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FOOD CRIME AND FOOD DEFENCE – EUROPEAN PERSPECTIVE

Abstract

A terrorist attack on the food or water supply chain with chemical, biological, radiological or nuclear (CBRN) agents can momentarily affect the stability of a state. The state has to ensure availability of sufficient quantities of food and water for the population, conduct preventive measures to avoid terrorist attacks as well as to prepare solutions for crises caused by intentional food and water contamination. A country's preventive action can be defined through a Vulnerability Assessment of Critical Control Point (VACCP), by adopting a mitigation strategy about the reduction of the system vulnerabilities, as well as developing security and food defence plans into practice. Vulnerabilities could be estimated with CARVER + Shock software (USA). In the event of a crisis, the state should have a prescribed response model to the terrorist attack, as well as an infrastructure recovery duration assessment. Criminal offenses committed through intentional contaminations of the food supply chain (human casualties) bearing ideological or political motives may be characterized as *terrorism*, but if there was another motive such as sabotaging a competitive product or because of personal motives can be referred as *the production and marketing of a harmful product for human health*', *food terror* or *murder* as a consequence. An attack on the water supply system with a CBRN agent may be an act of *terrorism*, but if the motive is not ideological then we can characterize it as *destroying or damaging public utilities* or *endangering the life and property with generally dangerous operation or medium*. Controlling the production, storage and transportation of hazardous substances (CBRN material) inside and outside the country, engagement of public services (intelligence, police, scientific institutes and ministries of health and agriculture) on time, as well as the fast detection of CBRN agents and medical care for casualties, if an attack occurs, is desirable.

Keywords: CBRN agent, intentional food contamination, critical infrastructures, vulnerability assessment, mitigation strategy.

1. INTRODUCTION

The imperative of a government is to keep peace and order inside the country, as well as to ensure the normal functioning and survival of the state. That is possible if the law enforcement, army or intelligence agencies are capable to confront new challenges linked to asymmetric terrorist activities. To fight against these activities, a country should try to protect its critical infrastructures recognized as possible spots of a terrorist attack. Some of the critical infrastructures offered by law are food and water (DHS, 2002; EC, 2008; NN 56/13). Food is defined as any substance or product, whether processed, partially processed or unprocessed, intended to be or reasonably expected to be ingested by humans. The term food includes drink, chewing gum and any substance, including water, intentionally incorporated into food during its manufacturing, preparation or treatment (EC, 2002).

Food can be spoiled or contaminated by unintentional or intentional human activity (Figure 1). Food safety implies the prevention of unintentional contamination (a natural source of pollution) of food products by agents reasonably believed to occur in the food supply chain (e.g. bacteria, bacterial toxins or parasites) (http://www.foodsafety.gov/). Food defence is an effort to prevent the intentional contamination (human intervention) of food products by biological, chemical, physical, radiological or nuclear agents that cannot reasonably occur in the food supply chain (http://www.fda.gov/fooddefense).

Intentional contamination of food/water has been identified as one of the world's major threats to public health in the 21st century (Puhač Bogadi, Banović, & Babić, 2016; WHO, 2008).

Generally, the chemical biological radiological and nuclear (CBRN) agents that could be used in food terrorism are under the control of countries that signed the Convention on the Prohibition of the Development, Production, Collection and Use of Chemical Weapons and on its Destruction (CWC, 1993) and the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction (BTWC, 1972), as well as their use for scientific purposes.

Food terrorism represents the use of CBRN agent by terrorists to cause death or injury to civil population. The motives for food terrorisms are ideological or political with the aim to induce economic or social disturbance.

Food terror is a criminal act committed for rather personal than ideological motives and it is not necessarily committed with CBRN agents from the list of agents (Jurica, Vrdoljak, & Brčić Karačonji, 2019), but with other agents available (household chemicals, pesticides, rat poison).

