooking thoroughly cattle or pork meat before eating. Freezing the cattle or pork meat at −5°C for several days.

6.7. Trichinella spiralis

Trichinella spiralis is a species of parasitic nematode. It is one of the most dangerous human parasites. It causes the disease called trichinosis. Trichinosis is cause by eating raw or undercooked meat of pigs, horses or wild boars.

Intestinal, initial **symptoms** can begin in 1–2 days after the infection and include: abdominal discomfort, diarrhoea, nausea, vomiting, fatigue and fever. Further symptoms, like headache, high fever, cough, chills, swelling of the face and eyes, muscles and joints pains, itchy skin, diarrhoea, or constipation, occur in 2-8 weeks later. Intensity of symptoms (from very mild to severe) are related to the number ingested parasites. In mild to moderate cases most symptoms last few months,

[52] Lisa Guardone, Andrea Armani, Francesca Mancianti and Ezio Ferroglio. A Review on Alaria alata, Toxoplasma gondii and Sarcocystis spp. in Mammalian Game Meat Consumed in Europe: Epidemiology, Risk Management and Future Directions. Animals 2022, 12(3), 263; https://doi.org/10.3390/ani12030263

muscles and joints pain, weakness and fatigue may last for many months. In severe infection, patients may have hearth and breathing problems and difficulty with movements coordination. In very severe cases, infection can be fatal[53].

Risk reduction of contamination and poisoning is possible by: cooking pork and venison thoroughly. Salting, drying or smoking process does not kill the parasites. Use only examined meat from trusted sources. Clean carefully all kitchen equipment (knives, cutting boards and especially meat grinders) after using.

[53] Olimpia Iacob, Ciprian Chiruță and Mihai Mareș. Trichinella spiralis and T. britovi in North-Eastern Romania: A Six-Year Retrospective Multicentric Survey. Vet. Sci. 2022, 9(9), 509; https://doi.org/10.3390/vetsci9090509.

7. The most common food borne viruses[54]

7.1. Hepatitis A

Hepatitis A virus (HAV) is a pathogenic virus, which can be found in the intestines and blood of people and the environment (soil, water) contaminated by faeces of infected humans. After ingestion even very small amount of HAV, causes an infection of the intestines and liver called hepatitis A or food jaundice. The infection is always contagious and can transmitted from person to person thought direct contact ("dirty hands" disease). Hepatitis A is usually a short-term infection and does not cause chronic liver disease.

In most cases, **symptoms** are mild and include: fever, nausea, diarrhoea, loss of appetite and weight, weakness, joint and muscles pain, stomach pain, dark colour of urine and yellowing skin or whites of eyes. Symptoms usually become in 2-4 weeks after exposure and generally last for 1-2 weeks (sometimes can continue for a few months). In cases of elder people or patients with weakened immune systems, hepatitis severe symptoms and acute liver failure, which is often fatal may be observed. Children under 6 years old can have no noticeable symptoms of infection.

People get infected by eating contaminated food (raw shellfish and oysters, fresh salads, fruits, vegetables, or any other foods prepared by infected people) or drinking untreated water[55].

Risk reduction of contamination and poisoning is possible by: vaccination. Thoroughly wash hands with soap and clean water before preparing and eating food, or after using the bathroom. Avoid eating raw or undercooked seafood. Rinse carefully fresh fruits and vegetables before eating. Drink only bottled or chemically treated water.

7.2. Hepatitis E

Hepatitis E virus (HEV) can be found in the intestines of people. HEV causes the hepatitis type E. The infection of the intestines and liver. In many cases infection HEV is mild and self-limited, not causing long-term liver complications. Young children may have no noticeable symptoms. Severe illness is possible in vulnerable people like

[54] The chapter prepared on the basis of report 5.4 concerning Best practices for prevention of food CBRN incidents – project Creation of CBRNE protection system for large area shopping malls IFS Grant Agreement No. 861643 – Mall – CBRN authored by University of Lodz.

[55] Yoonjeong Yoo, Miseon Sung, Jeongeun Hwang, Daseul Yeo, Ziwei Zhao, Changsun Choi, and Yohan Yoon. Quantitative Risk Assessment of Hepatitis a Virus Infection Arising from the Consumption of Fermented Clams in South Korea. Foods 2023, 12(4), 796; https://doi.org/10.3390/foods12040796

pregnant women, elder people and people with other liver diseases or weakness immune systems.

The first **symptoms** of infection become in 5 to 6 weeks after exposure and include mild fever, nausea, vomiting, reduced appetite, stomach pain, joint pain, jaundice, rash, dark-coloured urine and pale stools. In some cases, hepatomegaly (enlarged and tender liver) is observed. Symptoms usually go away in 1 to 6 weeks without liver damage. Pregnant women show a more severe infection than other patients. Liver failure can be fatal in 20% to 25%.

HEV can also break the placenta barrier and infect the foetus and may cause preterm delivery, stillbirth or neonatal death. People get infections generally through drinking contaminated, untreated water and poor hygiene standards ("dirty hands" disease), as well as eating raw or undercooked pork, venison or seafood[56].

Risk reduction of contamination and poisoning is possible by: thoroughly washing hands with soap and clean water before preparing and eating food, or after using the bathroom. Thoroughly cooking meat, especially pork and venison products. Avoid eating raw or undercooked seafood. Drink only bottled or chemically treated water.

7.3. Rotaviruses

Rotaviruses are a genus of viruses that cause severe diarrhoeal intestine infections. The genus includes 9 species named from "A" to "J", but only "A", "B" and "C" species can cause human diseases. Infection of Rotaviruses is highly contagious (infection dose less than 100 virus particles) and can be transmitted through faecal-oral or respiratory route and direct or indirect contact with infected people (hands, surfaces or objects). Viruses are stable in the external environment and can survive 9 to 19 days outside the host. Rotaviral intestine infection is a mild to severe disease.

Symptoms often start in 2 days after exposure and include: nausea, vomiting, watery diarrhoea and mild-range fever. In some cases, it can lead to severe dehydration. Rotavirus infections can occur throughout life because vaccines or natural infections do not provide full immunity. The first infection usually produces symptoms and may be severe, but the next is typically mild or asymptomatic. The most severe symptoms may occur in young children (from 6 months to 2 years of age), the elderly, and patients with immunodeficiency. The healthy adults are not susceptible to rotavirus[57].

[56] Owada, K.; Sarkar, J.; Rahman, M.K.; Khan, S.A.; Islam, A.; Hassan, M.M.; Soares Magalhães, R.J. Epidemiological Profile of a Human Hepatitis E Virus Outbreak in 2018, Chattogram, Bangladesh. Trop. Med. Infect. Dis. 2022, 7, 170. https:// doi.org/10.3390/tropicalmed7080170

[57] Serhii O. Soloviov, Tetiana S. Todosiichuk, Olena V. Kovaliuk, Gabriel M. Filippelli, Olena P. Trokhymenko, Iryna V. Dziublyk and Zachary A. Rodd. Rotaviruses and Noroviruses as Etiological Agents of Acute Intestinal Diseases of Ukrainian Children. Int. J. Environ. Res. Public Health 2022,

Risk reduction of contamination and poisoning is possible by: vaccination. Thoroughly wash hands with soap and clean water before preparing and eating food, or after using the bathroom. Thoroughly cleaning the surfaces and objects (especially toilets) with disinfectants containing sodium hypochlorite.

7.4. Astroviruses

Astroviruses are pathogenic for humans and animals. It includes over 8 identified serotypes that cause gastroenteritis diseases in humans. Astroviruses are associated with approx. 10% of the gastroenteritis diseases in young children. However, humans of all ages are susceptible. The incubation period is approx. 3 to 4 days.

The main **symptoms** of infection are: diarrhoea, followed by nausea, vomiting, mild fever, weakness and stomach pain. Dehydration is very rare, and in most cases, the symptoms will reduce by themselves after 2 to 4 days. In groups of high-risk patients (very young children, elderly and people with immunodeficiency or malnutrition) Astroviruses can cause severe dehydration, which could require hospital care.

The Astroviruses are transmitted via the oral-faecal route. However, the main mode of transmission is eating or drinking contaminated food products[58].

Risk reduction of contamination and poisoning is possible by: compliance with good food handling practices. Compliance with good hygiene practices. Disinfection of surfaces and objects.

7.5. Noroviruses – formerly Norwalk virus

It was named after Norwalk, Ohio where it was first isolated in 1968. It can be a significant problem in developing countries without proper water treatment. This is also the virus that commonly affects cruise ships. Noroviruses are a group of pathogenic viruses that cause acute stomach and/or intestines inflammation. Noroviruses group include 10 genogroups and 48 genotypes. Infections of Rotaviruses are highly contagious (infection dose is 10-100 virus particles) and can be transmitted through faecal-oral or respiratory routes and direct or indirect contact with infected people (hands, surfaces or objects).

Symptoms become usually in 1-2 days after exposure (eating contaminated food,

19(8), 4660; https://doi.org/10.3390/ijerph19084660

[58] Diem-Lan Vu, Albert Bosch, Rosa M. Pintó and Susana Guix. Epidemiology of Classic and Novel Human Astrovirus: Gastroenteritis and Beyond. Viruses 2017, 9(2), 33; https://doi.org/10.3390/v9020033

touching contaminated surfaces or objects), and include: frequent vomiting, nausea, muscles and head pain, moderate watery diarrhoea, low-range fever. In the case of very young children, elders and immunodeficiency people vomiting and diarrhoea can cause severe dehydration. In healthy people, the main symptoms are reduced by themselves in 1 to 3 days. Noroviruses are stable outside the host, heat resistant (inactivation in 30 minutes in 60°C), and for alcohol-based disinfectant[59].

Risk reduction of contamination and poisoning is possible by: thoroughly washing hands with soap and clean water before preparing and eating food, or after using the bathroom. Thoroughly cleaning the surfaces and objects (especially toilets) with disinfectants containing sodium hypochlorite. Rinse carefully fresh fruits and vegetables before eating. Avoid eating raw or undercooked seafood.

[59] Elias P. Papapanagiotou. Foodborne Norovirus State of Affairs in the EU Rapid Alert System for Food and Feed. Vet. Sci. 2017, 4(4), 61; https://doi.org/10.3390/vetsci4040061.

8. The most common food borne - prions[60]

8.1. Prions

Bovine Spongiform Encephalopathy (BSE) and Creutzfeldt-Jakob Disease (CJD) are diseases that are associated with the accumulation of abnormal protein in the brain (prions). Mad cow disease is not viral. It is caused by so-called “prions”. Misfolded proteins are found in the brain of infected animals. In humans, a disease called Creutzfeldt-Jacob disease produces similar symptoms and brain pathology. During the last decades this typically old-age disease was also observed in young patients. Most of them live in Great Britain and are called variant Creutzfeld-Jakob (vCJD). The disease could be traced back to eating cow meat from animals with mad cow disease. Previously populations with strange dietary habits like cannibalism in Papua New Guinea or eating monkey brains in the Far East were also associated with cCJD. Extremely resistant to heat, UV light, ionizing radiation, sterilizing processes, disinfectants -DNAse/ RNAse -Phenols.

Prions are misshaped proteins. Their 3-dimensional conformation is crucial to infectivity. Typically, phenols are used to denature proteins, but phenols do not denature prions. Surprisingly, ozone may have some efficacy against prions. So far only very high temperatures have been shown to effectively destroy prions.

It is believed that food containing carcass material from sheep with scrapie was the original source for the mad cow disease. Once a cow is infected, it may transmit the disease to other cows.

Humans can get infected by eating meat from diseased cows. It cannot be excluded that prions can be transmitted through cosmetics or food additives that contain bovine material. Transmission from human to human through blood and tissue transplants was also proven[61].

Risk reduction of contamination and poisoning is possible by: washing hands and exposed skin before eating, drinking or smoking. Do not eat parts of the cow like the brain and spinal cord.

[60] The chapter prepared on the basis of report 5.4 concerning Best practices for prevention of food CBRN incidents – project Creation of CBRNE protection system for large area shopping malls IFS Grant Agreement No. 861643 – Mall – CBRN authored by University of Lodz.

[61] Edgar Holznagel, Barbara Yutzy, Carina Kruip, Par Bierke, Walter Schulz-Schaeffer, Johannes Löwer. Foodborne-Transmitted Prions From the Brain of Cows With Bovine Spongiform Encephalopathy Ascend in Afferent Neurons to the Simian Central Nervous System and Spread to Tonsils and Spleen at a Late Stage of the Incubation Period. J Infect Dis 2015 Nov 1;212(9):1459-68. doi: 10.1093/infdis/jiv232. Epub 2015 Apr 20.

9. The most common food borne toxins[62]

9.1. Ricin

Ricin toxin is a natural poison found in castor beans. It can be acquired from whole beans or from the waste material arising in the technological processing of castor beans. The toxin can be in different forms: powder, pellet, mist and it can be dissolved in water or weak acid dilution. Under normal conditions ricin toxin is stable, inactivation occurs at temperature 80 °C or higher.

After ricin ingestion, initial **symptoms** occur in less than 6 -12 hours (depending on the amount ingested). Initial symptoms affect the gastrointestinal system and include: stomach pain, nausea and vomiting, often bloody. In result, after the next 12 hours, severe dehydration and problems with kidney, liver and blood pressure become. Late symptoms may include low blood pressure, seizures and blood in urine. After several days the liver, kidneys and spleen might stop working and victims of poisoning can die.

Currently, there is no antidote for ricin. In treatment, the most important thing is to quickly remove the toxin from the organism, without inducing vomiting. Supportive medical care in case of ingestion poisoning, includes giving intravenous fluids (not to drink), activated charcoal or stomach flushing (only in few hours after ingestion)[63].

Risk reduction of contamination and poisoning is possible by: no antidote, vaccine, or effective treatment is available. Best practices for the prevention of ricin are still under development.

9.2. Botulinum toxin

Botulinum toxin is a neurotoxin produced by Clostridium botulinum bacteria strains. Botulinum toxin is one of the most poisonous biological substances. A lethal dose in humans is 1.3–2.1 ng/kg of body weight. It is resistant to gastrointestinal tract enzymes but will be inactivated after 15-20 minutes at 100°C temperature (pasteurisation, boiling). Foodborne botulism can happen after consuming food contaminated by botulinum toxin. Foods at high risk are improperly homemade canned, pasteurised or fermented foods.

[62] The chapter prepared on the basis of report 5.4 concerning Best practices for prevention of food CBRN incidents – project Creation of CBRNE protection system for large area shopping malls IFS Grant Agreement No. 861643 – Mall – CBRN authored by University of Lodz.
[63] Jennifer Audi, Martin Belson, Manish Patel, MSc; Joshua Schier, John Osterloh. Ricin Poisoning A Comprehensive Review. JAMA. 2005;294(18):2342-2351. doi:10.1001/jama.294.18.2342.

Symptoms of foodborne usually start in 18-36 hours but can also occur in several days after ingestion of the toxin (depending on the amount of ingested toxin). Typically, symptoms include blurred and double vision, nausea, vomiting, muscles weakness, trouble in breathing and swallowing, reduced or absent nerve reaction. In treatment, antitoxin is available and reduces the harm and mortality, but not healing done damage[64].

Risk reduction of contamination and poisoning is possible by: do not try canned food to check if they are still good. Discard any cans, which bulging, leaking, or appear damaged. Make certain, that all foods, which are served are well-cooked. Retain oils infused with e.g. garlic or herbs in the refrigerator. Separate raw and cooked food. Store food at safe temperatures. The potatoes that have been baked should be kept in foil hot until eaten. Do not give honey or corn syrup to infants under 1 year old.

9.3. Staphylococcal Enterotoxin type B (SEB)

Staphylococcal Enterotoxin type B (SEB) is a toxin produced by Staphylococcus aureus bacteria strains. SEB is resistant to proteolysis enzymes in the gastrointestinal tract (pepsin, trypsin) and high temperatures. The dose that causes symptoms of poisoning in humans ranges from 20 to 100 ng/kg. The symptoms of poisoning develop quickly, approximately 30 minutes after consuming foods contaminated by toxins and last in 1-2 days. Food products at high risk of contamination are sliced meats, raw milk and dairy products. Staphylococcal Enterotoxin B does not change food taste or smell. In treatments, the most important is drinking plenty of fluids or in severe cases, giving medicines decreasing vomiting and intravenous fluids. Antibiotic therapy does not show any results in the treatment of SEB poisoning[65].

Risk reduction of contamination and poisoning is possible by: avoid consuming unrefrigerated meats, dairy, and bakery products. SEB can be destroyed by heating food and water to 100°C for a couple of minutes. For the purpose of decontamination soap and water is recommended. Foods suspected or contaminated by SEB should be discarded.

[64] Davide Lonati, Azzurra Schicchi, Marta Crevani, Eleonora Buscaglia, Giulia Scaravaggi, Francesca Maida, Marco Cirronis, Valeria Margherita Petrolini and Carlo Alessandro Locatelli. Foodborne Botulism: Clinical Diagnosis and Medical Treatment. Toxins 2020, 12(8), 509; https://doi.org/10.3390/toxins12080509

[65] Irina V. Pinchuk, Ellen J. Beswick, and Victor E. Reyes. Staphylococcal Enterotoxins. Toxins (Basel). 2010 Aug; 2(8): 2177–2197. doi: 10.3390/toxins2082177

9.4. Algal toxins (seafood toxins)

Algal toxins are produced by diatoms and dinoflagellates in the salt water of sea, oceans and bays. Harmful algal bloom toxins include: brevotoxin, saxitoxin, azaspiracid, dinophysistoxin, ciguatoxin, domoic and okadaic acids. Algal toxins are accumulated in many species of shellfish or sea fish during filter-feeding. People get sick after eating seafood containing toxins, or drinking contaminated water because the toxins are not destroyed by high or low temperatures. Food products at higher risk are: clams, crabs, coral fish, oysters, scallops, tuna, marlin, anchovy and sardines.

Symptoms occur usually 30 minutes to 6 hours after ingesting the toxin. They depend on the type of consumed toxin, but generally include: stomach pain, nausea, vomiting, diarrhoea, shortness of breath, headache and weakness. In a healthy person, the symptoms of not severe poisoning disappear within a few days, without any dedicated treatment (only supportive care). In severe cases, it can cause coma, paralysis, memory loss, disorientation, irregular heartbeat, respiratory failure and finally can be fatal[66].