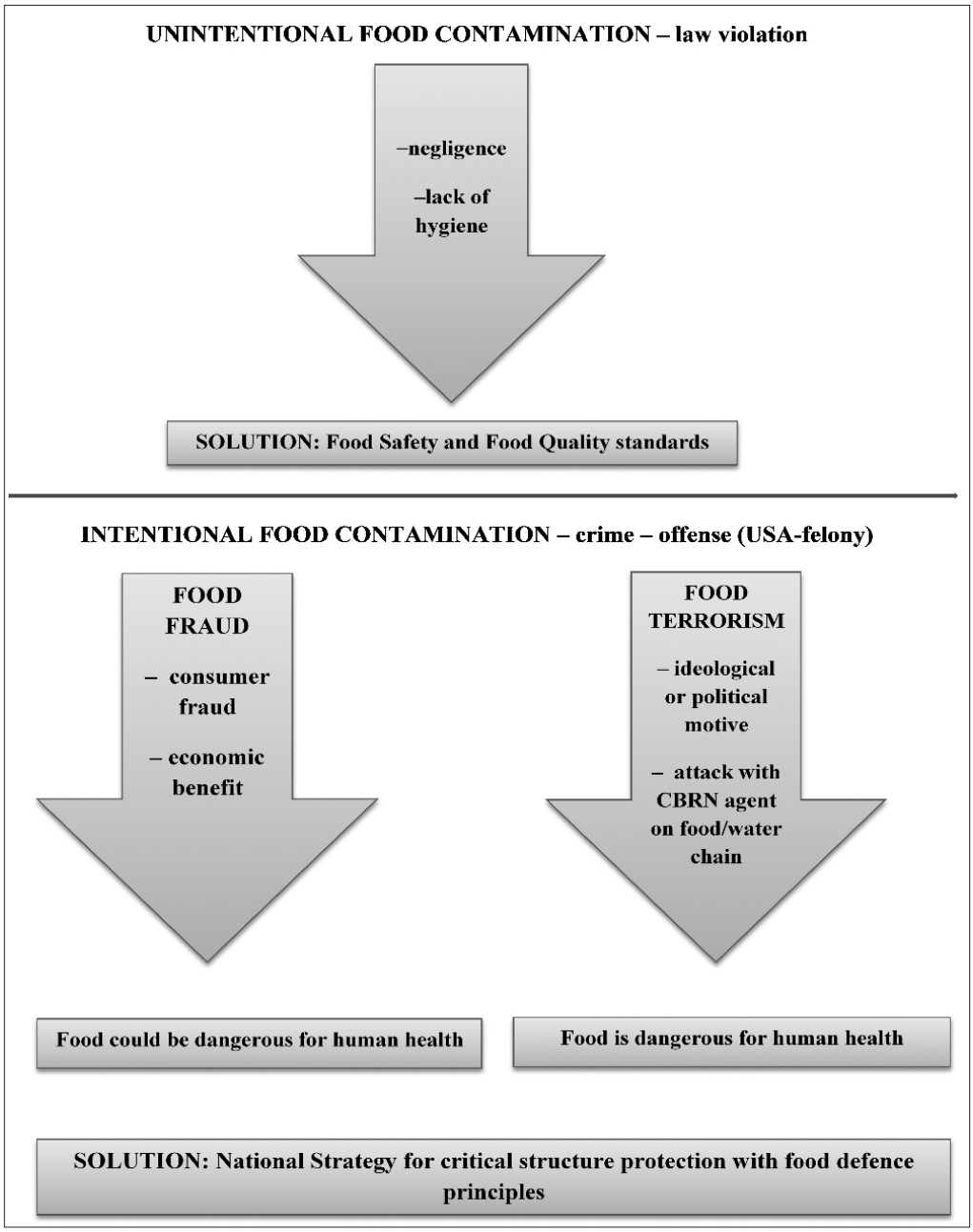

Figure 1. Food crime and food law violation
Source: Jurica et al., 2019

2. LITERATURE REVIEW

After the 9/11/2001 incident at the World Trade Centre, the US established the *Department of Homeland Security* (DHS), which became a part of the US Federal Government's cabinet, with the purpose to protect the US from terrorist attacks and provide answers to natural disasters.

This was made possible by the *Homeland Security Act,* also called the *Critical Infrastructure Information Act* of 2002, that defined state critical infrastructures (DHS, 2002).

CPNI (*Centre for the Protection of National Infrastructure*) was established in the United Kingdom in 2007. The Government identified 13 critical infrastructures, including chemicals, **food, water**, **health**, transport, and reasons why a particular infrastructure is important for the national security of the country. The *National Infrastructure Security Coordination Centre* (NISCC) and the *National Security Advice Centre* (NSAC) were also established (CPNI, 2019).

The Council of Europe Directive 2008/114/EC (EC, 2008) has indicated that each Member State should identify potential European Critical Infrastructures (ECI) and Member States have the primary and ultimate responsibility for their protection. Determination of ECIs should be identified through cross-cutting criteria: *casualties criterion* (assessed in terms of the potential number of fatalities or injuries); *economic effects criterion* (assessed in terms of the significance of economic loss and/or degradation of products or services; including potential environmental effects); *public effects criterion* (assessed in terms of the impact on public confidence, physical suffering and disruption of daily life; including the loss of essential service). Each Member State shall appoint a European critical infrastructure protection contact point ('ECIP contact point').

In 2013, Croatia adopted the *Critical Infrastructures Act* (NN 56/13) which highlighted possible sectors of national critical infrastructures (water holdings, food production and supply sector) that could be recognized by central government departments. After critical structure identification (Government confirmation) and risk evaluation, owners or managers of declared critical infrastructure have to make a Defence Plan.

The food sector in the US is one of 17 federally recognized critical infrastructures (DHS, 2002), while the Homeland Security Presidential Directive 7 (2003) and 9 (2004) set out the various roles and responsibilities of government agencies with food responsibilities.

In 2002, the US passed the *Public Health Security and Bioterrorism Preparedness and Response Act* (2002), which elaborated how the state must prepare and respond to a terrorist act that **threatens food/water** as a national infrastructure. This law also covers improvements to public health, *Centres for Disease Control and Prevention* (CDC) and national health system development in crisis, elaborates scientific countermeasures, as well as the improvements required by hospital systems in terms of preparedness and response to a bioterrorist attack. This law enables additional controls over hazardous biological agents and toxins (Department of Health and Agriculture), food protection

from counterfeiting/tampering and defence of the food/drug supply chain, control and inspection of food importation, food production and food processing facilities, as well as their registration.

In 2014, the British Standard Institution (BSI) defined malicious activities against the **food supply chain** and food itself in the *Food and Drink Protection Guide*. These categories are: economically motivated adulteration, intentional food contamination, espionage, food counterfeiting, and cybercrime (BSI, 2017).

Food safety legislation (Figure 1) has been thematically covered in the Regulation EC 852/2004 (EC, 2004) on food hygiene, while Regulation EC 178/2002 (EC, 2002) has introduced the concept of crisis management and the obligation to adopt a *General Food Safety Crisis Management Plan* in cooperation with the European Food Safety Authority (EFSA) at the national level of Member States. Basically, this act covers food protection regarding the unintentional food contamination and there is no legislation that covers food terrorism preparedness or solution for food/water critical infrastructure protection.

Food safety and food defence have overlaps, and any information in a food safety strategy can be useful when planning food defence strategies. Unintentional food contamination is the result of unhygienic food handling and represents a violation of law (Figure 1). The solution for unintentional food contamination are food safety standards application in the food supply chain (HACCP, ISO 22000) (BS EN ISO 22000, 2018; CAC, 2003). Intentional food contamination is an act committed with the clear intention of introducing an agent into food with the motive of harming, adulterating, or counterfeiting food for fraudulent purposes or economical gain. Both acts (food terrorism and food fraud) represent criminal offenses (Figure 1). The answer lies in a state's Strategy regarding the critical infrastructure and food producers with food defence components incorporated into the food safety/food quality systems (BSI, 2017; FSSC, 2017; IFS, 2017; SQF, 2019; BRC, 2018).