Risk reduction of contamination and poisoning is possible by: shellfish products should be purchased only from reputable and licensed seafood brokers or stores. Avoid serving the viscera, gonad and roe. Toxins are heat stable. They cannot be destroyed through the cooking process. However, cooking at 100^0C until their shells open, hence boiling for an additional 5 minutes will reduce the risk caused by contamination.

9.5. Mycotoxins

Mycotoxin is a group of toxic metabolites produced by some genus of fungi (Aspergillus, Penicillium, Rhizoctonia, Fusarium, Claviceps). It can cause rare diseases in humans and animals. Major groups of mycotoxins include aflatoxins (produced by Aspergillus flavus and parasiticus), ochratoxins (Penicillium and Aspergillus species), citrinin (Penicillium citrinum and other Penicillium and Aspergillus species), ergot alkaloids (Claviceps species), patulin (Penicillium expansum and other Aspergillus, Penicillium, and Paecilomyces species) and fusarium toxins (Fusarium species). People can get poisoning after directly eating contaminated food products. Mycotoxins can contaminate food because of fungal infection of crops or livestock feeding products. The food products at high risk of contamination by mycotoxins are

[66] Stephanie L Hinder, Graeme C Hays, Caroline J Brooks, Angharad P Davies, Martin Edwards, Anthony W Walne & Mike B Gravenor. Toxic marine microalgae and shellfish poisoning in the British isles: history, review of epidemiology, and future implications. Environmental Health volume 10, Article number: 54 (2011)

dry spices (red chili, ginger, pepper, etc.), beverages (beer, wine, juice), cereals (wheat, rye, barley, oats, rice and corn), food coloured with Monascus pigment.

Prevention methods include using chemical and biological fungicide in crops, control of temperature and humidity conditions during storage of cereals grains, irradiation and photodynamic treatment. Mycotoxins can cause acute and chronic poisoning called mycotoxicosis.

The **symptoms** depend on the type, amount and time of exposure of mycotoxin, but generally they cause gastrointestinal complaints (nausea, diarrhoea, vomiting), and sometimes also severe liver damage, euphoria, hallucinations, skin inflammation, neurological disorders (e.g. convulsions), bleeding and even miscarriages. Severe poisoning can be fatal[67].

Risk reduction of contamination and poisoning is possible by: the grains and nuts should be consumed as fresh as possible. Store food products properly. Food products should be protected from insects and stored in dry not too warm environment. Do not keep food products for extended periods of time before using.

9.6. Aflatoxins

Aflatoxins are a one of the type of mycotoxins, produced by Aspergillus species (flavus and parasiticus mainly). Fungal species produced aflatoxins were found in rotting plants, fruits and soil. Fungal spores are dispersed by insects and wind and as a result they attack agricultural crops. Infection can occur during the growth of the plant, as well as during processing, storage or transport. Major types of aflatoxins are B1, B2, G1, G2, M1 and M2, the most harmful for humans is aflatoxin B1. Aflatoxins can cause acute and chronic poisoning, allergies, as well as serious diseases of the liver, respiratory, digestive and immune systems. They are also classified as mutagenic and highly carcinogenic substances. They cause primary liver cancer and stomach, oesophageal, soft tissue and leukaemia cancers. The symptoms depend on the amount of ingested toxins and the time of exposure.

Initial **symptoms** include allergic signs (rhinitis, conjunctivitis, laryngitis, headaches and skin changes). Symptoms of acute aflatoxin poisoning include: pulmonary oedema, cough, shortness of breath, internal bleeding, abdominal pain, nausea, vomiting, fever, jaundice, convulsions, and coma. Chronic poisoning can lead to: cirrhosis of the liver, kidney damage, severe skin and respiratory allergies, growth disorders in children, mental disorders, swelling of the limbs.

Aflatoxins can be found in incorrect stored food imported from tropical countries

[67] Jagoda Kępińska-Pacelik and Wioletta Biel. Mycotoxins—Prevention, Detection, Impact on Animal Health. Processes 2021, 9(11), 2035; https://doi.org/10.3390/pr9112035

(peanuts, almonds, raisins, dates, figs, cereal grains - especially in rice and corn), spices, vegetable oils, and even meat and dairy products from animals feeding contaminated feed[68].

Risk reduction of contamination and poisoning is possible by: the nuts and nut butters should be purchased only from major commercial brands. The nuts, which look mouldy, discoloured, shrivelled should be discarded. Enforce strict food safety standards.

[68] Solomon Abrehame, Valsa Remony Manoj, Merry Hailu, Yu-Yi Chen, Yu-Chun Lin and Yen-Po Chen. Aflatoxins: Source, Detection, Clinical Features and Prevention. Processes 2023, 11(1), 204; https://doi.org/10.3390/pr11010204

10. The most common food borne - chemicals[69]

10.1. Lead

Lead has been used by humans since pre-historic times and still is used in industry and crafts. Lead was used in water pipes and can therefore be a problem in older houses and neighbourhoods. Lead is still used in lead glazed pottery and lead-soldered cans. If these items encounter acidic foods, lead can easily leach out and contaminate the food item. Thanks to increased awareness about the negative health effects of lead, various laws were issues that resulted in a strong reduction of lead in our environment and food. It is estimated that the daily average intake of lead from food is around 20ug/day, down from 400-500 ug/day in the 1940s. This intake can be considerably higher under certain circumstances, i.e. old lead water-pipes, lead-glazed dishes, and uptake of lead from paint chips and house dust in old houses by babies and little children.

Lead is neurotoxic. Exposure of children to lead causes a blood lead level of 10ug/dL. Lead lowers the IQ by about 4-7 points. For a population a downshift of the average IQ by only 5 points results in a decrease in highly gifted individuals and an increase in mentally retarded once by about 57%[70]. Such a shift would not easily be recognized, but the consequences for society and the individual are enormous.

Food decreased dietary intake from 400-500ug/day (1940s) to < 20 ug/day now. Environment - paint, lead dust in households. Drinking water (about 10ug/day, seldom 20ug)[71].

Risk reduction of contamination and poisoning is possible by: washing vegetables and fruit in order to remove dust and soil (may contain lead). Remove outer leaves from leafy greens and peel root crops. Wash your hands before preparing food.

[69] The chapter prepared on the basis of report 5.4 concerning Best practices for prevention of food CBRN incidents – project Creation of CBRNE protection system for large area shopping malls IFS Grant Agreement No. 861643 – Mall – CBRN authored by University of Lodz.

[70] J Schwartz. Low-level lead exposure and children's IQ: a meta-analysis and search for a threshold. Environ Res
. 1994 Apr;65(1):42-55. doi: 10.1006/enrs.1994.1020.

[71] Marcella Malavolti, Susan J Fairweather-Tait, Carlotta Malagoli, Luciano Vescovi, Marco Vinceti, Tommaso Filippini. Lead exposure in an Italian population: Food content, dietary intake and risk assessment. Food Res Int . 2020 Nov;137:109370. doi: 10.1016/j.foodres.2020.109370. Epub 2020 Jun 2.

10.2. Mercury

Mercury is a natural component in the earth's crust. Mercury use in the chemical industry and metal processing and release during coal burning and waste incineration has increased the atmospheric mercury level considerably. This is a problem, since mercury is highly persistent and biomagnifies in ecosystems. A major source of human mercury exposure, especially of the highly toxic methylmercury, is through fish consumption. Mercury has the potential to cause severe health damage, affecting multiple organs, but especially the CNS (Central Nervous System).

Risk reduction of contamination and poisoning is possible by: limit the amount of fish you eat. In case of woman, avoid fish consuming, if you're pregnant or breastfeeding.

10.3. Persistent Organic Pollutants (POPs)

POPs are persistent, lasting for years or decades before degrading. Often highly toxic, damaging the CNS, endocrine system, reproduction and others. Evaporate and travel long distances; since this depends on the temperature, POPs travel from warm to cold climates. Accumulation in fatty tissue; this leads to "bioaccumulation" and "biomagnification". Unlike metals which are natural compounds, POPs are manmade and a problem of the "chemical revolution" of the 20th century. This large group of compounds has several characteristics in common. They are persistent, because they don't degrade easily in the environment. They are often highly toxic to specific or all species. They evaporate and can travel long distances in the air, thus reaching regions of the world where they have never been produced or used, like mountain lakes in the Himalayas and the Arctic. They accumulate in fatty tissue due to their lipophilicity, which results in bioaccumulation and biomagnification[72].

Risk reduction of contamination and poisoning is possible by: use natural cleaning solutions and thorough equipment cleaning. Ensure that the food products are from a certified source.

[72] Hing Man Chan, Kavita Singh, Malek Batal, Lesya Marushka, Constantine Tikhonov, Tonio Sadik, Harold Schwartz, Amy Ing, and Karen Fediuk. Levels of metals and persistent organic pollutants in traditional foods consumed by First Nations living on-reserve in Canada. Can J Public Health. 2021 Jun; 112(Suppl 1): 81–96. doi: 10.17269/s41997-021-00495-7

10.4. Dioxins

Dioxins and dioxin-like compounds (DLCs) are a group of highly poisonous chemical compounds that are persistent organic pollutants in the environment, belonging to the type of chlorinated aromatic hydrocarbons. Group includes over 400 compounds that are released into the environment as a result of human activity (wastes burning, accidental and wildfires, metal smelting and refining). Dioxins accumulate in environment and can be released to food products, like fish and seafood, fat meat, milk and dairy products and drinking water. Acute dioxin poisonings are reported extremely rare and are associated with direct exposure to high doses.
The **symptoms** include chloracne, skin discoloration, rash, and moderate liver damage. Symptoms of long-term exposition for small doses and accumulation in organism include: disorders of the central and peripheral nervous system, chronic skin allergies, increased susceptibility to infections, hormonal disorders, lung and liver cancer, infertility, foetal damage, increased risk of cardiovascular diseases and diabetes, lower bone strength.

Risk reduction of contamination and poisoning is possible by: removing fat from meat and consuming low fat dairy products. Introduce a balanced diet (including fruits, vegetables and cereals).

10.5. Arsenic

Arsenic is a chemical heavy and toxic metal, found in water, air, food and soil as a naturally occurring substance or due to contamination from human activity. The sources of contamination are herbicides, defoliants, dyes (tanning), glass (pigments), batteries, accumulators, pollution by smelters (copper and other metals) and coal mines. From the contaminated environment, arsenic gets into food products: fish (seafood, tuna, salmon, sardines, mackerel), poultry, plants (rice and its products), mushrooms, beer and wine. The toxic dose for humans ranges from 10 to 50mg, a single dose of 70 to 200mg causes instant death.

Symptoms due to dose and time of exposure. Acute symptoms become from 1 to 30 hours after exposure to higher doses: severe vomiting, diarrhoea, headaches, drop in blood pressure, loss of consciousness, toxic liver damage, cerebral haemorrhage, shock and finally death. Late symptoms occurring after several years (exposure to low doses over a long period of time: kidney, skin, lung, liver, bladder cancer, dermatitis (keratosis, hyperpigmentation), chronic diarrhoea and vomiting, mucosal and conjunctivitis, sensory and movement neuropathies.

Arsenic is a natural component in soil and water. Some areas have higher arsenic levels than others. Arsenic is the primary cause of black foot disease, the first sign of arsenic poisoning that was observed in Bangladesh after new wells delivered arsenic-laden water from high arsenic soil strata to the population. Arsenic has several useful

applications. The major use of arsenic nowadays is in pesticides, but it is also used in some forms in medicine and the electronic industry. Occurrence and use: natural soil and ground water component. Pesticides (80% of use), medicine (trypanosomiasis, chemotherapy), computer chips, semiconductors, glassware, paints. Uptake: food (~10µg/day, other sources estimate 1mg/day), water (~10µg/day, assuming 5µg/L water). The allowance reduced since 1/2006 to 10µg/L. Arsenic is a carcinogen and teratogen[73].

Risk reduction of contamination and poisoning is possible by: safe drinking water is a priority. Ensure that the food products are from a certified source.

10.6. Tin metal

Tin is a metallic compound found naturally in the environment. Sources of food contamination are mainly preserved food cans, organotin pesticides, plastic packaging where tin compounds are used as stabilizers. Inorganic tin compounds cause various types of anaemia by disrupting heme formation. Organic compounds are much more dangerous. They are almost as toxic as cyanide. They cause damage to the nervous and digestive systems (bile ducts). They damage the thymus gland.

Symptoms include: lack of appetite, diarrhoea, vomiting, muscle weakness, convulsions, photophobia, balance disorders, toxic liver damage, cholangitis, porphyria, kidney damage, nervous system damage, increased intracranial pressure, brain damage. It causes anaemia, respiratory system disorders, erythematous skin lesions and difficult to heal wounds[74].

Risk reduction of contamination and poisoning is possible by: do not use canned food in incorrectly manufactured tins (especially canned tomatoes).

10.7. Acrylamide

Acrylamides are chemicals that can form during the cooking or processing of certain starchy foods. Acrylamides can cause skin, gastrointestinal and lung cancer or nervous system damage. Acrylamides were detected in many food products including coffee,

[73] https://pmj.bmj.com/content/79/933/391

[74] Anirban Goutam Mukherjee, Kaviyarasi Renu, Abilash Valsala Gopalakrishnan, Vishnu Priya Veeraraghavan, Sathishkumar Vinayagam, Soraya Paz-Montelongo, Abhijit Dey, Balachandar Vellingiri, Alex George, Harishkumar Madhyastha, and Raja Ganesan. Heavy Metal and Metalloid Contamination in Food and Emerging Technologies for Its Detection. Sustainability 2023, 15(2), 1195; https://doi.org/10.3390/su15021195

tea, fried or roasted potato products (chips, frites), and cereal-based products (sweet biscuits or toasted bread)[75].

Risk reduction of contamination and poisoning is possible by not storing the potatoes in the refrigerator or in lighting places. Process the food products by boiling, steaming or microwaving.

10.8. Cyanide

Cyanide is a very strong poison, fast and violent acting. The most common cause of poisoning is hydrogen cyanide - a volatile gas with the characteristic smell of bitter almonds. In food products, it can be found as a result of intentional adding in powdered form (potassium cyanide salt crystals), causing death after a few hours. The lethal dose for humans is 150-500mg (95% lethality).

Symptoms of poisoning include: headache, tinnitus, shortness of breath with tightness in the chest, vomiting, faster and weaker pulse, drop in blood pressure, coma, pink colour of the skin. Less specific symptoms include: irritation of the mucous membranes, feeling of scratching in the throat, burning tongue, conjunctivitis, cardiac arrhythmia, states of agitation, mydriasis[76].

Risk reduction of contamination and poisoning is possible by: cooking, in most cases eliminates the cyanide compounds. Store food products in sealed glass or metal containers. Wash the outside of the container before using. Avoid using the food products, if smells, tastes, or looks unusual.

10.9. Cadmium

Cadmium was first discovered in 1817 and unlike many other metals is only a trace element. Nevertheless, it is a health concern because cadmium bioaccumulates (uptake higher than excretion) and the likelihood of exposure has increased significantly during the last decades since the usefulness of cadmium was discovered and industrial use increased. Cadmium is not corroding, a characteristic that makes this metal highly desirable for many industries. Cadmium is taken up and accumulated at very different degrees in different plants. Unfortunately, some major food plants like

[75] Health Implications of Acrylamide in Food. https://apps.who.int/iris/bitstream/handle/10665/42563/9241562188.pdf;jsessionid=A6231C2DD7663E46474DB8F3E2B81C1A?sequence=1

[76] Tara B. Hendry-Hofer, Patrick C. Ng, Alyssa E. Witeof, Sari B. Mahon, Matthew Brenner, Gerry R. Boss, and Vikhyat S. Bebarta. A Review on Ingested Cyanide: Risks, Clinical Presentation, Diagnostics, and Treatment Challenges. J Med Toxicol. 2019 Apr; 15(2): 128–133. doi: 10.1007/s13181-018-0688-y

wheat and rice and tobacco have a high uptake rate for cadmium. If these plants are grown in soil that is contaminated with cadmium, due to run-off from a factory or use of cadmium-containing sewage sludge for example, the levels of cadmium can be very high. Other foods that can contain high levels of cadmium are shellfish and organ meats (e.g. kidney, liver). Cadmium has a half-life (the time during which half of the incorporated compound is excreted) of about 10-30 years. Adverse health effects are expected when the lifetime uptake has reached 2000mg. The average uptake through food, water and air is estimated as 10 – 40ug/day, but that is an estimated average, and individual uptakes may be much higher. Major health effects of cadmium are nephrotoxicity (affects the kidney) and in older women bone weakening (itai-itai disease), due to high accumulation in these organs, but cadmium was also shown to induce cancer, systolic hypertension and lung damage.

Occurrence and use: a byproduct of Zn and Pb mining and smelting. Released by coal burning. Industrial use has been increasing for the last 50 years, and continues to increase. Electroplating, galvanizing, Ni-Cd batteries, colour pigment. Exposure: food - plant uptake of Cd from soil, sewage sludge, fertilizers, air deposition. High accumulation of Cd by rice, wheat, tobacco. Cadmium is present in high levels in shellfish (100-1000ug/kg); in meats, especially kidney and liver. Daily intake for humans is estimated on 10-40µg/day. Cadmium half-life is estimated on 10-30 years. Bioaccumulates to nephrotoxic levels. Accumulates in bone.

The **major sources** of cadmium in food are: rice, cereal grains, potatoes, vegetables, meats (mainly liver and kidneys)[77].

Risk reduction of contamination and poisoning is possible by: use the above mentioned products only from verified sources.

10.10. Nicotine

Nicotine is a very toxic, natural alkaloid that has an addictive effect. Found in tobacco roots and leaves. It can be in volatile or liquid form - a colourless or pale-yellow liquid with a sharp, burning taste (pure nicotine solution is colourless and almost odourless). It is a component of pesticides and insecticides. The toxic dose is 4-8mg of nicotine taken at one time. The lethal dose is 40-60mg for an adult.

The first **symptoms** of acute poisoning appear from 1 to 4 hours after exposure.

[77] Mehrdad Rafati Rahimzadeh, Mehravar Rafati Rahimzadeh, Sohrab Kazemi, and Ali-akbar Moghadamnia. Cadmium toxicity and treatment: An update. Caspian J Intern Med. 2017 Summer; 8(3): 135–145. doi: 10.22088/cjim.8.3.135

Tachypnoea, headache, dizziness, nausea, pallor, diarrhoea, sweating, drooling, tachycardia and an increase in blood pressure are observed. After the gradual disappearance of these symptoms, there is a period of weakness. After high doses of nicotine, there is a burning sensation in the mouth, throat, stomach and the above-mentioned symptoms, and after they slowly subside, the patient is exhausted and gets convulsions, respiratory weakness, cardiac arrhythmias, motor coordination disorders, and finally coma. Death occurs within 5 minutes to 4 hours. Chronic poisoning is characterized by the same symptoms but stretched over time. Long-term nicotine poisoning causes an increased incidence of cardiovascular diseases by increasing blood pressure, poorer blood supply to the vessels, and accelerates atherosclerotic processes in blood vessels. Vascular changes result in collapse states, angina pectoris, and destroy the coronary vascular system. Other symptoms are associated with the nervous system - poor memory, poor coordination of thoughts, slowing mental processes, decreased energy and general weakness[78].

Risk reduction of contamination and poisoning is possible by: keeping away all tobacco products, especially products containing liquid nicotine from food products. Store nicotine products in their original container.

[78] Nicotine Poisoning After Ingestion of Contaminated Ground Beef --- Michigan, 2003. https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5218a3.htm

11. The most common food borne - radionuclides[79]

Radionuclides or radioisotopes are nuclides of chemical elements, which possess excess nuclear energy and for this reason, are unstable. Radionuclides show radioactive decay (alpha, beta or gamma decay). Radioactive isotopes have found applications in many fields of science and economy (food preservation, nuclear medicine - cancer treatment, energy source, radiocarbon dating, non-destructive testing, mining). Food products and drinking water may be contaminated by radionuclides of natural or artificial origin from soil, water pathways or fallout. The sources of radionuclides in food include: radionuclides of natural origin, particularly radionuclides of potassium, carbon, polonium, uranium or thorium which are present throughout the environment[80]. Accidental releases as an effect of accidents in nuclear facilities (Windscale in 1957, Chernobyl in 1986 and Fukushima in 2011) are a main source of contamination of food products. The other way of contamination of food products may be intentional use as a terroristic act. Food products at high risk of high levels of accumulated radionuclides include: milk, nuts, forest mushrooms, fish, shellfish, offal (liver and kidneys), rice, leafy green vegetables and hedgerow fruits.[81]

Radioactive isotopes pose a threat to human health and life due to their easy absorption and ability to accumulate in the body. Radionuclides cause biological effects on human bodies that depend on the dose and time of influence on the human body. Radioisotopes after ingestion can cause cancer and teratogenic activity. In cases, when high doses of isotopes are ingested, they cause death in a few days. Radionuclide can cause cancers of the bones, thyroid, liver, lung, kidneys, myeloid leukaemia, and bone marrow atrophy. Children and embryos are particularly sensitive to radiation. Even small doses of radiation can cause mental retardation, stunted development, disability and cancer[82].

Risk reduction of contamination and poisoning is possible by: purchasing food only from checked sources. Avoid purchasing mushrooms from high radiation level regions. Avoid purchasing fish and shellfish from the sea nearest the nuclear power plants.

[79] The chapter prepared on the basis of report 5.4 concerning Best practices for prevention of food CBRN incidents – project Creation of CBRNE protection system for large area shopping malls IFS Grant Agreement No. 861643 – Mall – CBRN authored by University of Lodz.

[80] Nobuaki Kunii, Maya Sophia Fujimura, Yukako Komasa, Akiko Kitamura, Hitoshi Sato, Toshihiro Takatsuji, Masamine Jimba, and Shinzo Kimura. The Knowledge and Awareness for Radiocesium Food Monitoring after the Fukushima Daiichi Nuclear Accident in Nihonmatsu City, Fukushima Prefecture. Int J Environ Res Public Health. 2018 Oct; 15(10): 2289. doi: 10.3390/ijerph15102289

[81] Shuying Kong, Baolu Yang, Fei Tuo, Tianxiang Lu. Advance on monitoring of radioactivity in food in China and Japan after Fukushima nuclear accident. Radiation Medicine and Protection Volume 3, Issue 1, March 2022, Pages 37-42. https://doi.org/10.1016/j.radmp.2022.01.006

[82] Laurent Bodin, Florence Menetrier. Treatment of radiological contamination: a review. Journal of Radiological Protection, 2021, 41 (4), pp.S427-S437. ff10.1088/1361-6498/ac241bff.

12. Shielding the food[83]

Food terrorism by definition is an act or threat of deliberate contamination of food with chemical, biological or radiological agents[84]. Is unpredictable and by the agents' nature (as an example biological agents) easy to execute. The incidents described in Chapter 2 “History of CBRN incidents in the food chain” clearly point out that, there is a need to elaborate and implement dedicated programs and procedures, which can protect the food products in the whole food chain. For this reason, food shielding is crucial in order to protect food products and people's health. Food shielding is a method of protecting food from intentional or unintentional contamination by CBRN agents. The protection should begin by identifying critical points in the food chain, which are vulnerable, and all efforts should be placed in order to minimize threats and effects in case of this attack. All steps aim to minimize the threat and effects of the attack and should cover Critical Control Points (CCP) in the whole food supply chain. Critical Control Points (CCP) are the steps in production, where control measures are essential[85]. The efforts should start with controlling the food supplies at the manufacturer's premises, and ending with restaurants, which provide ready-to-eat products to the consumer. All these efforts are aimed at making all food chains less attractive for terrorists and less vulnerable in case of unintentional or intentional food contamination. The rising threat forces all members of the food chain (starting from food producers and ending on restaurants) to elaborate food protection/food shielding plans and procedures. However, the members of the food supply chain are facing several limitations, which are illustrated the Figure 6. These limitations are imposed by client deadlines concerning the implementation of food defence plans and setting this as a condition for further development. Lack or very limited consciousness concerning threats to food arising from food terrorism. A lack of national standards in the field of food defence/food shielding is observed in most countries. Insufficient knowledge concerning the existing and implemented plans/procedures. Very limited academic literature, mostly known only in the scientific community.

[83] The chapter prepared on the basis of report 5.5 concerning Countermeasure procedures in case of food CBRN events – project Creation of CBRNE protection system for large area shopping malls IFS Grant Agreement No. 861643 – Mall – CBRN authored by University of Lodz.
[84]https://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-center-for-public-health-preparedness/tips/topics/food_security.html
[85] C.A. Wallace, S.E. Mortimore. Handbook of Hygiene Control in the Food Industry. doi.org/10.1016/B978-0-08-100155-4.00003-0

Figure 6 Limitation concerning the implementation of food defence/shielding plans/procedures

A plan, despite its limitations, should cover all assets and actions needed to timely fulfil their essentials[86]. Each plan should be clearly described and contains the following parts: describing the project goals and the pathway how to achieve them, identifying the problems, elaborating the way to resolve the problems and methods, which allow preventing future appearance, verification of elaborated solution aiming to introduce plan modification, if needed. One elaborating plan isn't a closed document. It should be adjusted according to the changes introduced. A **food shielding plan** similar to the statements above, should fulfil similar conditions. The plan identified as a document describes the control assets undertaken by restaurants in order to prevent unintentional/intentional food contamination. The plan should be: elaborated in written form, implemented, tested, verified and sustained. The knowledge taken from the USA as a country, which is "experienced" due to the terrorist attacks, provides several standards, which can be used in elaborating effective food shielding plans. The first defence CB (chemical, biological agents) plan was created in 2000, before September 11 by the US Center of Disease Control[87]. The first elaborated plan contained agent identification, grouping them and pointing the most possible agents, which can be used

[86] W Wójcicki. Protoeconomics - Elements of Economics in Antiquity. DOI: https://doi.org/10.2478/ers-2018-0043

[87] Biological and Chemical Terrorism: Strategic Plan for Preparedness and Response. https://www.cdc.gov/mmwr/preview/mmwrhtml/rr4904a1.htm

in case of terrorist attacks. The plan covered the following fields: CB preparedness and prevention, CB detection methods, CB characteristics, countermeasures, and communications methods.

All subsequent plans, despite the organization, which was elaborated were followed on the first CDC plan. The breakthrough moment in the field of elaboration of effective food shielding plan was released in 2002 – as Public Health Security and Bioterrorism preparedness and Response Act[88]. In this document, the strict control over food processing is described. Directly in Section 306 – Maintenance and Inspection of Records for Food is stated that the food handler should keep records concerning delivered food products to confirm their identity. Following this, in 2003, appeared the Homeland Security Presidential Directive[89]. The Directive appointed all National Services and described their roles in food shielding. It should be underlined that the food shielding plans are recommended but not required. US Food Safety and Inspection Service recommends the implementation of food shielding plans in the food industry, whereas the United States Department of Agriculture (USDA) propagates food defence plans among farmers, while Food and Drug Administration (FDA) among other food handlers including restaurants and catering points. It should be mentioned that, the above-mentioned legislation created an environment which allowed broad cooperation including representatives of governmental institutions and university communities in the field of food shielding. As a result of this cooperation, the collection of guidelines and recommendations was elaborated and published. Starting from 2003 the guidelines concerning the food industry appeared[90] and since then updated several times. Follow the guidelines for the food industry, the recommendation concerning the food detailers and processors (including restaurants and catering points) and also the food transporters and distributors appeared[91].

In Europe, exists several organizations and institutions dealing with the food safety on the national level, however, the main one is the European Food Safety Authority (EFSA)[92]. The opinions concerning the responsibility of elaborating the food shielding plans vary. The consumer opinion in this field is presented in Fig. 7. While, the organization, which should finance these activities is presented in Fig. 8[93]

[88] H.R.3448 - Public Health Security and Bioterrorism Preparedness and Response Act of 2002
[89] HSPD 8: National Preparedness (2003)
[90] Guidance for Industry: Food Security Preventive Measures Guidance for Food Producers, Processors, and Transporters. FDA-2020-D-1929.
[91] https://www.fsis.usda.gov/about-fsis
[92] https://www.efsa.europa.eu
[93] Thomas F. Stinson, Koel Ghosh, Jean Kinsey and Dennis Degeneffe. Do Household Attitudes about Food Defense and Food Safety Change following Highly Visible National Food Recalls?. American Journal of Agricultural Economics. Vol. 90, No. 5, Proceedings Issue (Dec., 2008), pp. 1272-1278

The food countermeasure procedures are based on existing food shielding plans. According to these plans the fundamental procedures aiming to analyse the risk in order to protect the food are as follows:

- assess the risk,
- risk management,
- risk reporting
- risk communication.

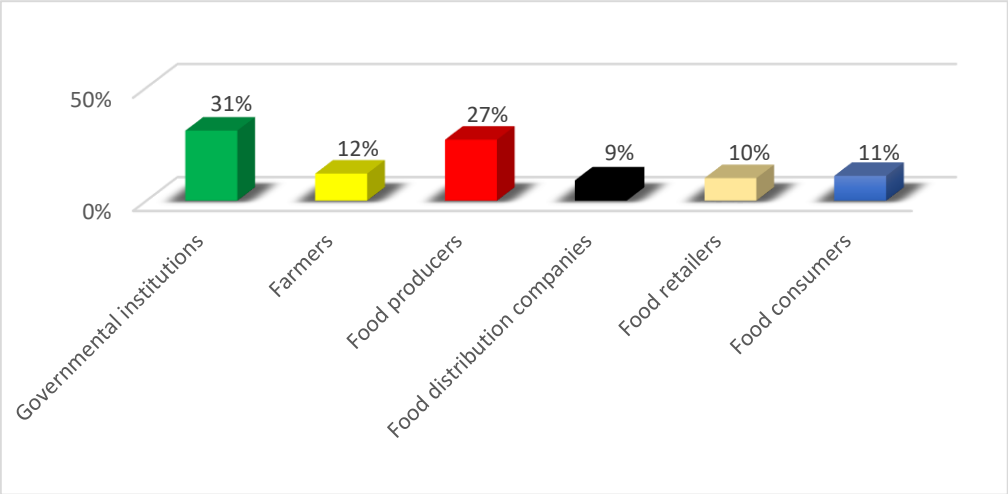

Figure 7 The organization responsible for elaboration of food defence/shielding plan – consumers perspective

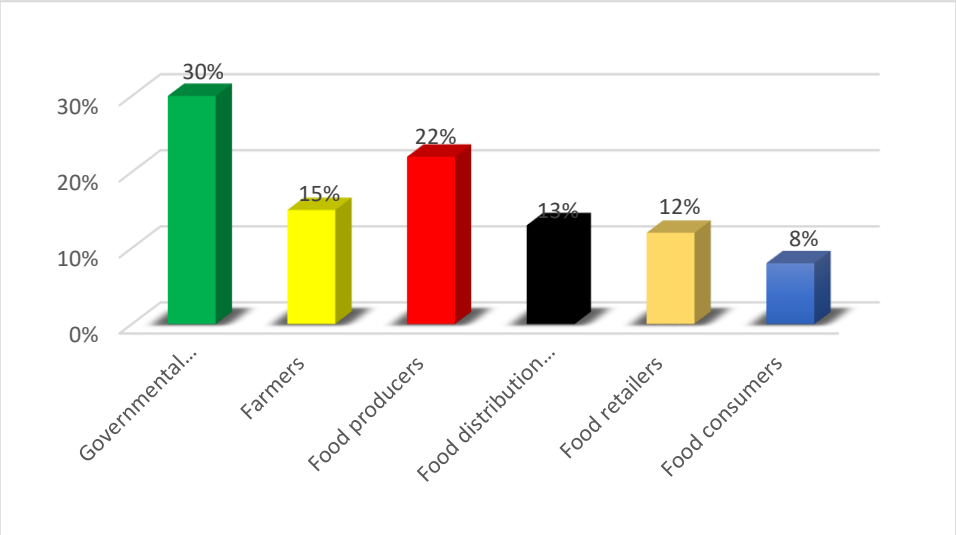

Figure 8 The organization financing the elaboration of food defence/shielding plan – consumers perspective

Risk analysis is part of the risk assessment process – vulnerability assessment in case of a food terrorism attack (assessment) -, the elaboration of a detailed plan of action (preparedness), and the food shielding management plan (management). In detail, assessment, permanent and seasonal food employee behaviour assessment (their contacts with other persons, organizations), cleaning personnel, who provide their services in food industry premises (their contacts), employees of food transport companies and others, which are directly and indirectly (e.g. security, technical staff) connected with food and food-related products.

Any suspicious activities should be reported immediately to the supervisors. Besides the human factor in the assessment, the analysis of the food processing procedure should also be evaluated in order to discover possible vulnerability points (the points where the food contamination unintentionally/intentionally is most probable). The key elements that should be examined during a vulnerability assessment are presented in

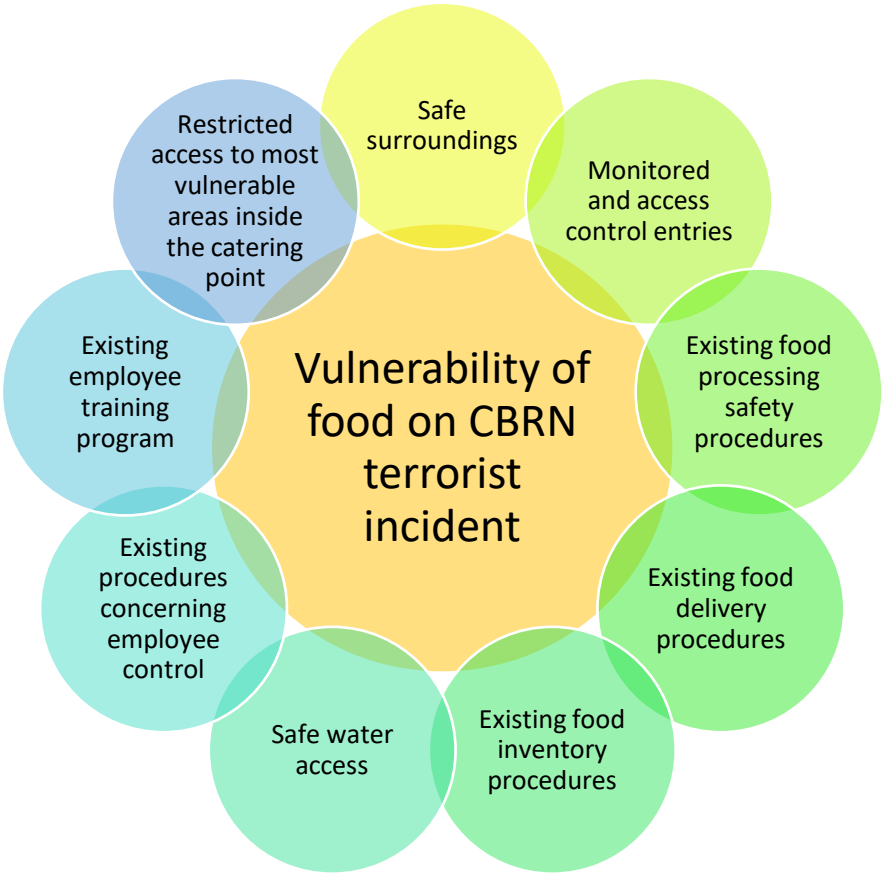

Figure 9 The crucial points in susceptibility analysis of food provider on CBRN events

The vulnerability assessment is one of the crucial elements of the food shielding plan and should be explained in detail.

Safe surroundings: access to the premise delivery point, which includes fences, gates (if necessary) and other barriers aimed to prevent unauthorized access by persons or vehicles. Delivery point and surrounding monitoring, which include the presence of

security personnel, and cameras.

Monitored and controlled entries, which include the presence of access control entry from the delivery point to the premises. The doors should be equipped with security locks, which open on the basis of a PIN or card reader. A single PIN or card should be given only to dedicated personnel. Furthermore, the entry surroundings should be equipped with cameras, which allow for visualization of the entry. The records should be kept.

Existing food processing safety procedures aim to control the following aspects: controlling the food processing technology, verification of food producers, brokers and transport companies focusing on the food delivery, protective clothes rules of conduct (their washing, cleaning, storing etc.), verification of cleaning services personnel (if outsourced), access to household chemicals.

Existing food delivery procedures aim to verify access to food delivery areas, rules in case of planned and unplanned food product deliveries, verification of amounts food product deliveries, verification of food cargo security, and controlling activities aiming to verify food delivery vehicles (cleanliness, preservation).