In 2017 the Republic of Croatia passed a draft of the basic Homeland Security Act (2017). Terrorism under the Croatian criminal law is defined in Article 97: "Whoever, with the aim of seriously intimidating the population, or forcing a State, or an international organization to do or not to do, or seriously violate or destroy the fundamental constitutional, political, economic or social structures of the State or an international organization, commits one of the acts (endanger the lives of people, the destruction of state infrastructure, public facilities, property, produce, possess or use the weapons, explosives, nuclear, biological or chemical weapons or research those weapons, releasing the hazardous substances, possesses or uses radioactive substances, uses a radioactive material or uses instrument releasing the radioactivity or damages a nuclear facility), which could seriously damage the state, committed an act of terrorism" (NN 125/11, 144/12, 56/15, 61/15, 101/17, 118/18). The same is stated in the US Criminal law in Chapter 113B (terrorism, or weapons for mass destruction use), Chapter 10, and 11B (prohibition of biological and chemical weapons) (USA, 1948).

The main goal of food terrorism is to destabilize a state infrastructure (ideological motive) while food terror implies personal motives to frighten somebody or sabotage a food product (Jurica et al., 2019).

In 2014, the Croatian Ministry of Agriculture adopted a *Food and Feed Safety Crisis Management Plan* (2014), which provides answers to potential crisis situations and "emergencies", risk management in food safety situations, and ways of coordinating state and local services. This crisis management plan (food safety) is not an absolute solution for potential food terrorism threats. The solution is a national strategy for food/water protection with food defence principles incorporated (Figure 1). The coordination, investigation, and determination of a CBRN agent used in possible food terrorism attack should be guided by the Homeland Commanding Centre (HCC) for crisis. HCCs should be formed by the Ministry of Defence or Homeland Security Department (Figure 2). HCCs have to coordinate all public service included in food terrorism response (Figure 2).

Public state services (intelligence agencies, law enforcement, and military) should do everything in their power to prevent a terrorist attack on the food/water supply chain, but the state must possess elaborated strategies for action if a terrorist attack does occur.

The obligation to create a National Response Plan at all levels of government (health, defence, agriculture, homeland security, agencies, food manufacturers) is mandatory in the US as well as the creation of a single crisis commanding centre (National Incident Management System, NIMS) (DHS, 2003).

The European perspective should be based on similar procedures which could be incorporated in EU Member States' national legislation.

Preparedness for crises caused by food terrorism should be proscribed through a legislative framework as the US does with the *Public Health Security and Bioterrorism Preparedness and Response Act* (2002). Each European State should have a strategy and plan to act in the event of a food/water supply chain terroristic attack, as well as other critical infrastructures.