Existing food inventory procedures aim to verify the rule of storing and inventorying all food products and other items used in food processing and food serving (plates, forks, knives etc.), and verification of inventory records.

Safe water access aims to verify the security of water used in food processing. Verification of existing access control to water source, condition of water installation and verification of equipment, which used water in food processing (e.g. ice machine).

Existing procedures concerning employee control aim to verify the process of personnel employment (their previous experience and records), their pre-employment and periodical training, which underlined the procedures in case of any observed suspicious behaviour among other employees, bystanders and food consumers.

The existing employee training program aiming to verify, if any of CBRN issues are parts of the pre-employment or periodical training.

Restricted access to most vulnerable areas inside the catering point aiming to verify the rules of access to most vulnerable areas inside the restaurant (food and food-related items storage pints, rules of wearing protective clothes during food processing and food serving).

13. General best practices for the prevention of food CBRN incidents

13.1. Detection of Food-Related Problems

Detection of the agent that caused the disease in a sample of the food that the ill person has eaten. Detection of the agent causing the infection can be a problem. Several steps can be taken, if it is assumed that the illness of a person is food-borne. One method is to analyse samples of the food that a sick person has eaten in an effort to find the agent that caused the illness. Sometimes, many people show the same symptoms of the disease at the same time. If there is such a cluster of cases, questioning the affected patients to identify a consumed food item that all have in common may be sufficient to detect the source of the illness. Observing a cluster of cases of an illness among people who had nothing else in common than having eaten the same food. Transmission via food may be inferred because the illness affects the digestive tract and can be a false clue. The absence of digestive tract symptoms does not prove that the disease was not food-borne. Transmission via food may be suspected when the disease is one that is known to be conveyed this way. Transmission via food may be inferred because the illness affects the digestive tract, but this clue may not always be available. Individual people might have no digestive tract symptoms yet. Have the infection and sometimes the infectious agent may cause primarily other symptoms like fever or dizziness. Finally, certain diseases are known for having a food connection. It is therefore natural to start the search into the cause of the disease with an inspection of the food items that were consumed recently[94].

[94] B. Priyanka, Rajashekhar K. Patil and Sulatha Dwarakanath. A review on detection methods used for foodborne pathogens. Indian J Med Res. 2016 Sep; 144(3): 327–338. doi: 10.4103/0971-5916.198677

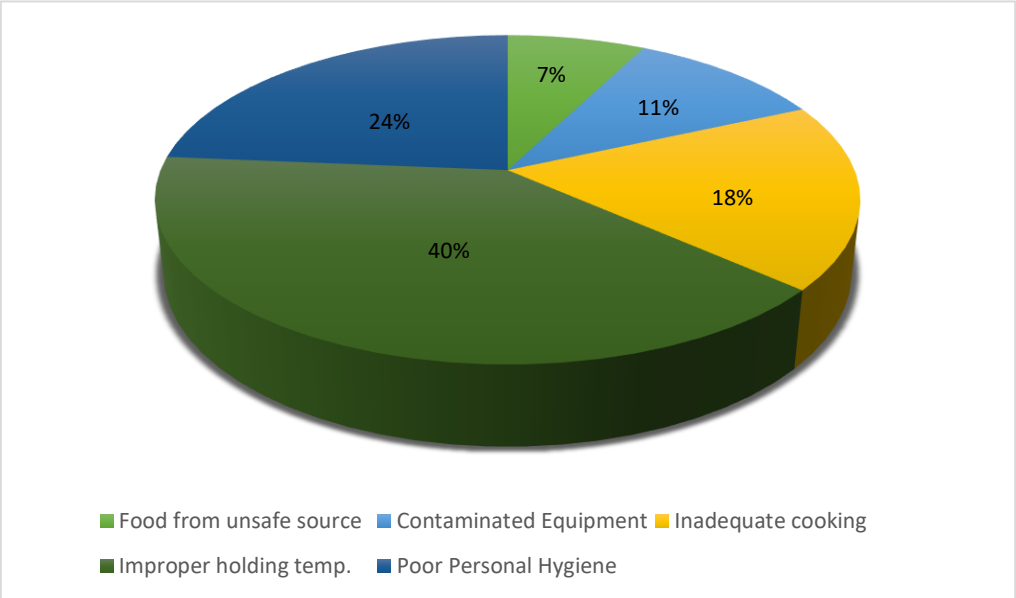

Figure 10 Factors contributing to food borne illness

In order to shield the food, the following strategies were elaborated.

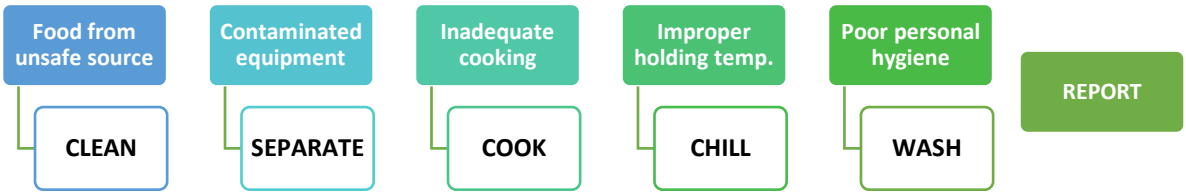

Figure 11 Food shielding strategy

13.2. Symptoms of food-borne diseases

Upper gastrointestinal tract symptoms (nausea, vomiting) occur first or predominately. Later symptoms include: cyanosis, headache, dizziness, dyspnoea, trembling, weakness, loss of consciousness. Lower gastrointestinal tract symptoms (abdominal cramps, diarrhoea) occur first or predominate – Clostridium perfringens, Bacillus cereus, Streptococcus faecalis, others: in 2-36h, mean 6-12h. Abdominal cramps, diarrhoea, sometimes nausea and vomiting. – Salmonella species, Shigella, Escherichia coli, other Enterobacteriaceae, Campylobacter jejuni: in 12-74 h, mean 18-36h. Abdominal cramps, diarrhoea, vomiting, fever, chills, malaise, nausea, headache, possible. Giardia lamblia: in 1-6 weeks - Mucoid diarrhoea(fatty stools) abdominal pain, weight loss.

Generalized infection symptoms (fever, chills, malaise, aches, swollen lymph nodes) – Salmonella typhi: in 7-28 days, mean 14 days. Later malaise, headache, fever, cough, nausea, vomiting, constipation, abdominal pain, chills, rose spots, bloody stools. Neurological symptoms (visual disturbances, vertigo, tingling, paralysis) occur – Muscaria-type mushrooms: in less than 1h. Excessive salivation, perspiration, gastroenteritis, irregular pulse, pupils constricted, asthmatic breathing – Clostridium botulinum and its neurotoxins: in 2h to 6 days, usually 12- 36h - vertigo, double or blurred vision, loss of reflex to light, difficulty in swallowing, speaking, breathing, dry mouth, weakness, respiratory paralysis – Organic mercury: in more than 72h - numbness, weakness of legs, spastic paralysis, impairment of vision, blindness, coma.

Sometimes the symptoms can be easily mistaken for a common cold; other times they may be so puzzling and the onset so late that the patient finds it difficult to think about connections.

Incidence of food-borne illnesses WHO reports that 7 food-borne pathogens found in animal products cause 3.3 - 12.3 million cases of food-borne illness per year (roughly 1 in 30). Food-borne illness often shows itself as flu-like symptoms such as nausea, vomiting, diarrhoea, or fever, so many people may not recognize the illness is caused by bacteria or other pathogens in food[95].

The incidence rate of food-borne illnesses is huge, even in a country where refrigeration and clean water are everywhere available. In fact, in Public Health, there is no other problem that affects a population as much as this. Food-borne illnesses may compare or exceed water-borne illnesses. The key problem in food-borne illnesses is adequate reporting, since mild cases will go unreported and many cases will not even be recognized as being food-borne, due to flu-like symptoms instead of typical GI (gastro-intestinal) symptoms.

[95] https://www.who.int/activities/estimating-the-burden-of-foodborne-diseases

13.3. Food Sanitation

Definition of Food Sanitation:

Protection of food from contamination.

- Prevent foods from becoming contaminated.

  - source, cross-contamination, personal hygiene

- Limit the growth of contamination in foods.

  - proper cooking and storage.

Food sanitation in general means eliminating potential sources of food contamination. Taking a personal inspection in kitchens, asking how long we should use and disinfect our sponge, which places are not cleaned regularly, what goes on inside our refrigerators, and other issues like the use and cleaning of cutting boards. The goal is to prevent contamination as well as to limit the growth of contamination in foods (for example via refrigeration).

Contamination is the presence of harmful agents: biological, chemical, radiological or physical[96].

Spoilage is damage to the edible quality of foods caused by yeasts, moulds, bacteria. Observed through unacceptable taste, smell, or appearance[97].

Contamination can be biological, chemical, radiological or physical and may cause illness. On the other hand, spoilage is when food items start looking bad in the refrigerator, typically from the growth of yeasts, moulds, and bacteria. An example is when we have had the jar of jam in the refrigerator for some time and upon opening it, we find that mould is forming on the top of it. Many may think that food-borne illnesses are a problem that is confined to the developing world, but that assumption is wrong. There are huge problems associated with food-borne illnesses, including deaths, loss of time at work, and medical costs which run into millions each year. With regard to these problems, the published recent data shows that the problems are actually even larger than first suspected by the WHO[98].

- [96] Aladjadjiyan A. Physical Hazards in the Agri-food Chain. In: Safety in the Agri-Food Chain. Safety in the Agri-Food Chain Publisher: Wageningen Academic Publishers
[97] Doyle m. E. Microbial Food Spoilage - Losses and Control Strategies. https://fri.wisc.edu/files/Briefs_File/2017-07-18_0857_FRI_Brief_Microbial_Food_Spoilage_7_07.pdf
[98] Somnath Pal. Incidence of Foodborne Illness. US Pharm. 2017;42(12):14.

13.4. Personal Hygiene

Hand washing must follow any act that offers a possibility of picking up contaminants Such as using the restroom, using a handkerchief or tissue, handling raw food or chemicals, touching areas of the body: ears, nose, hair, mouth, infected areas on the body, touching unclean equipment, smoking or chewing tobacco, cleaning dirty dishes or scraping dishes, etc., eating food or drinking beverages.

Personal hygiene mainly comes down to hand washing and habits like not touching your nose, and not sneezing into food. This may sound trivial, but everybody who self-observes for a short time will realize how often we unconsciously touch our face, ears, hair etc. A person who is sick should not show up for work – again common sense, but a very commonly broken rule, and many people do not realize how easy it is to carry contamination from one food item or dirty dish to another, so hand washing during the handling of different food items is often not considered necessary, a wrong assumption[99].

13.5. Hand Washing

Procedure:

- Use very warm water
- As hot as can be tolerated.
- Lather with soap up to the elbow.
- Scrub between fingers, back of hands, and under nails.
- Rub hands together for 20 seconds.
- Rinse thoroughly.
- Dry with disposable towels.
- Turn the water off using the towel.

In hand washing, 20 seconds is the magic number for rubbing the hands together. The mechanical dislodging of microbes by rubbing and flowing water is most important. Substituting alcoholic solutions for soap and running water is efficient in killing most bacteria, but some spores can survive. After washing, turning off the water by using the towel that was used to dry your hands will prevent re-contaminating your hands.

[99] https://www.health.vic.gov.au/food-safety/personal-hygiene-for-food-handlers

The method of drying the hands is very important and in discussion. There is the issue of paper towels versus electric dryers. The debate is whether or not electric dryers help to decontaminate our hands more than the mechanical drying of using paper towels[100].

13.6. Effective Workplace Infection Control Program

Identify infection risks and develop control measures. Educate workers about infection control and personal responsibility. Coordinate infection control personnel to effectively monitor cases and control outbreaks. Apply an administrative structure to monitor compliance and efficacy of the program. Provide health care and counselling for workers who sustain exposures or develop infectious diseases. Educating workers about contaminations and their personal responsibilities is an important element in infection control. This is very important with certain types of diseases, like ones that might be life threatening. Workplace Infection Control Measures are effective where: workers are concentrated, the workforce is well structured, infection hazards are recognized, resources are available to provide, physical controls, training programs, surveillance, and confidentiality.

Infection control approaches include an adequate ventilation system, hand washing, and personal protective equipment e.g. gloves[101].

13.7. Outbreak vs Incident

Sometimes “outbreak” and “incident” are used interchangeably, but specifically, an outbreak is when there is a cluster of two or more people getting sick, while the term incident is typically used for an individual case. The likelihood of the detection of an outbreak is dependent on the alertness and activity of physicians and healthcare workers. Sometimes an outbreak remains undetected in a community with many physicians, since individual patients go to different physicians and neither of them sees enough cases to realize that an outbreak occurred, since they don’t communicate these cases among each other.

[100] https://www.cdc.gov/handwashing/handwashing-kitchen.html
[101] https://www.qcs.co.uk/infection-control-policy-importance-risk-assessment/

14. FMEA (Failure Mode and Effect Analysis)

Failure Mode and Effects Analysis (FMEA) is an approach to discovering potential failures that may exist.

FMEA can be found in ISO 31010 Risk management — Risk assessment (2019)[102], along with a variety of risk assessment methods for different applications.

14.1. Introduction and method description

The aim of the analysis is to examine the actual state of the Organization in terms of the possibility of carrying out an attack with the participation of CBRN on the food chain. The FMEA - (Failure Mode and Effect Analysis) is carried out for the identification of potential failure modes in a system, their causes and effects.

The FMEA systematically:

- failure cause and effect analysis,
- analysis of the possibilities and effects of defects,
- analysis of possible causes and effects of defects,
- analysis of the causes, effects and criticality of defects

Risk is the product of the vulnerability to a hazard (P), the impact of the risk (W) and the probability of its occurrence (PR).

R=P*W*PR

Each of the elements will be assessed on a five-point scale according to the tables below.

[102] https://www.iso.org/standard/72140.html

Table 1 - Vulnerability Assessment.

SCALE	VULNERABILITY ASSESSMENT (P) HIGHER THE LESS WE ARE PROTECTED AGAINST THIS HAZARD
1	low (comprehensive security measures implemented and supervised)
2	average (partial security measures implemented and supervised)
3	high (comprehensive unsupervised security)
4	very high (unsupervised partial security)
5	critical (no security system)

Table 2 - Risk Impact Assessment.

SCALE	THE IMPACT OF A THREAT (W) HIGHER IT IS The MORE ADVERSE ITS EFFECTS ARE
1	low (possibility of further functioning)
2	average (difficulties in functioning)
3	high (excluding part of the facility from functioning)
4	very high (over 50% of the facility is unfunctional)
5	critical (complete exclusion from the functioning of the facility)

Table 3 - Assessment of the likelihood of a hazard occurring.

SCALE	THE LIKELIHOOD OF A HAZARD (PR) HIGHER IT IS, AS POTENTIALLY MORE LIKELY THREAT MAY OCCUR
1	low (potential number of events: no more than once a year)
2	average (potential number of events: no more than one in 6 months)
3	high (potential number of events: no more than 1 per month)
4	very high (potential number of events: no more than 1 per week)
5	critical (potential number of events: 1 or more times a week)

Table 4 - Risk level.

No	The analysed elements of the food safety chain	The vulnerability to the hazard (P)	The impact of the hazard (W)	The probability of a hazard occurring (PR)	Risk (R) R=P*W*PR

In order to estimate the risk priority number concerning food safety and security in organization, the following topics will be considered and analysed in order to introduce the countermeasure actions:

- Food suppliers – verification, ordering process
- Vehicle access (monitoring, identification of unauthorized access, security)
- Access for persons (monitoring, identification of unauthorized access, security)
- Food transport inside the Hotel
- Food Storage
- HACCP procedures
- Employees with tasks concerning foodborne threats (training, hazard awareness)
- The kitchen personnel employment process
- Access to the restaurant/restaurant back rooms – the presence of video surveillance
- Food incident reporting procedures
- Thermal processing of food products
- Waste management
- Cleaning and dish washing
- Kitchen Equipment
- Food products served in open manner (allowing free access to the product for outsiders)
- Dining room preparedness for the guests eating meals on-site
- Preparation of food products to be served
- Service of prepared products to takeaway
- Reprocessing of food products

- The inspection was carried out by an individual posing as a Public Health Inspector.

During the visits/inspections carried out by University of Lodz (in Poland, Spain and Cyprus) within the project realization in hotels, the above-mentioned areas were identified as vulnerable and were checked to estimate the probability of intentional or unintentional contamination of food products. Below, in Figure 12, the summary of the most vulnerable CCP is presented.

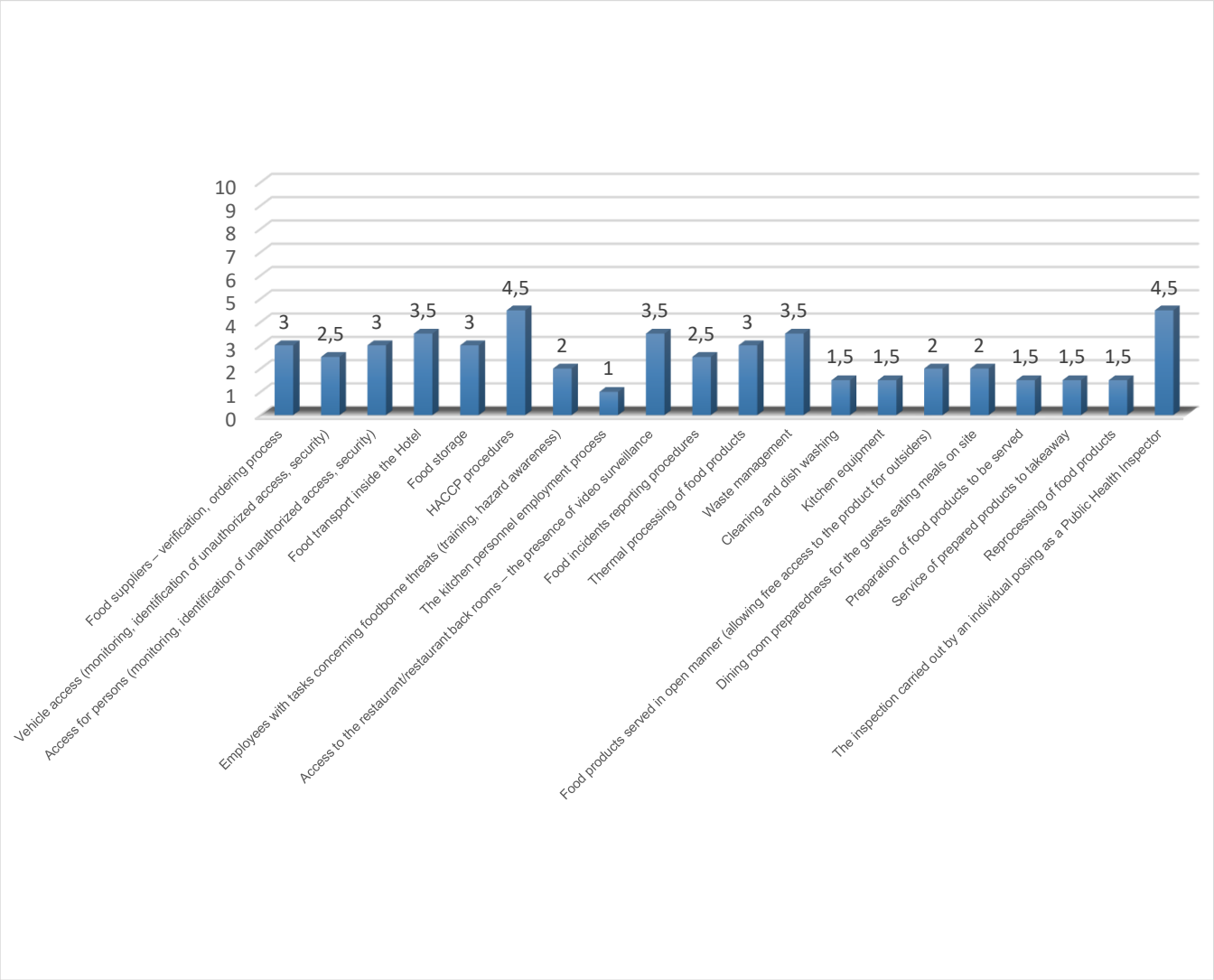

Figure 12 The likelihood of intentional or unintentional contamination of food products

14.2. Food suppliers – verification, ordering process

In most restaurants, the raw materials and supplies orders are placed in a routine way. Routine can make the manager give up on order planning. It is enough for the chef to list from memory a few items that he thinks may have already run out. However, such trust in intuition may not work. That's why, despite the greater workload, it's best to make a shopping list and prepare the order on the basis of recalculated inventory and control of food product consumption. It is worth using sales management software, thanks to which the consumption history of a given food product is well known. Do not forget to take regular inventory to verify the real amount of food products in storage.

The biggest difficulty lies in finding a balance between ordering food products and creating non-rotating, unnecessary storage. On the one hand, avoidance of throwing away spoiled, out-of-date food products (and thus the money spent on them), and on the other hand, avoidance of a situation, in which the chef must change the composition of the served meals, lowering its flavour just because an ingredient has just run out. Below in Figure 13, the typical ordering process is presented.

Figure 13 The typical ordering process

Nowadays, special ordering programs are available and the process itself seems uncomplicated. However, it is worth mentioning a few rules that should be kept in mind before ordering.

- Set a price range in order to not exceed the specified budget
- Always require confirmation of the availability of the products ordered
- Agree with the supplier on substitutes and price values for the products in question
- Remember to specify the exact delivery date
- Check the exact packaging, in which products are shipped (by the piece, bulk packaging, etc.)
- Avoid phone orders
- Check the order summary carefully
- Make sure that the prices of goods are stated net or with VAT

- For stationary purchases, don't forget to include fuel costs
- Familiarize yourself with the terms and conditions of the online store, the terms and conditions for filing complaints, etc.

The delivery reception stage requires attention, meticulousness and precision. The delivery point should be equipped with an efficient scale, where the weight of all delivered food products can be done. During the delivery, an adequate number of employees should be present in order to carry out the pickup quickly, efficiently and accurately. In addition to verifying the weight, the transportation temperature and storage conditions should be checked. In this situation, the driver should be asked for a printout of the thermograph from the refrigerated truck, but it is also a good idea to measure the temperature yourself. For this purpose, the restaurant should be equipped with a needle thermometer (measuring the temperature inside the product) and a pyrometer (measuring the temperature of the surface by analysing heat rays).

Typical errors caused by the supplier:

- Unloading -- This is an important moment in the process of managing food products because any oversight slows down and disorganizes the work of the whole kitchen. In addition, once the supplier has left, it is difficult to successfully place the complaints, as it is too late to prove the supplier's fault. Any errors should be verified and reported during unloading, in the presence of the supplier. It is best to write a complaint protocol right away and agree on the terms of compensation.
- Quality and quantity of goods -- the most important thing is to check during the delivery: the freshness of products, expiration date, transport temperature, compliance with the order in terms of brand and declared quality, weight, and whether the products have not been damaged in transit. If there are irregularities, only part of the delivery can be returned, leaving the good products. Alternatively, they accept the entire delivery but enforce a discount or freebies. It is necessary to determine when (as soon as possible) the supplier is able to complete/correct the order or to abandon the goods and complete the deficiencies.
- Delayed delivery -- this is a situation that can happen in any restaurant. It's important to prevent such situations. Do not place the order at the last minute. Do not limit cooperation to a single source of delivery and reasonably assess minimum food product storage levels, differentiated by product.
- Verification of documentation -- it is important to check the order conformity with the actual state, the correctness of the amount booked, and the invoice data, to avoid double invoicing.

Typical errors caused by employees:

- Accepting too much merchandise -- this is troublesome especially when the excess of food products cannot be returned, and the error involves fresh food products.
- Theft of company goods or equipment -- this issue can affect both employees and suppliers. It is important to hire trusted people and in the case of new employees, ensure that the first deliveries are accompanied by an experienced/trusted employee. Remember not to leave the supplier alone at the delivery point. In case of repeated situations, consider installing CCTV.
- Freebies -- remember that freebies received from the supplier are the property of the company, not the employee. Agree with the employees not to force or suggest the supplier to give gratuities in exchange for a declaration of further cooperation, as this can negatively affect the hotel's image.

Recommendations

- Order the food products only from trusted sources
- Introduce the procedure to verify new supplier
- Introduce the delivery hours dedicated only to food products
- Do not leave the food products during delivery unattended
- Errors in delivery should be verified and reported during unloading, in the presence of the supplier
- Verify the identity of the delivery person/vehicles
- Verify the transport documentation
- Check the quality and quantity of delivered food products
- Check the integrity of food product packages
- Transport the food products to dedicated storage places as soon as possible

14.3. Food delivery - access to the facility

General access of people, vehicles and materials onto premises should be restricted to those associated with business functions. This will reduce the possibility of intrusion. As an example, in most cases, delivery of food products is executed by vehicle, so any pedestrian present in the food delivery point should be carefully monitored. Furthermore, any delivery of food products should be appointed, so the presence of delivery outside of the scheduled time should be investigated. Visible and comprehensive food delivery point fencing may act as a deterrent to intruders,

however, in many premises the delivery point is localized inside the building so CCTV monitoring and an associated alarm system can give an indication that intrusion take place. Advice on the need for perimeter fencing depends upon operational requirements provided by the threat assessment. Unauthorized access may be monitored and controlled by above mentioned CCTV, security guards and a suitable lighting system. The roads, waterways, other buildings, planning constraints vicinity as well as technological aspects important in food delivery safety like pest control should be carefully considered. The food delivery point controls should be viewed as a whole, so the weakness in one part does not necessarily negate strengths in other parts.

Vehicle access (monitoring, identification of unauthorized access, security)

Entry to vehicles involved in the food business should be through monitored access points. The approach roads should be equipped with features (if possible) allowing to minimize the speed of the vehicle. The features should be verified routinely. Deliveries of food products should be scheduled in advance and unscheduled deliveries should only be accepted in specific situations (the list of these situations should be elaborated with management). Staff responsible for receiving food products should check the documentation and the integrity of loads. The record of serial numbers from any tamper evident tags should be performed. Deliveries of other goods other than those related to the food chain should not be overlooked as potential carriers of hazardous material. The reception staff should be aware of the dangers of the unlawful use of emergency service and other liveried vehicles (e.g. 'Trojan' horse type vehicles), which are not what they seem. Any delivery that takes place out of schedule and agrees with the list of situations, should be carefully investigated and reported to supervisors.

In most of the visited hotels, the delivery of food products is conducted using the ramp/ramps. In the best option, access to the food product delivery point should be equipped with a gate for vehicles entering and covered by access monitoring points. The access roads should be equipped with speed limiters and have maximum facilities for inspection and possible refusal of entry for vehicles. Entry and exit roads should be clean (free) and allowed for inspection. To make vehicle control easier, regularly remove any objects from the road (tree leaves, wastes, etc.).

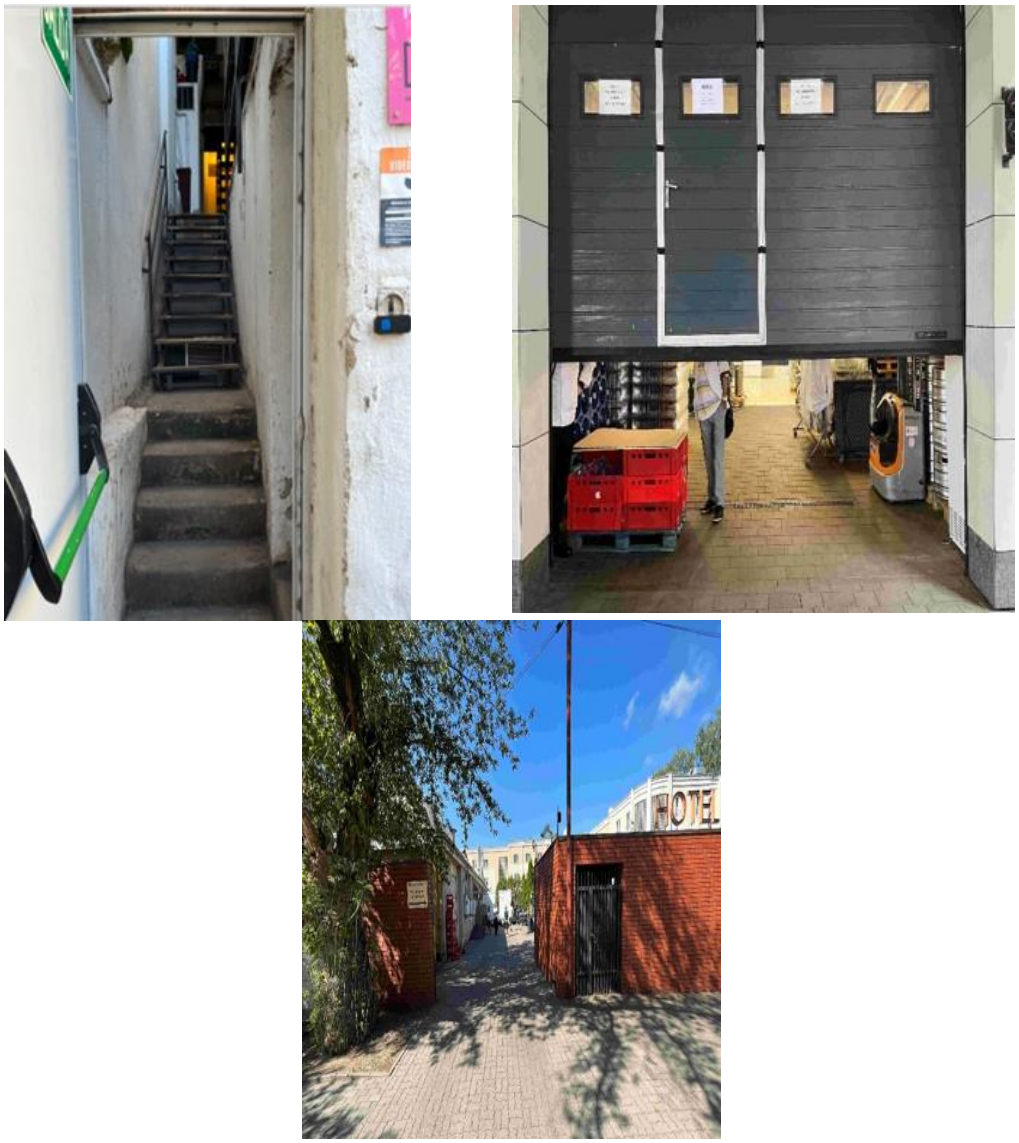

Figure 14 Different types of food products delivery point

The delivery of food products should be conducted according to the established daily/weekly schedule. The delivery of food products out of schedule should be avoided. In certain circumstances, the scheduled delivery may be accepted with the manager's permission and notification. The restaurant personnel responsible for receiving the food products should check the documentation and the condition (inviolability) of the transported food products. The serial numbers and other key information from the security labels or seals should be performed and recorded.

Recommendations

- Equip the access to food product delivery point with a barrier (if possible) in order to prevent unauthorised entry
- Equip the roads to the food product delivery points with speed limiters (if possible)
- Equip the delivery point with CCTV monitoring
- Introduce the food products delivery schedule
- Record all vehicles (registration tags) transporting the food products
- Limit the vehicle access to the food product delivery point, especially during food product delivery hours
- Elaborate the list of circumstances allowing to delivery of food products outside the dedicated schedule
- Keep the door/gate to the food delivery point closed at all times
- Equip the door to the food delivery point with buzzer/bell allowing to be notified about delivery
- Introduce the procedure of reporting any suspicious activities to supervisors

14.4. Human access

Identification of personnel. Constant identification of employees is recommended. It can be done by using appropriately marked clothing and/or identification passes/ cards. Employees should be trained and motivated to be vigilant to identifying, monitoring and reporting the presence of any unauthorized person. The CCTV monitoring should be present. Access to delivery points should be allowed for the personnel based on held authorization (e.g. key or access card) or on knowledge of the password or code. The best protection combines both elements.

Figure 15 and 16 Restricted access to food products delivery point

Recommendations

- Equip the delivery point with CCTV monitoring
- Equip the doors to delivery points with authorization
- Provide sufficient light allowing to recognize employee
- Keep the doors to the delivery points closed
- Equip the doors to delivery points with bells/buzzers signalling that, the door is open
- Introduce procedure of reporting any suspicion activities to supervisors

14.5. Food transport inside the Hotel

The proper protection of food products during inside transportation is one of the crucial elements of food product safety in restaurants. The transportation of food products should be conducted in dedicated containers, which meet safety guidelines. It is regulated by Regulation (EC) No 852/2004 of the European Parliament and of the Council of 29 April 2004 on the hygiene of foodstuffs. Internal transportation can be divided into:

- Horizontal, involving activities on a single floor
- Vertical, involving the movement of food products between floors.

Internal transport equipment is divided into:

- Mechanized
- Manually driven.

Concerning internal transport in restaurant the different types of carts are used. Among them are:

- Heated
- Unheated
- Cooled
- Uncooled.

Food product safety during food transportation requires meticulous attention to every detail, from temperature control to compliance with the highest sanitary-epidemiological standards. Maintaining the right temperature during transport is crucial, especially for products that are sensitive to temperature changes. The usage of proper containers plays an important role in protecting food during transportation. Robust and compliant packaging protects food from external factors. They also provide protection against unintentional/intentional contamination.

Recommendations

- Introduce the procedure of food products transportation
- The road for food products transportation is so-called “clean road”
- The waste road is so-called “dirty road”
- Never cross these roads
- Use only certified products (containers, carts etc.)
- Clearly mark the products used for the transportation of food products
- Never use these carts for other purposes
- Introduce the procedure of reporting any suspicion activities to supervisors

14.6. Food storage

Secure storage of food products and packaging materials will reduce the chances for intentional/unintentional contamination. Hazardous materials present on the premises, in particular cleaning and sanitizing chemicals, should be handled safely and in locked storage under control and monitored by CCTV. It is strictly forbidden to leave food products in the restaurants' back door area unattended. Any food products with damaged seals should not be used without further investigation and clearance.

Product tamper evidence closure provides important knowledge concerning food product safety and information concerning undamaged external packages, which have not been opened – see Fig 17. For other food products, protective seals assure integrity and contribute to product traceability see Fig. 18. The protective seal needs to be checked for existing holes or other damage suggesting prior opening or broken integrity see Fig. 19. In case of any suspicion concerning broken tamper evidence or sealed cup, the food product should be placed in quarantine and the investigation prior to use, should be started.

Figure 17 The example of tamper evidence closure

Figure 18 The example of tamper evidence closure

Figure 19 The example of sealed cup

The personnel responsible for food products reception should record vehicle details and tamper-seal numbers and confirm there are no damaged packs. Furthermore, the food product expiration date should be checked and recorded – see Fig. 20. The expiration date is placed on every single food product package. Moreover, the expiration date mark should be checked for the purpose of any visible changes. Sensory examination for unusual odours is recommended. The lot (batch) coding facilitates product recall of food products should be recorded by food reception personnel – see Fig. 21. Any suspicions during reception should result in the refusal of acceptance of the delivered product.

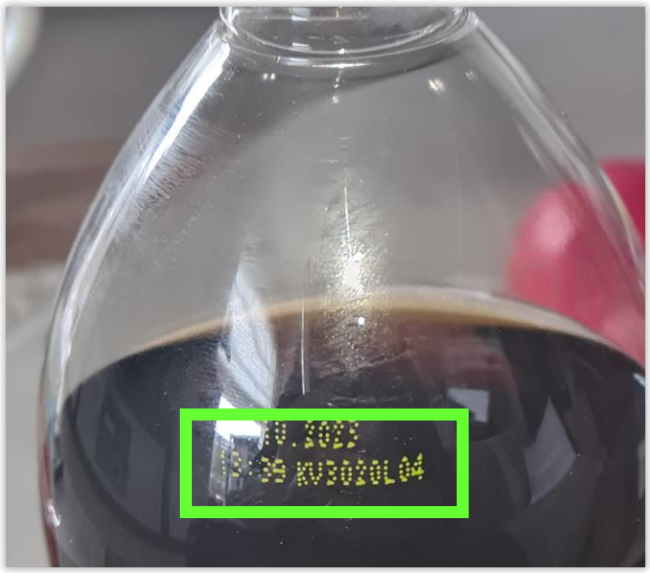

Figure 20 Expiration date

Figure 21 Lot (batch) coding facilitates product recall (in green colour)

Assurance that the sources of food products are reliable is crucial. The integrity of food products supplied to restaurants point is fundamental to good practice. Casual purchases should be avoided. Casual purchases should be the exception rather than the norm. Moreover, it should be ensured that casual suppliers do not become permanent suppliers without prior appropriate checks and controls.