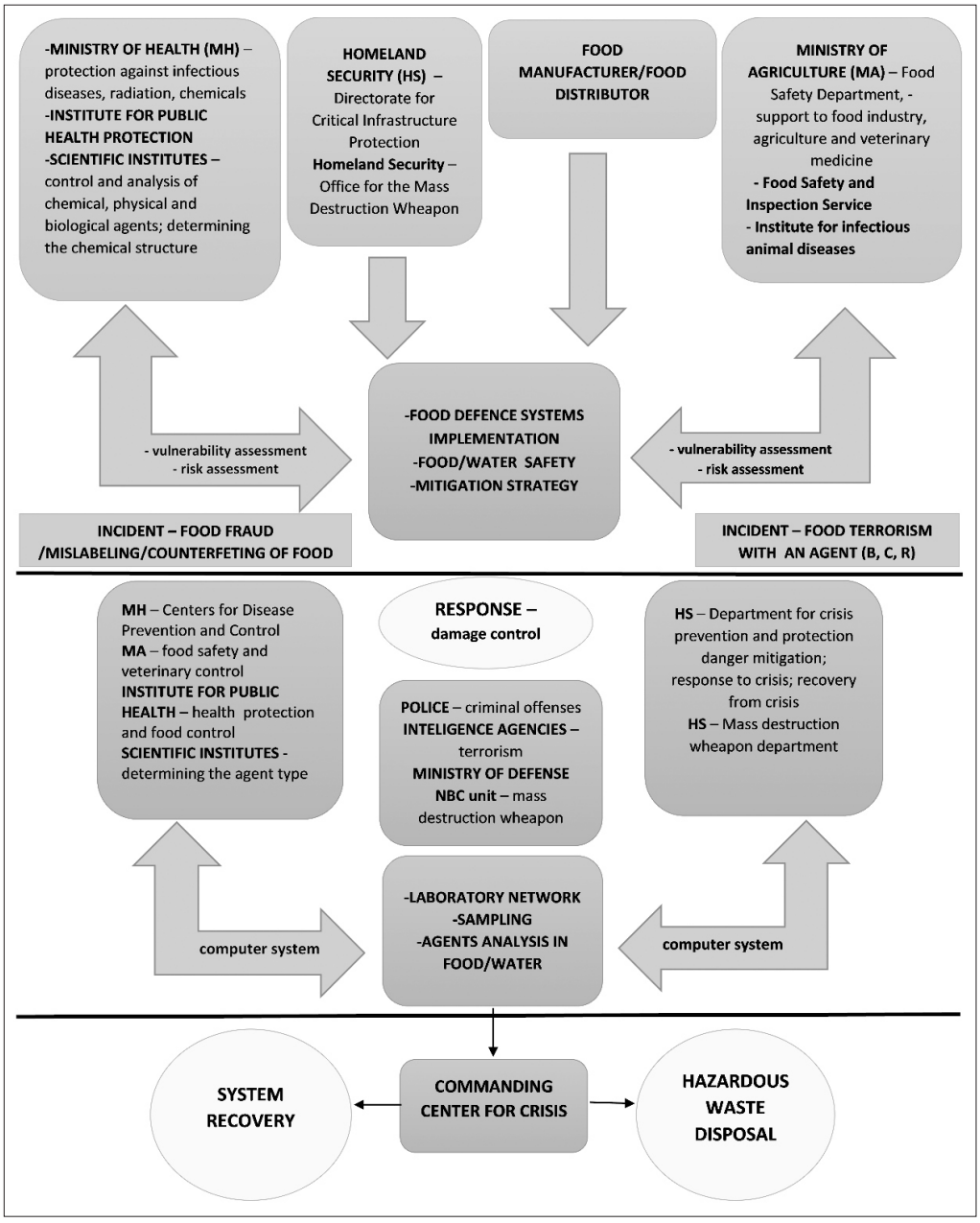

Figure 2. Food terrorism and food fraud response scheme
Source: Jurica et al., 2019:250

3. DISCUSSION

3.1. Food crime – food fraud, food terror and food terrorism

Food crime is a broader concept for food fraud, food terror and food terrorism activities, done with a clear intention by humans. Concerning an attack on a critical infrastructure (food/water facility) excluding food terrorism the act could be qualified as the production and marketing of a product harmful to human health (Art. 188), by a unconscionable inspection of meat for human consumption (Art. 189), or by endangering life and property with a generally dangerous act or medium (Art. 215), destroying or damaging public utilities (Art 216) (NN 125/11).

The European Union for the first time officially acknowledged food crime activities in 2013 during the horse meat scandal (EC, 2013). That was a food fraud offense and the detection and understanding of food fraud is at the beginning, while food terrorism was not a threat we encountered so far (Figure 1).