Restaurants should possess dedicated food product storage areas. The following food products should be stored separately:

- Vegetables and fruits;
- Root crops - they can contain soil, so they should not be mixed with other vegetables;
- Beverages;
- Alcohols;
- Dry products
- Perishable products – require refrigerated storage;
- Pickled products, with their intense aroma can spoil the taste of other items, and should also be stored in separate places. Since they contain live cultures of bacteria, they can also contribute to other food products' fermentation/degradation.

Figure 22 The example on division and labels of stored food products

The food products should be placed in airtight containers. Those certified for food storage are marked with a glass and fork symbol. Correct labelling is also very important. The labels should contain the name, and in the case of prepared meals also the date and time of preparation. It will ensure the proper freshness of the food product served, and improve the work of the staff.

Separation of food is also important because of the possibility of so-called cross-contamination. The lactose-free, egg white-free or gluten-free food products for example can be accidentally contaminated and can cause a very serious allergic reaction.

The functional layout of restaurant storage areas must take into account the fact that each storage area should provide different conditions appropriate to the certain type of food product.

- Vegetables and fruits should be stored in dry, airy places with a temperature 5 - 9^0 C
- Bottled beer, vodka, white wine and mineral water should be cooled to 8-10^0C. The optimal temperature for draft beer is 3-7^0 C
- Red wines should be stored at a temperature similar to carbonated cola drinks, that is 15^0C
- Meats, fish and dairy products, depending on the expected date of use, should be stored either in refrigerators (-2 to 4^0C) or freezers (-18 to -24^0C).

As a rule, raw food products should not be stored in refrigerators for more than 3 days (the period is extended if they are, for example, packaged in a protective atmosphere).

Food products should be arranged in a certain way. The earliest purchased food products are stored in the most accessible place (First In, First Out - FIFO principle). It will prevent food products from going out of date, thereby reducing the losses.

The rules for storing food in refrigerators and freezers require maintaining a certain temperature. The freezers should be able to maintain -18^0C while storing food products in the refrigerator requires 4^0C. If the food products require a different storing temperature (according to the label) should be placed in the refrigerator, where the temperature can be higher - up to 12^0C. The refrigerators and freezers should be equipped with external thermometers, which must be calibrated periodically. According to the Good Hygiene Practices and the HACCP book the temperature measurement should be performed and recorded 2×day.

The refrigerators and freezers should be placed on dry, washable floors. It must be levelled so that the equipment does not wobble and pose a hazard. It is also important to ensure adequate air circulation. The ventilation holes must not be obstructed, and the minimum distance from the wall should range approximately 5 cm. Otherwise, the compressor may be overheated. This will generate costs associated with high energy consumption and may lead to equipment failure.

There are many ways to extend the shelf life of food products. Most can be used in conjunction with freezing or refrigeration.

A good way to extend shelf life is protective atmosphere packaging. Depending on the product, a mixture of different gases (oxygen, carbon dioxide and nitrogen) is used. Products packaged in this way remain fresh for a very long time:

- Cooked meats at about 7^0C for up to 5 weeks
- Poultry at 4^0C for up to 12 days
- Fresh fish (0-2^0C) up to 5 days.

However, this method can be quite cumbersome - it requires the right apparatus and gas mixtures. That's why usually the products go to the premises already packed in this way.

In restaurants, vacuum packing can be used. It involves extracting air from airtight bags using relatively inexpensive strip/chamber packers. Products packaged in this way take up little space, and the extension of their shelf life is also significant.

- Raw and cooked meats (4^0C) up to 6 days
- Vegetables up to 20 days
- Bread - at room temperature for up to 7 days.

Recommendations

- Maintain the order, segregation, and proper description of goods to ensure the ability to efficiently control inventory
- Ensure the freshness of stored products for as long as possible
- Take care of storage conditions: i.e. proper temperature, hygiene, adherence to GMP principles
- Do not leave the food products outside storage places unattended
- Equip the door to storage places with locks (electronic, mechanical etc.)
- Limit the access to food products places to dedicated personnel
- Maintain the proper order of issuance of products to the kitchen
- Follow the HACCP procedure concerning the food products storage
- Follow FIFO principle (first in, first out)
- Follow FEFO principle (first expired, first out).

14.7. HACCP procedures

Hazard Analysis and Critical Control Points (HACCP) is a scientific system for analysing any recipe or any kind of food preparation process, in order to determine the "critical control points" (places where there are possibilities of contamination). This was developed by NASA when they were trying to control food-borne illnesses among astronauts. NASA has a strong interest in preventing food-borne diseases with their motto "nothing worse than having an astronaut with diarrhoea in orbit" This NASA-developed system is so good that it was incorporated into the food code[103].

Figure 23 The example on CCP according to HACCP

There are 7 Steps in the HACCP Systems, listed below:

1. To analyse potential hazards (know your enemy) – biological, chemical, or physical
2. To identify critical control points (CCPs) – points in a food chain at which the potential hazard can be controlled or eliminated: e.g. cooking, cooling, serving, transporting, packaging.
3. To establish preventive measures with critical limits for each control point. Example: setting the minimum cooking temperature and time required to ensure the elimination of any microbes
4. To establish procedures to monitor the critical control points in order to establish

[103] https://safefoodalliance.com/haccp/the-history-of-haccp

corrective actions to be taken when a critical limit has not been met. Thus, if something goes wrong everybody knows what needs to be done to correct the problem. Example: determining how and by whom cooking time and temperature should be monitored.

5. To establish corrective actions to be taken when a critical limit has not been met. Example: reprocessing or disposing of food if the minimum cooking temperature is not met
6. To establish procedures to verify that the system is working properly. Example: testing time-and-temperature recording devices to verify that a cooking unit is working properly.
7. To establish effective record-keeping to document the HACCP system. Records of hazards and their control methods. Monitoring of safety requirements. Action taken to correct potential problems.

Within the HACCP exist the common critical control points. The points involve:

- Cooking
- Cooling
- Points of cross-contamination
- Re-heating
- Holding

Cooking

The critical control point: cook ingredients until an internal product temperature of 60°C or higher is reached. Stir frequently. Serving and Holding. Serve immediately. The critical control point: hold food at 60°C or above for service. Do not mix new products with old. Transporting and Serving. The critical control point: hold food at 60°C or higher.

Cooling

The critical control point: cool food to 4°C or lower within 4 hours in shallow pans with a product depth of 5cm or less. Stir frequently. Store at a product temperature of 4°C or lower in a refrigerated unit.

Reheating

The critical control point: reheat food to a product temperature of 74°C or higher within 2 hours. Sanitation Instructions:

- Measure all temperatures with a thermocouple.

- Wash hands before handling food.
- Wash, rinse, and sanitize all equipment before and after use.

The final product of the HACCP system is the creation of a table so that every step of the cooking process is tabulated with additional columns with the headings shown to include applicable information for each step.

The table should be created to categorize every step of the process with the following headings:

- Possible hazard
- The critical control point
- Operational step
- Type of monitoring
- Corrective action if standard not met
- Standard or criteria applied (verify)
- Applicable records

Fig. 24 below, presents the schematic diagram of the food processing with HACCP guidelines, in order to protect the food product and consumer health.

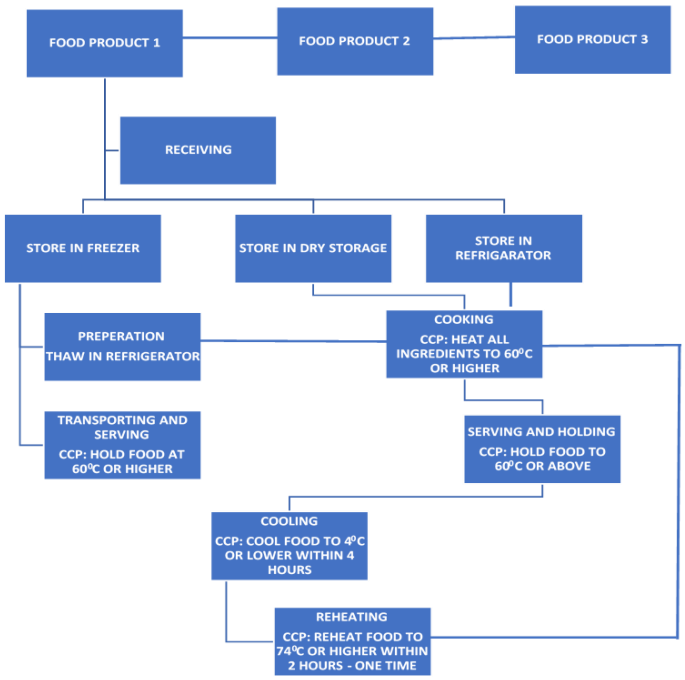

Figure 24 A flow diagram illustrating the food product processing within the HAACP guidelines and showing all the critical control points. This chart categorizes every step of the process under the listed headings.

Recommendations

- Introduce the HACCP
- Train the personnel in HACCP
- Strictly follow the seven steps in HACCP

14.8. Employees with tasks concerning foodborne threats

Training & hazard awareness

Professional training helps to make the employees understand the potential hazards of food processing and how to prevent food poisoning resulting from unintentional/intentional contamination. Also, it makes personnel aware that food safety helps maintain or increase profits and minimize waste and is essential for quality control. Less food products will be wasted when personnel are fully trained in food safety/security and hygiene best practices. Both factors directly influence restaurant/hotel profit and allow the employee to maintain their jobs and earnings. Sometimes employees may question that, they must perform certain tasks in a certain way. However, after completing food safety/security training, they will gain a deeper understanding of their responsibilities. The training will remind them that the health and safety of their co-workers and guests is their responsibility. Educating employees on the proper use of equipment can help increase restaurant efficiency, as well as maintain hygiene standards. Employees should know what the misuse of some equipment can result in. And be aware of how to carefully use, clean and manage kitchen equipment. Even possessing the best household chemicals and the best dispensing systems, without trained personnel, the results will not be appropriate. Only the proper operation of all elements - personnel, preparation and equipment - will guarantee a high level of hygiene and is the crucial factor in preventing unintentional/intentional food product contamination. A weakness of one of these elements will result in a significant decrease in hygiene and in the long term, decrease the safety/security of food chain and restaurant/hotel guests. However, the awareness of personnel, including restaurant management, plays a special role. The deficiencies in this area are due to the lack of personnel training. Therefore, it is necessary to systematically conduct appropriate training. It is worth checking whether restaurant/hotel personnel can perform the simplest hygienic activities and indicate the purpose of the cleaning preparations used in the restaurant.

Recommendations

- Introduce the personnel training in the field of CBRN threats as a part of their initial training
- Periodically organize personnel training in the field of food safety/security.

14.9. The kitchen personnel employment process

The right people in the restaurant/hotel food chain are the key element to success. Employees' involvement is needed at every stage of the food chain: logistics, processing, food service, cleaning or storage. Even in a small hotel restaurant, one person cannot do all these activities well. Trusted employees are therefore the foundation of a well-run restaurant/hotel. They are the ones who will help in difficult times and keep an eye on the restaurant when the owner/manager is absent. The bad employees can cause trouble instead. Building a cohesive and trusted team is one of the main challenges for restaurant owners, as well as managers. How to recruit the best ones and how to make them stay. First, the recruitment process. A good job advertisement should contain several elements:

- The name and address - location is one of the main criteria for an employee to choose a workplace.
- The position with a brief description of the responsibilities.
- Working hours - most often their scope and flexibility. If the working hours are non-standard, it is worth noting this at the very beginning.
- Type of contract.
- The amount of salary.
- Other expectations of the candidate.

By properly constructing the ad, the manager/chef will save the time spent answering candidates' questions even before the meeting. Moreover, it guarantees that the ad will be answered by people who are actually interested in the provided terms and conditions and avoid later misunderstandings. Secondly, the managers go through a thorough analysis of the candidates' CVs. The candidates with the bests CV should be invited to an interview. During the meeting with the candidate, is worth noting the candidate's appearance, pronunciation and gesticulations. The manager should ask about the candidate's experience, workability and strengths. Only after the initial verification, the candidate should be invited to the next stage of the recruitment process. An interesting solution is to invite more candidates to a joint recruitment stage, which allows them to observe how candidates behave in a group. However, one of the most effective methods of checking an employee's competence is to use references received from a previous employer. The food service industry is a group that everyone knows each other very well, and it is not difficult to get information on a particular employee on your own. This is also an important hint for food service employees. It is worth leaving the previous position in the right way and obtaining valuable references.

The Ideal employee: has passed all recruitment stages, endured a trial period, received training and is a valuable person in the team.

In the end, one of the most important elements that keeps an employee in the hotel/restaurant is the right approach of the manager. A good manager can set new goals and helps to improve employee's professional competence.

Recommendations

- Verify the documents provided by the candidate
- Ask for the recommendation letter
- Contact the employee previous employer
- Introduce a trial period for new employee
- Observe the new employee performance during trial period
- Verify their competence
- Try to avoid seasonal employee
- Try to avoid outsourcing the employee in crucial parts of food chain safety

14.10. Access to the restaurant back rooms

The back-office access to the restaurants area should always remain closed. It should be equipped with authorization and CCTV monitoring. Only verified personnel should possess access to this area. In case, when in this area the storage room for chemicals is present, it should be closed and monitored by CCTV. It is not allowed to storage the food products there. The personnel should verify above mentioned. Any faults should be reported to the supervisors. Any unattended food products found there should be secured.

Figure 25 Access to the restaurant back rooms

Recommendations

- Keep the door to back-office access to the restaurant area closed all the time
- Install the electronic verification access (key cards, PIN) or door buzzers (open door warning bells)
- Install the CCTV monitoring covering the back-office access to the restaurant
- If a chemicals storage room is present there, keep this door always closed. Install the electronic verification access (key cards, PIN) there. Install the CCTV monitoring covering this area
- Do not allow storage of the food products there
- Report the cases of storage of the food products there and remove the food products for the purpose of further verification
- Establish the protocol for faults reporting

14.11. Food incidents' reporting procedures

Ensuring food safety is at the heart of the running of any restaurant. The existing EU regulation is based on the Directive 2003/99/EC of the European Parliament and of the Council of 17 November 2003 on the monitoring of zoonoses and zoonotic agents, amending Council Decision 90/424/EEC and repealing Council Directive 92/117/EEC. The existing regulations were elaborated not only for the health and safety of

customers but also for maintaining the restaurant's reputation. Below, there are several key aspects to consider for ensuring the highest standards of food product safety.

Educate your personnel

Regular food safety training is essential for every restaurant employee. This includes learning about proper food storage, handling, preparation etc. It is important that personnel understand the importance of food safety rules and the consequences of not following them. Training should be regularly updated and include the latest standards and practices. The personnel should be regularly tested and evaluated on their understanding and application of these principles.

Manage the temperature

Controlling the temperature of food storage and preparation is essential to prevent the growth of harmful bacteria. Restaurants should follow strict recommendations for cooking and cooling temperatures, and regularly monitor and record storage temperatures. Implementing automatic temperature monitoring systems can help ensure that these standards are always met.

Maintain hygiene

Proper cleaning and disinfection procedures are essential in any kitchen. Regular cleaning of equipment, work surfaces and the entire kitchen prevents the accumulation of bacteria and other contaminants. Promoting personal hygiene among employees, such as frequent hand washing and wearing proper clothes, is equally important.

Prevent cross-contamination

Separate storage of different foods, especially raw meat from prepared meals, helps to prevent cross-contamination (the transfer of bacteria or other microorganisms from one product to another). Using separate areas for handling different food products and properly labelling products can significantly reduce the risk of contamination.

Regularly audit and inspect

Implementing regular audits and internal inspections is essential to ensure that all food safety procedures are being followed. These audits can range from checking documentation to physical inspections of kitchens and storage areas.

Document and track food sources

Accurate documentation of food origin, expiration dates and storage procedures is important for quality management. Tracking the source of food products and maintaining accurate records can help to identify and resolve potential problems quickly.

This will help you stay calm in a crisis and minimize the damage - both in terms of safety and your business image. Following strict hygiene standards, regular staff training, effective temperature management, cross-contamination prevention and incident response preparedness are key elements of a successful food safety strategy. Implementing these practices not only protects consumers but also raises business

trust and contributes to the long-term success of the restaurant.

Recommendations

- Ensure that you have an effective action plan in case of food incidents.
- The plan should include procedures for notifying the relevant authorities and customers.
- The plan should include the corrective steps that will be taken to resolve the problem quickly and effectively.

14.12. Thermal processing of food products

There are several factors that affect the growth of bacteria in food. Bacteria need nutrients, without that they are not going to grow too well. They take up these nutrients after the nutrients have been dissolved in the solution; this means that a certain amount of moisture is required. Also needed is a neutral environment, so pH is also important. Oxygen is required if the bacteria are aerobic. Other factors are time and temperature. We cannot easily control most of these factors, without using special techniques like dehydration, canning etc., apart from time and temperature[104].

Primary bacteria growth factors are as follows:

- Temperature
- Time
- Neutral environment (pH)
- Moisture (Water Activity)
- Oxygen
- Food (Nutrients)

Only the first two can be controlled daily.

For example: the ideal temperature for the growth of Salmonella is near 30°C. Any temperatures above or below 30°C will slow growth. For the purpose of food product safety, the holding temperatures should be less than 4°C or greater than 60°C (in between is the “Danger Zone”). Holding temperatures is important in food handling. Thus, outdoor weather in the summer is often at a good temperature for salmonella growth. A certain area of temperature exists that promotes growth so holding temperatures should be less than or greater than this “danger zone”. It is important to follow precisely the precaution of not allowing food to be left out too long in the danger

[104] Siddig Hussein Hamad. Factors Affecting the Growth of Microorganisms in Food. https://doi.org/10.1002/9781119962045.ch20

zone; 2 hours is the maximum time food should remain in the danger zone of 4-60°C (while on a serving table for example). 74°C degrees is the temperature every food should be reheated[105].

The food products processing temperature. Internal temperatures required to ensure disinfection of certain foods as follows:

- Stuffed meat, poultry, all stuffing: 74°C
- Ground beef: 68°C
- Pork: 65°C,
- Rare roast beef: 55°C.

All other potentially hazardous foods are 60°C. All foods must be reheated to 74°C. Cooking temperatures required to ensure disinfection vary between 60 and 74 degrees Celsius[106].

The “sous-vide” technology is a common practice in restaurants. Is a cooking method, in which raw food material is cooked inside vacuum pouches under a controlled environment. However, the typical errors are inter alia not fully submerging food, using the wrong bag for submerged food, using the wrong temperature for food processing, wrong water level during the process[107]. As mentioned above, the important factor in thermal processing is time. Under ideal conditions, bacteria double every 10 to 30 minutes. Foods must be cooled and heated quickly to avoid time spent at or near ideal conditions. Foods must be reheated to 74°C within 2 hours. Foods must be cooled to less than 4°C within 4 hours. Use a temperature monitor inserted in food to record the change in temperature over time to ensure proper cooling[108]. Methods to cool food products fast.

- Shallow containers, no deeper than 10cm. Do not stack hot pans. Provide adequate air circulation.
- Ice bath.
- Withhold water during cooking, add ice at the end.
- Size reduction.
- Pre-chill ingredients prior to mixing.

[105] https://www.statefoodsafety.com/Resources/Resources/holding-time-and-temperature-log
[106] https://www.statefoodsafety.com/Resources/Resources/cooking-times-and-temperatures-poster
[107] Mar Roldán, Jorge Ruiz, José Sánchez Del Pulgar, Trinidad Pérez-Palacios, Teresa Antequera. Volatile compound profile of sous-vide cooked lamb loins at different temperature-time combinations. Meat Sci
. 2015 Feb;100:52-57. doi: 10.1016/j.meatsci.2014.09.010.
[108]https://www.statefoodsafety.com/Resources/Resources/time-temperature-control-for-safety-tcs-foods-poster

There are several ways to hasten the cooling of food products. One method is refrigeration; walk-in refrigerators are often used in restaurants. Opening doors and placing hot food inside, however, heats refrigerators momentarily. Storing food in shallow pans (not deeper than 10cm), which increases surface area, helps to cool it down quickly. Don't stack hot pans. Ice baths can also be used to hasten the cooling process[109]. Other important factors are pH and moisture. Microorganisms of food safety concern grow in surroundings that are at neutral pH (~7). These organisms do not grow, or grow very slowly below a pH of 4.6. Spoilage organisms can grow at low pH. A pH of 7 is conducive to most microbes - a pH of 4.6 has been found to limit microbial growth.

pH Values

- Vegetables 4.2 – 6.5
- Fruits 2.0 – 6.7
- Cheese 4.9 – 5.9
- Fish 6.6 – 6.8
- Ground Beef 5.1 – 6.2

While the optimum pH for:

- Yeast 4.0 – 6.5
- E. Coli 6.0 – 8.0
- Salmonella 6.0 – 7.5

The ranges of pH values for different microbes relative to those existing in various foods. For food, items like fruits are going to be less likely to be contaminated by microbes, especially items like an orange or lemon with low pHs[110]. In the case of moisture, water activity is one of the crucial factors. Water activity (Aw) - microorganisms need water in an available form. Solutes (salts and sugars) decrease the available water. Water activity is the ratio of the vapour pressure of foods compared to that of water (a measure of moisture content).

Typical Water activity values:

- Fresh fruits and pudding 0.97 - 1.00
- Cheese and fresh meat 0.95 - 1.00
- Jam 0.75 - 0.80
- Crackers 0.10

[109] https://foodsafetytrainingcertification.com/food-safety-news/cooling-food-safely-two-stage-process/
[110]https://extension.okstate.edu/fact-sheets/the-importance-of-food-ph-in-commercial-canning-operations.html

Water Activity (Aw) is defined in those foods with an Aw > 0.85 as “potentially hazardous”. Methods to reduce water activity are:

- Freezing
- Dehydrating
- Mixing with a solute (salt or sugar)
- Cooking (e.g. bacon)

Water activity can be increased in some foods (rice, beans) by soaking. The recommendation for water activity is that it be kept at < 0.85, which is a high number. Anything above 0.85 will encourage bacterial growth. Quite a few techniques can be used to reduce water activity, like dehydrating the food, freezing, cooking, or mixing with a solute. Raw bacon has a high-water activity, but when cooked it gets dry. This is the opposite of what we do with rice and beans when we prepare them, i.e. soaking which increases water activity[111].

Recommendations

- Follow the above-mentioned temperature for handling the food products
- Follow the above-mentioned pH values for dedicated food product
- Follow the above-mentioned Water Activity (Aw)

14.13. Waste management

Restaurants as a food producer, whose activities cause or may cause waste generation should plan, design and conduct these activities in such ways to:

- Prevent the waste generation or reduce the amount of waste and its negative impact on the environment during food processing, as well as after their use
- Ensure environmentally compatible recovery, if waste cannot be prevented
- Ensure environmentally compatible disposal of waste that cannot be prevented or cannot be recovered

Properly running the kitchen at all stages of the food processing contributes to reducing waste generation and includes:

[111] Chiachung Chen. Relationship between Water Activity and Moisture Content in Floral Honey. Foods 2019, 8(1), 30; https://doi.org/10.3390/foods8010030

- Controlling the inventory levels and sales rates on an ongoing basis
- Controlling the products' shelf life during storage
- Preventing food product overproduction from the planning stage
- Purchasing and storing only those food products that will be consumed.

During the food processing phase, where the most food waste is generated, try to use as much of the food product as possible. If possible, trimmings should also be used e.g.: for soup or salads. It is also worth paying attention to proper portioning, which can prevent food from being left behind. Waste generation is an inedible byproduct that should be properly managed, otherwise, it can be an additional source of contamination and become a breeding ground for pests. They can also prove to harbour infectious diseases and contribute to their transmission.

Sound Food Sanitation Program.

A Sound Food Sanitation program includes a safe water supply, adequate garbage and refuse disposal, proper wastewater and sewage disposal, and effective insect and rodent control. During food safety inspections, for instance, in a restaurant, the inspectors check out these possible sources of problems by going over a long checklist of items associated with these concepts[112].

Figure 26 Waste area behind restaurant

Rodent Control

Rodent control can include the elimination of their sources of food, which can be done

[112] Leslie H. Bond. Sanitation is part of Good Food Management: A sound sanitation program is based upon management's knowledge of bacterial hazards and upon line enforcement of good sanitary practices. https://doi.org/10.1177/001088046000100113

by control of refuse/garbage and by minimizing access to water (standing water can be a source). Another method is to rat-proof buildings. Rats can get through holes as small as 12 mm in diameter and mice can get through holes of 6mm diameter size. This means that any hole equal or bigger than this dimension should be sealed. Typically, old buildings that are vacant have lots of rodents. Recommendations for rat-proofing include sealing around pipes with sheet metal or concrete and putting channels underneath doors (so that they are close to the ground)[113].

Eradication programs

Include the use of traps, poisons, or fumigation of the building with methyl bromide (done with caution, because it is harmful). An example of a rat poison is warfarin. It is well known and in use, but rats have developed some immunity to it. The main issue is that it has to be appealing to rats, but not to other animals. Education and organization are critical; one without the other is not good enough; particularly education without organization, because if in an apartment complex only half the residents are trying to deal with rodents, then it cannot be a successful intervention[114].

Arthropod Control

Besides rodents, arthropods are a major health problem for humans. Arthropods are the most successful phylum in the animal kingdom with respect to number of species and number of individuals. All Arthropods have a hard exoskeleton and breathe through a trachea system. The lifecycle of most arthropods includes four stages; egg to larvae, then nymph, and finally adult (complete metamorphosis in flies, moths, butterflies, etc.), while others are just in three stages (without larval stage, incomplete metamorphosis; roaches, body lice, etc.). Control can be applied at any of these stages. The males could also be rendered infertile so that there would not be fertilization of eggs. The two classes within the phyla of Arthropods that we are most concerned about with respect to human health are the Insecta and the Arachnida. The difference between insects and arachnids. Insects have a head, thorax, and abdomen, while arachnids (spiders) have either one or two body segments. Arachnids have simple eyes and 4 pairs of legs, but no wings and include spiders, scorpions, ticks. Insects have only 3 pairs of legs and typically one or two sets of wings as adults (but not always). Five-sixth of all species on earth are insects, including cockroaches, flies, lice, flees, wasps, butterflies, beetles, bees, and ants. Both groups are very adaptable. Both can live in brackish water, fresh water, salt water, and in various conditions in the soil. They can also live on or in plants and animals. Both very successfully compete with other parasites and have a very well-established sensory system. They can detect

[113] https://www.slcgrouponline.com/food-safety-and-pest-control-several-ways-to-prevent-food-poisoning/

[114] https://inspection.canada.ca/preventive-controls/preventive-control-plans/the-food-safety-enhancement-program/eng/1525869691902/1525869759693

people by sensing body heat or exhaled carbon dioxide or through other means. Roaches are an ancient species. They have been almost unchanged for 400 million years. There are many different kinds. Examples are German cockroaches, American cockroaches, Oriental cockroaches, etc. Discussed mainly with regards to the allergens, they are also good sources of endotoxin and bacteria.

Arthropod control includes proper sanitation: use of screens, refuse control, and basic public health measures. Insecticides can be applied but they sometimes carry risks associated with them, so they have to be used judiciously and carefully. Environmental changes include the removal of tires and other water collecting /stagnant products. Radiation to sterilize the males can also be attempted. What is most important here is an integrated pest management plan[115].

Integrated Pest Management

With integrated pest management, the whole life cycle of the arthropod is considered. Then several different approaches to deal with the problem can be explored. This is performed while considering the weaknesses of certain pests. Environmental opportunities can sometimes be applied rather than the use of insecticides[116].

Recommendations

- Waste should always be placed in specially designated containers. They must be airtight, clean and properly labelled.
- The containers should be open in such a way that employees do not have to touch them with their hands.
- Consider using color-coding waste containers for dedicated waste groups.
- The waste should be removed on a regular basis from both the consumption room and kitchen areas.
- Waste containers filled to 2/3 of its height is considered full and must be emptied.
- The waste storage area in the production area must be far away from the areas where any food processing activities are carried out.
- Waste containers must be kept reasonably clean and must be washed and disinfected after each emptying.
- The containers must also be cleaned periodically.
- Avoid the crossing the food product delivery with waste routes.

[115] Lina Bernaola, Jocelyn R Holt. Incorporating Sustainable and Technological Approaches in Pest Management of Invasive Arthropod Species. Annals of the Entomological Society of America, Volume 114, Issue 6, November 2021. https://doi.org/10.1093/aesa/saab041

[116] https://www.food-safety.com/articles/2462-food-safety-calls-for-an-integrated-pest-management-plan

- Introduce rodent and arthropod eradication program.
- Introduce waste management instruction.

14.14. Cleaning and dishwashing

The dishwashing area should always be located near the dining area in order to minimize the dirty dishes' transportation distance. In the absence of a separate area for washing dishes, the situation is that restaurants should use disposable tableware and cutlery only. The essential dishwashing equipment includes:

- Double sink with hot and cold-water supply
- Table for sorting dirty dishes
- Draining table
- Sterilizer
- Waste container.

In order to wash your tableware and cutlery properly, in the beginning, the food leftovers should be removed by using a rubber spatula and rinsing them under running water. Then, manually wash the dishes in the sink using water at a temperature approx. 45°C along with cleaning agents. Rinse the dishes again under running water in a second sink bowl. The final step is to sanitize the washed dishes by immersing them in water heated to a minimum temperature of 90°C. This steaming process effectively eliminates any remaining microorganisms on the dish surfaces, even after washing. After scalding, simply place the dishes on drainers to dry, eliminating the need for wiping.

There are many detergents that soften the water and make it easier to rinse the remaining fats. Most of them possess bactericidal effects. All remains on the washed surfaces can enter the meals. Therefore, the last rinsing in the current water must be very accurate.

Machine dishwashing allows to automatically perform several functions without human involvement. Dishwashers are customized in size to suit different needs. Among them are tunnel machines designed for delivering more than 150 meals and capturing machines for smaller restaurants. The programmed device performs preliminary washing at 30–45°C, specific washing with detergent at 65°C and rinse and evaporate at temperatures above 90°C.

In some machines, the program also includes drying steam at temperature of 100–120°C. Machine washing does not relieve from the manual execution of preliminary actions, i.e. removal of food residues and rinse. Washing dishes should be done on a regular basis to avoid drying up the remaining meals. Dishes with dried dirt and meals leftovers should first be soaked in cool water softened with soda or detergent. When washing glass dishes, the edges should be especially washed. After draining from the water, it should be dried with clean towels. Each type of tableware and cutlery (knives, forks) should be cleaned separately using brush in warm water with detergent, then flushed and evaporated at temperature above 85°C. Evaporated tableware and cutlery should be quickly wiped with a clean towel. After work completion, the washing equipment used should be thoroughly cleaned, the towels washed, boiled and dried, the sink washers washed with hot water and evaporated, and the waste storage containers empty and washed.

Recommendations

- Introduce the cleaning logs in all kitchen areas
- Use only certified chemicals for the purpose of cleaning
- Store chemicals in closed dedicated area
- Train the personnel in tableware, cutlery and other kitchen equipment washing and disinfection
- Equip the restaurant with dishwasher, which allows to record of achieved temperature during their cycle
- Keep the records of dishwasher cycles
- Properly maintain the dishwasher

14.15. Kitchen equipment

In the kitchen, there is a lot of equipment that is used for the purpose of food products processing. Knives, cutting boards, containers, bowls, etc. Each of these equipment should be separate for a particular food group. One and the same boards (for cutting) and knives should not be used for meats and vegetables or dairy products. Problem is associated with cuts and grooves in surface that can harbour bacteria. The best option is to use separate boards for raw and cooked foods. Need to be washed, rinsed and sanitized between every use. Hard plastics can be sterilized in dishwashers. Cutting boards are a major source of cross-contamination. Therefore, different cutting boards should be used for raw and cooked foods, or they must be properly sanitized in dishwashers between uses. Also, cutting boards with a lot of grooves in them allow

potential places to grow bacteria, so the cutting boards should be changed regularly[117].

In order to make it easier for kitchen staff to separate the different equipment for a given assortment, there should be a colour division. Equipment of the same colour is used only for one food group, such as dairy products. Equipment of a particular colour must be stored at the station where they are used, separately from other colours. To make it easier for employees to remember the different divisions, you can hung a diagram on the wall together with an instruction manual.

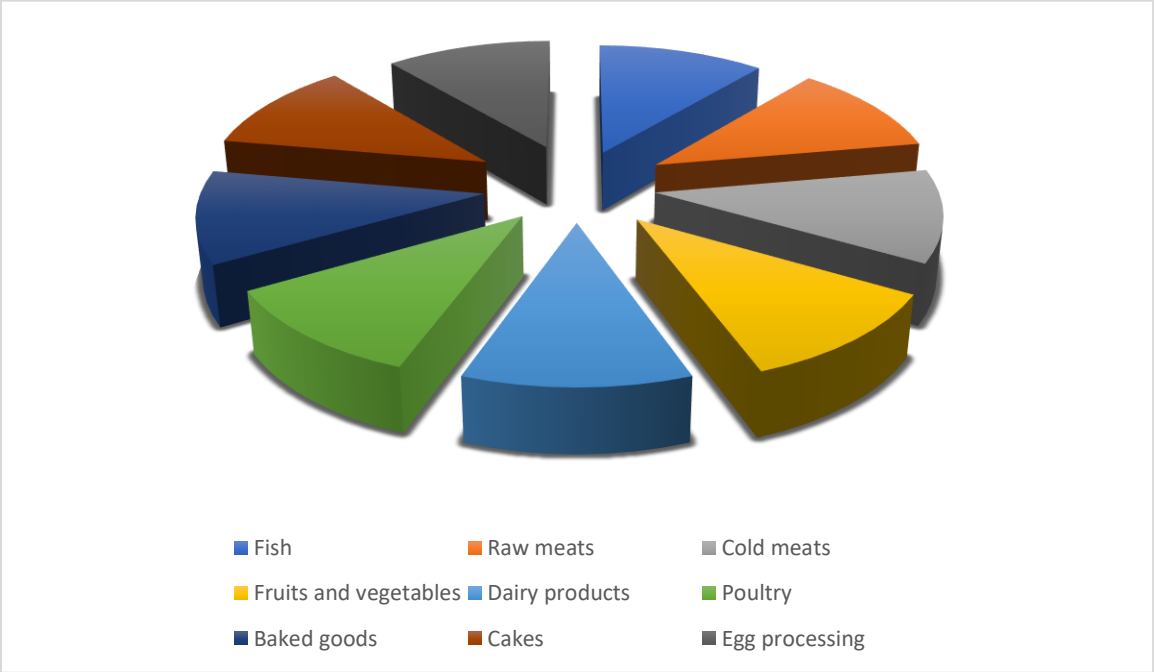

Figure 27 The example of colour coding kitchen equipment

During the small equipment purchasing process, it should be remembered to minimize wooden and glass equipment. These are the items that become a potential source of contamination of food products. Wood deteriorates over time with its use, becoming soggy. It can leave its fragments in food. Microorganisms can grow on wooden objects. In areas associated with food processing, glass objects should be used, when necessary and in the smallest possible quantity. Breaking glass is associated with getting glass particles into food and cuts. Replace wooden boards, glass bowls and containers with those made of plastic.

It is also worth isolating items used for egg processing. Eggs are high-risk raw materials. Therefore, in order to avoid products cross-contamination, label bowls and containers should be used only for egg handling.

[117] https://totalfood.com/avoid-cross-contamination-cutting-boards/

Recommendations

- The proper selection of kitchen equipment has a very large impact on the correctness and hygiene of all food product processing.
- All kitchen equipment must be made of materials that do not exhibit a harmful effect on food products.
- Materials must be durable, easy to keep clean and do not react with food ingredients and cleaning and disinfecting agents.
- Each kitchen area must be equipped according to the requirements for the activities carried out.
- The presence of glass and wooden objects in food processing areas should be avoided.
- In order to distinguish the group of small equipment (knives, cutting boards) for a particular food group, colour division is recommended.