Food terror is a concept that points to similarities with food terrorism but there is no ideological attack on critical infrastructure. Many cases of food terror have murder as a result of CBRN agent use, and the result was fear among people and short state crisis. But it should be remembered that CBRN agent production, possession or use is terrorism by definition (NN 125/11; USA 1948), unless CBRN agents are used for scientific or medical purpose by authorised subjects according to the Conventions (BTWC, 1972; CWC, 1993).

Food terror would be an act with motives to revenge someone, to frighten someone, to destroy competitor food manufacturers, to sabotage the food product but not the country, or simply because of a psychological misbalance of the perpetrator (Jurica et al., 2019) and it is not necessarily committed with a CBRN agent from the list of CBRN agents (Jurica et al., 2019). The most commonly used agents for food terror are rat poison, cyanide, arsenic, mercury, pesticides, and household chemicals (Dalziel, 2009; Mohtadi & Murshid, 2009).

In Europe, only the British and the Ukrainians had a few cases of CBRN agents use for intentional food contamination. It was more food terror and assassination attempt but CBRN agents were used (possible terrorism act?). Examples are cases of Litvinenko (ex-KGB agent Litvinenko drunk tea with radioactive polonium-210) (Dalziel, 2009) and Yushchenko (Ukrainian president eat the soup with 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) (Karmanau, 2004).

The real examples of food terrorism happened worldwide in the second half of the 20th century. One event took place in 1989, when fruits imported from Chile were contaminated with cyanide. The US Government got the information about the food terrorism act from the US Embassy from Chile. Traces of cyanide have been found in two samples of Chilean grapes in the Philadelphia area. Economical damage in Chile was 300 million dollars. The US had to destroy 45 million various fruits from Chile (nectarines, apples, berries, grapes) and lost 50 million dollars (Shenon, 1989). This event destabilized the economy of the state, and cyanide is on the CBRN agents list (Jurica et al., 2019).

In 1972, members of the terrorist group RISE were arrested in Chicago with 30 kg typhoid (*Salmonella typhimurium*) cultures (biological agent), which was intended to poison the water supply system of the Chicago region, but the new members of the group informed the law enforcement about it. There were no consequences because the chlorination resolved the problem (Franz, 2002).

Chechen rebels planned to sell poisoned vodka at a market in Grozny. During the search in the village of Alkhan-Kala, the Russian Federal Security Agency (FSB) discovered pots containing potassium cyanide solution lying next to several bottles of vodka. The analysis of several bottles of vodka determined potassium cyanide mixed with vodka (Turnbull & Abhayaratne, 2003).

In 2011, *Escherichia coli* appeared in Germany in plant sprouts (fenugreek). It was *E. coli* O104: H4 (biological agent) that came to Germany from France and Egypt in 2009 in fenugreek seeds, and was later grown in Lower Saxony (Burger, 2012).

Some examples are linked to food terror activities because the agents used point to personal motives for committing the food criminal offense (product sabotage, psychological misbalance of the perpetrator, motive to murder someone). In those cases, chemical agents were used but not the CBRN agents (Jurica et al., 2019).

In 2002, in China in the city of Tangshan near Nanjing, Chen Zhengping put tetramine poison in the water system and gnocchi of a rival restaurant, hoping that guests would have digestive disorders at breakfast. He used a prohibited rat poison (DU Shu Qiang). Thirty-eight to one hundred people died (The numbers vary from newspaper to newspaper) and 300 people ended up in the hospital (Deutsche Presse-Agentur, 2002). This was not food terrorism (no CBRN agent used, no critical infrastructure) but it was food terror (private issue of the perpetrator, sabotage of a competitor restaurant).

In 2003, in the City of Ruyang County in central Henan province, China, Cao Qianjin dumped pesticides into a water tank. Cao bought 20 bottles of pesticide called “3911” and threw 500 mL of it into a water tank. He admitted this act and justified it by explaining that he had hoped to use poisoned water to sell the water purifiers he was selling. Sixty-four residents were poisoned, 42 of whom were sent to hospital (Radio Free Asia, 2003).

3.2. Threat Assessment of Critical Control Point (TACCP) – risk management

Threat Assessment Critical Control Point (TACCP) is a methodology that can help the food and drink industry to evaluate, document, understand, and control a wide range of threats to their food supply chain. Basic principles are included in the BRC Global Standard for Food Safety Issue (International Conference on Global Food Safety, 2016; BRC, 2018).

TACCP is the systematic management of risk through the evaluation of threats, identification of vulnerabilities, and implementation of controls to materials and products, purchasing, processes, premises, people, distribution networks and business systems (BSI, 2017).

The TACCP team should deal with four questions (BSI, 2017):

a) Who might want to attack us?
b) How might they do it?
c) Where are we vulnerable?
d) How can we stop them?

All spectres of food criminal offenses that could be committed (intentional food contamination, sabotage in food supply chain, food terrorism, food fraud) pose a potential threat. The CBRN agent and other available agents that could be used in attack pose a threat.

A threat is something that can cause loss or harm which arises from the malicious intention of somebody (BSI, 2017).

3.3. Vulnerability Assessment of Critical Control Points (VACCP) for European critical infrastructures

Food Terrorism is an "act of intentional contamination or threat for intentional contamination of food for human consumption by chemical, biological or radionuclide means for the purpose of causing injury or death to civilians and/or disrupting social, economic or political stability" (WHO, 2008).

Hazardous agents have four categories: physical agents such as glass, needles, metals, objects; chemical agents (heavy metals such as lead; industrial chemicals such as ethylene glycol; toxins such as botulinum); biological agents are bacteria (*Escherichia coli* O157: H7), viruses (foot-and-mouth disease virus), parasites. We could also add radioactive and nuclear substances here. The full list of CBRN agents can be found at the CDCP's website (CDCP, 2018) or in the article by Jurica et al. (2019).

For the evaluation of the food/water supply systems vulnerabilities, a Vulnerability Assessment of Critical Control Points (VACCP) has to be conducted (Yadav & Sharma, 2011) as well as other countries which have grown well economically and countries undergoing the metamorphosis to developed nations, are under serious threat of bio-terrorism. This has led to the development of the software CARVER + Shock by Sandia National Laboratories and Food and Drug Administration (FDA as well as a mitigation strategy implemented in food/water defence policy regarding the CBRN agents that could be used in food terrorism attack (FSIS, 2018).

For VACCP evaluation, FDA published the software program CARVER + Shock (Yadav & Sharma, 2011) as well as other countries which have grown well economically and countries undergoing the metamorphosis to developed nations, are under serious threat of bio-terrorism. This has led to the development of the software CARVER + Shock by Sandia National Laboratories and Food and Drug Administration (FDA. CARVER is an acronym for Criticality, Accessibility, Recuperability, Vulnerability, Effect, and Recognisability (FDA, 2009).

3.3.1. CARVER + Shock (FDA, 2009)

Criticality: The more significant the economic or health impact on a state following the introduction of an agent into a specific point of the food supply system, the more critical it is (Table 1).

Table 1. Criticality evaluation from European and Croatian perspective (FDA, 2009; adjusted)

Criticality - criteria	Scale
Loss of 20000 (**120**) lives or economic loss exceeding 80 (**0.3**) billion euro. (Note: a loss of > 90% of the total economic value *)	**9 – 10**
Loss of life between 2000 (**12**) and 20,000 (**120**) or economic loss between 8 (**0.03**) and 80 (**0.3**) billion euro. (Note: between 61% and 90% of the total economic value *)	**7 – 8**
Loss of life between 200 (**1-2**) and 2000 (**12**) or economic loss between 0.8 (**0.003**) and 8 (**0.03**) billion euro (Note: loss between 31% and 60% of total economic value *)	**5 – 6**
Loss of lives less than 200 (**1-2**) or economic loss between 80 million (**0.03**) and 0.8 (**0.003**) billion euro (Note: loss between 10% and 30% of the total economic value *)	**3 – 4**
No loss of lives or economic loss does not exceed 80 (**0.03**) million euro (Note: loss of <10% of the total economic value *)	**1 – 2**