14.16. Food products served in open manner

Buffet service (open manner) is one of the methods of service involving the preparation of a buffet table. In this method, guests put the food on the plates themselves or sometimes they can use the help of service personnel. The buffet table is prepared in a form that is attractive to consumers. The dishes are exposed, and they are encouraged to collect them. In the form of a buffet, various types of meals/dishes can be prepared, such as breakfast, snacks, salads, desserts, fruits, drinks, lunches, dinners etc. Buffets are prepared for closed groups of people, such as hotel guests, or are open to the public for all restaurant guests. The buffet table should be located in such a place that the restaurant guests can have easy access to it. Usually, the table is placed along the wall or in the central place. Everything depends on the room architecture. In addition, buffets for a small number of people look different compared to buffets for a larger group. A properly positioned buffet also affects the comfort of the wait personnel. If the buffet is placed against the wall, some space (behind the table) for service should be left. The buffet can be one table, but also on several. If the menu is rich and there are a lot of guests, then several buffets can be set up in the dining room, each with a different type of food. To sum up, the arrangement and type of buffets is a very individual matter, however, when preparing the tables the following principle - safety of the products and comfort of the guests should be followed. In most restaurants, the side surfaces of the tables are upholstered in a certain way. They should not touch the floor. They should hang equally from each part of the table. In addition, they should be clean and not creased.

Tables should be covered with tablecloths and other elements of table linen that affect their aesthetics. Decorative elements that will not disturb guests can also be used.

Plates and napkins should be placed at the beginning of the table in medium-sized piles (they should not be too high so that they do not obscure other items on the table).

Cutlery: should be placed at the beginning, end of the buffet or a separate table (items to be consumed should be covered with a napkin/serviette - the idea is to prevent other people from coming into contact with parts of the cutlery used for consumption).

Cups, saucers: at the beginning of the buffet. The proper arrangement of the buffet table should correspond to the menu (appetizers, soups, main courses, cheeses, desserts, fruits, baked goods). Should be properly displayed. Should be decorated and described, so the guests have no doubt about what they are putting on their plates. Descriptions should be legible, written in large font and located as close as possible to the relevant dish. Next to each dish should be the cutlery.

Side dishes, e.g. sauces should be placed next to the dish. If there is a possibility of brewing coffee and tea on the buffet table, then all the necessary elements should be close to each other, e.g. coffee, tea, milk, cream, sugar, lemon slices, cups, saucers, spoons etc.
In order to prevent food from drying out, it should be placed under transparent lampshades. Glasses should be placed near beverage dispensers. For displaying/dispensing of drinks and beverages refrigerated display cases, warmers, kettles, thermoses, coffee makers should be used.

Figure 29 The example food product display in ”close manner”

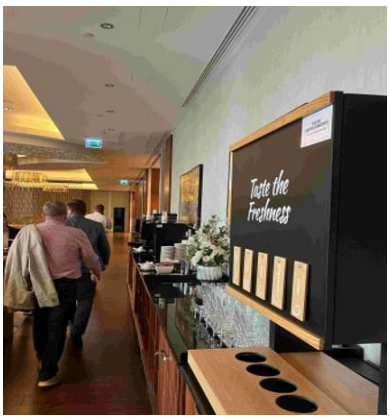

Figure 28 The example of buffet line

Recommendations

- Consider using product display in “close manner” in the buffet line.
- Display small amounts of food products and resupply them frequently, when are

finished.

- Equip with a large amount of tableware as well as special equipment (refrigerated display cases, warmers, etc.) and frequently check their cleanliness.
- Try to prevent the "disappearing cutlery" - guests swap service cutlery between dishes, which can transfer the taste/contamination from one dish to another.
- Frequent inspection of buffet tables by service/restaurant personnel should be executed.
- Always dispose of not-eaten food products displayed previously in the buffet line.
- Consider installing CCTV covering the buffet line.
- Increase awareness among employees concerning any suspicious activities observed in the buffet line.
- Introduce the procedure of reporting any suspicious activities observed in buffet.

14.17. Dining room preparedness for the guests eating meals on site

Concerning the dining room, the customer has an aesthetic in addition to culinary expectations. Satisfying both of these needs increases consumer satisfaction. Properly selected elements of the restaurant decoration and table settings should be an integral whole. Depending on the class and nature of the restaurant, as well as the menu and method of serving, the dining room requires different preparations before guests arrive. The dining area should be prepared differently for everyday service, and differently for special occasions, such as a family party, business meetings, training, tours etc. When organizing events, it is necessary to determine the number of expected guests, pay special attention to the nature of the meeting, whether the premises are booked (if so, or in full), the time of day, and the menu. Determining these things is the basis for properly preparing the venue for the arrival of guests. This knowledge will allow you to properly prepare the following:

- Table setting
- Napkins (type and method of their formation)
- Tableware (method of setting the table)
- Handling of glassware and tableware items (method of service)
- Number of tables
- Setting of tables and chairs

- Setting of the buffet
- Providing an adequate number of wait staff.

Figure 30 The example of dining room preparedness

All these elements have a huge impact on the quality of the service provided. The dining room should be aired and clean so that guests feel comfortable. Tablecloths, individual napkins, and decorations should be neatly and elegantly arranged. An equally important part of preparing the room for serving guests is the waiter's performance. These involve preparing the appropriate equipment, dishes, glassware, table linen and other things necessary for quick and professional service.

Recommendations

- Develop a hygiene checklist
- Consider installing CCTV covering the dining area
- Maintaining the cleanliness of the dining area
- Take care of regular garbage removal
- Garbage should not be left overnight, and it is a good idea to empty the bins when they are ⅔ full.
- Dining area personnel should wash their hands after most of the activities
- Consider wearing dining area personnel disposable gloves
- Create a detailed list by job category with specifications, such as separate duties for different sections among dining area personnel
- Increase awareness among employees concerning any suspicious activities

observed in the dining area.

- Introduce the procedure of reporting any suspicious activities observed in the dining area.

14.18. Preparation of food products to be served on-site

In the case of food processing two basic terms are crucial. The concepts of Good Hygiene Practice (GHP) and Good Production Practices (GPP). Adherence to GPH and GPP standards is essential when working with food. Good Manufacturing Practice (GMP) is a set of standards used in food production, which ensures the high quality and safety of food products, as well as full control over the origin and quality of raw materials. The principles of Good Hygienic Practice include: the layout of areas and equipment, the selection of appropriate equipment, the procedure for cleaning, disinfection, maintenance of machinery and equipment or the use of appropriate technological procedures and operations, as well as training in occupational health and safety. These two standards are mainly focused on food product processing, however, in the case of service exist the Good Catering Practices (GCP). Good Catering Practice covers the basic requirements of the technological processes of food preparation carried out, as well as the requirements for equipment involved in these processes. The aim of GCP is to serve quality food, completely safe for the health of the consumer, with the right taste qualities. Good Catering Practice is a variation of Good Manufacturing Practice, specifically for restaurants.

Food display and serving

After preparation, food served to the restaurant's guests must be stored at certain temperatures. These are: 4ºC for cold dishes such as desserts, salads, the so-called cold plates, min. 75ºC for soups, min 63ºC for hot main dishes, and min. 80ºC for hot beverages such as coffee or tea. As for hot dishes that have been previously cooled, their temperature must be 12ºC higher, or 75ºC. This is to ensure the microbiological safety of the food, which has already crossed the dangerous temperature limit. Food products that are not served immediately, but are exposed, should be stored in warmers with the required temperatures. Warmers allow the food to be stored for a maximum of 2 hours. After this time, the food is no longer suitable for consumption and should be discarded. When displaying food, remember to place individual products in separate plates, baskets and containers, which will also protect them from physical contamination. Each dish must be accompanied by separate cutlery. This is required not only for the quality of the food (eliminating possible mixing of flavours) but also for safety reasons. Separate cutlery will allow to avoid cross-contamination of the food, if one in the dishes becomes contaminated.

Recommendations

- Introduce the GHP, GMC and GCP standards.
- Follow the GHP, GMC and GCP standards.
- Maintain the right food product temperature
- Use separate cutlery for each meal
- Increase awareness among employees concerning any suspicious activities observed during the processing of food products.
- Introduce the procedure of reporting any suspicious activities observed during the processing of food products.

14.19. Service of prepared products to take-away

The restaurant serving take-away meals should be organized in order to operate efficiently and effectively. It will be necessary to change the organization and adapt it to the new conditions. It is necessary to plan the process of preparing, serving and delivering, so that it saves time and money, and the meals will be delivered in a safe way (avoiding unintentional/intentional contamination). Very useful in handling orders is the Point of Sale (POS) system. Thanks to it, the person receiving orders can immediately mark them as a meal for delivery and send this information straight to the kitchen. The staff receives the information directly, which will make the process of preparing the meal faster and without mistakes. It is also worth considering adapting the kitchen equipment to the new conditions. When serving takeaway meals, disposable packaging should be used.

The typical form of ordering meals in hotels is phone orders. In this way, most mistakes can be made - due to poor call quality of phone call or uninformed personnel. Solutions such as quick phone ordering applications combined with a POS system allow you to avoid mistakes. It is important that a contact phone number is always available at the restaurant.

The meals ordered need to be delivered to the customer. It can be done in several ways. When deciding which will be chosen, there is the need to analyse all the pros and cons so that it is, on the one hand, the most efficient and professional, and on the other hand, the most cost-effective and safe. In hotels, which possess several buildings in different locations, the use of food couriers (couriers, which are not the hotel employee) for the purpose of meals delivery is routine. In one building hotel, the delivery of meals should be executed by kitchen personnel, waiter or dedicated

member of hotel staff. By hiring own courier, it is assured that delivery will be made on restaurant terms. However, it needs to be considered, whether hiring own driver, which involves fees such as additional salary, car, fuel, food packaging, will be more profitable than the cost of commission for orders processed by an external company. An intermediate option is to cooperate with a company (trusted and verified), engaged in delivering food from the restaurant to customers. This is a good solution, when the restaurant has regular take-away orders. In the case of sporadic take-away orders, a safer option is to engage in this process dedicated hotel staff.

Transportation of prepared food products

In the case of catering that involves the delivery of food prepared off-site, appropriate conditions must be maintained during transportation. The food products should be protected against the possibility of contamination from outside and keep it at the right temperature. Foods served cold require transportation at 4ºC (with the possibility of briefly exceeding it to 7ºC). Hot meals must be transported at a minimum temperature of 60ºC inside the dedicated container. Foods, depending on their type and serving temperature, can be transported in either individual or in bulk packages.

Following three mentioned standards is equally important. Failure to comply with any of the standards can result not only in a deterioration of the taste characteristics of the food and a decrease in consumer satisfaction, but also in the danger of food unintentionally/intentionally contamination.

Recommendations

- Consider adapting the kitchen area to receive takeaway orders
- Introduce the system of receiving of phone take-away orders
- Consider introducing a web or app-based system for takeaway ordering
- Use only the disposable packaging
- In case of using external delivery courier – introduce the process of verification of delivery company and couriers
- Consider hiring own courier
- Maintain the right food products temperature during transportation
- In case of using internal delivery – appoint the hotel personnel with responsibility to deliver meals to the outside guests

14.20. Reprocessing of food products

In restaurants, food products remain include: residues from processing or consumption, products that do not meet quality requirements and expired products. Post-processing remains are generated in the restaurants and can no longer be used (e.g. seeds, peelings etc. – should be stored in the dirty preparation area) and remains that can be used so-called post-processing remains (e.g., bones, fat – should be stored in the clean preparation area). In restaurants, in order to reduce the amount of remains, it is important to rationally use post-processing returns. Most of the resulting post-processing waste can be used for the preparation of full-fledged meals. Post-consumer remains as well as kitchen remains (e.g. used fryer oils, inedible vegetable parts) should be disposed of. They should not be re-served to consumers or processed after heat treatment. They should not be frozen. Plates with post-consumption remains (leftovers of unconsumed food) should be brought to the dishwashing area. The handling of post-consumer remains is regulated under Regulation (EC) No. 1774/2002 of the European Parliament and of the Council). In addition, according to the Regulation existing in many EU countries list the types of kitchens remains that restaurant can transfer to individuals or organizations. The remains, which do not pose a threat to human and animal health can be used for feeding animals in animal shelters or used in home composting facilities. However, according to HACCP principles, remains cannot be transferred to private individuals but should be disposed of.

Recommendations

- Post-consumer remains as well as kitchen remains should be disposed of
- Post-processing remains, which can be used in food processing should be stored in a clean area of the kitchen.
- Post-processing remains, which can’t be used in food processing should be stored in a dirty area of the kitchen.
- Do not reprocess of food products, which were displayed for more than 2 hours

14.21. Inspection carried out by an individual posing as a Health Inspector

Supervising food safety and hygiene in restaurants is one of the main duties of the Health Inspectorate. That's why sanitary inspections of a restaurant, both routine and intervention inspections - are an everyday occurrence. The inspection is carried out to verify the terms of hygiene, the technical condition, procedures following by employees

and presence of required documentation.

Routine health inspection - announced

A scheduled sanitary inspection is one which the restaurant owner/management is informed of in advance**.** The authority notifies of an upcoming routine inspection 7 to 30 days in advance, which gives the chance to prepare for the inspector's visit. At the same time, it is worth remembering that the heath authority is not obliged to announce the exact date of the inspection. The inspection can be general and aimed at detecting all kinds of irregularities, but it can also focus on a specific area.

Intervention health inspection - unannounced

The health inspector can also conduct an unannounced inspection. This usually happens after receiving information that the restaurant doesn't meet the appropriate conditions for serving food. In such an event, inspectors are required to visit the restaurant within two days. There is no need to notify the owner/management. During the inspection, the health inspector is obliged to verify that the restaurant implemented HACCP standards. It will check whether the records are kept in accordance with procedures, such as cleanliness logs and equipment condition with monitoring logs.

Particularly, the health inspector will check the restaurateur's logs, which consist of:

- Temperature log of refrigeration equipment - for reasons of food safety, the temperature in refrigeration and freezing equipment must be monitored with professional kitchen thermometers and systematically recorded - twice a day. This obligation applies only to those devices that store food products that can spoil.
- Cleanliness log - cleaning activities in the restaurant, such as equipment, the floor and toilets, as well as weekly disinfection. These activities should be carried out according to a schedule and confirmed each time with an employee's signature. The cleaning log must also include information about the detergents used.
- Delivery log - every delivery received must be recorded in a special delivery tracking notebook. The information should consist of the date, record the name of the delivered product, its temperatures and invoice number.

How to prepare to inspection

In addition to verifying the documentation, the inspector will personally check the condition of the restaurant: the cleanliness, freshness and safety procedures. Therefore, before the health inspector visit, it is worth taking a special look at such aspects as:

- The general condition of the kitchen and equipment

- Cleanliness and hygiene throughout the restaurant, especially toilets and social areas
- Handwashing area with soap and towels, with clearly visible handwashing instructions
- Organization of food service area, including easy-to-clean floors and worktops, adequate equipment (e.g., working refrigerators and freezer cabinets, sink, dishwasher with evaporator, working thermometers in refrigeration and freezer cabinets)
- Clean floors, countertops and kitchen equipment
- Required pre-treatment area for vegetables, fruits and meat, and a separate dishwashing room
- Freshness of ingredients and semi-finished products used

Health inspections are an everyday occurrence in restaurants, which the owner/manager must get used to. To reduce the stress accompanying inspections, it is worth to daily verifying the irregularities, when it comes to food safety, cleanliness or documentation kept.

Recommendations

- Introduce the procedure for accepting the health inspection
- In case of any doubts verify the identity of the health inspector
- The employees should be acquainted with the health inspector identity card
- Provide the contact numbers to the regional health inspectorate
- Accompany the health inspector during the inspection.

14.22. Unauthorized persons in the restaurant back room

Rules for guests' movement around the hotel and especially restaurants should be established. It is important that the rules of movement on the hotel restaurant premises should be introduced to hotel guests. In the case of restaurant employees, the rules of movement should include information on the hazards present, the production technologies used and the hygiene and sanitary requirements that apply in individual areas. In view of the above obligation, the employer should develop internal rules for the movement of interested parties, guests and employees. One of the most important methods of ensuring the safety of so-called "unauthorized" is to restrict the movement around the restaurant. For this purpose, clearly mark the places to which they will not have access by using appropriate informational signs, such as the sign "No admission" or posting placards / signs on doors, and gates with a clear inscription: "Prohibition of

unauthorized entry". In case of presence of "unauthorized" in restaurant/back rooms, the person should be escorted to manager by security officer, doorman or another responsible person. The manager notification can also be done through the intercom system or by telephone.

Recommendations

- Keep the doors to restricted areas always closed
- Equip the doors with key locks (electrical)
- Equip the doors with ring bells/buzzers signalling opening the doors
- Equip the restricted areas with signs "Prohibition of unauthorized entry"
- Consider installing CCTV in these areas
- Introduce the protocol of reporting by employees the presence of "unauthorized" in restricted areas
- In case of lack of knowledge concerning the activities performed by "unauthorized" in restricted areas quarantine the food products
- Introduce the procedure of escorting the "unauthorized" to manager
- Introduce the procedure of notifying the police forces

15. Conclusions

Restaurant food safety is extremely important for the health and well-being of all hotel customers. It can be stated that effective procedures concerning restaurant food safety require constant attention, diligence and adherence to strict hygiene standards and sanitation procedures. The implementation of appropriate monitoring systems, employee training and regular inspections are the key elements to minimizing risks associated with intentional/unintentional food poisoning.

The main conclusions are summarized below:

1. **Staff awareness and education**: Regular training of restaurant staff on personal hygiene, safe food storage and preparation is the key. Well-instructed staff can consciously counter the risks of intentional/unintentional food poisoning.
2. **Rigorous adherence to procedures**: Following established procedures for HACCP, hygiene, cleaning and disinfection and storing food in appropriate conditions is essential to minimize the risks of intentional/unintentional food poisoning.
3. **Monitoring and inspection**: Regular inspections, both internal and external, help to identify potential hazards and ensure that the restaurant adheres to all food safety standards.
4. **Attention to the quality of raw materials**: Ensuring that all products used in food processing process are fresh, high quality and from trusted suppliers.
5. **Implementation of provided recommendation**: The provided on each examined CCP should be introduced and implemented. Most of them require only the procedural changes with no financial input needed.
6. **Transparency and communication with customers**: Restaurants should provide clear information to customers about food products used and existing safety procedures in order to provide customers with a safe and satisfying dining experience.