***The total economic value taken into consideration depends on your perspective (company), or the state could evaluate economic loss with state economy contributed to these products.**
Value – this value is for European Union perspective (excl. the UK) regarding the differences in GDP and number of inhabitants compared with US. A 2.0 coefficient was used for life loss; a 0.8 coefficient was used for the economy loss.
Value – this value is for Croatian perspective regarding the differences in GDP and number of inhabitants compared with US. A 0.012 coefficient was used for life loss; a 0.003 coefficient was used for economic loss.
Data for the USD conversion to EUR was extrapolated from the European Central Bank. Data for the number of inhabitants was extrapolated from www.worldmeters.info and https://data.worldbank.org
Data for the GDP comparison from http://data.worldbank.org

Criticality is most often based on the number of deaths, which is calculated from the size of the food product batch, the distribution units produced, and the number of consumers per distribution unit produced at the critical control point. Criticality assessment is made through public health impact assessments based on the number of deaths, but disruptions that can occur due to the large number of patients could also have a serious impact on the food company and product market or significant influence on public health.

Accessibility: describes the ease of conducting an attack on the food supply chain, contaminating the food, and remaining undiscovered and the probability that an attack would be successful. Accessibility is the openness of the target to the threat agent (Table 2).

Table 2. Accessibility of the food products (FDA, 2009)

Accessibility – criteria	Scale
Easily accessible (the target is outside the building and has no fence) There are limited physical or human obstacles to observing the object. The attacker has a relatively unlimited access to the target. An attack can be carried out in large quantities of agents without concern for detection. Multiple information sources about the target object (facility) are easily accessible.	**9 – 10**
Accessible (target is inside the building but in an unsecured part of a facility). Human observation and physical barriers are limited. The attacker has access to the target in an hour or less. An attack can be performed with a moderate to large amount of contaminant but requires the use of concealment. Only limited specific information about the target object (facility) is available.	**7 – 8**
Partially accessible (target is inside the building but in a relatively unsecured part and working part of the building). Food processing is under constant human observation. Physical barriers may be present. The agent - contaminant must be concealed and the time limitation is significant. Only general, non-specific information about the object (facility) and destination are available.	**5 – 6**
Hard to reach (the product is inside the building in a protected area). Human observation and physical barriers with established mode of detection are present. Access is generally restricted to workers or authorized persons. The contaminant must be concealed and time limitations are extreme. Limited and general information about the object and target is available.	**3 – 4**
Not available The facility has physical barriers, alarms and constant human observation. The mode of action is defined. The attacker can access the target in less than 5 minutes with equipment or an agent on his body. There is no publicly available target information.	**1 – 2**

Accessibility, coupled with vulnerability, is one of the most useful CARVER + Shock factors for distinguishing between more and less critical points, and usually provides an excellent basis for discussion regarding physical security, level of observation and equipment design.

Accessibility is not as relevant in assessing where public access to a facility is inherent in its purpose (retail environment) or during the evaluation of food products growing in open fields (imported products: spices).

Recuperability is measured by the time required to recover a specific system (infrastructure, facility, or food processing company) in terms of new productivity (Table 3).

Table 3. Time for recuperability of the system (facility) (FDA, 2009)

Recuperability – criteria	Scale
> 1 year	9 – 10
6 months to one year	7 – 8
3 – 6 months	5 – 6
1 – 3 months	3 – 4
< 1 month	1 – 2

Vulnerability is a measure of simplicity by which a threatening agent can be introduced into a food product in sufficient quantities (Table 4).

Table 4. Food production supply system vulnerability assessment (FDA, 2009)

Vulnerability – criteria	Scale
Target characteristics (part of facility) make it easy to introduce sufficient amounts of an agent to achieve the goal.	**9 – 10**
Target characteristics almost always allow the introduction of sufficient amount of the agent to reach the goal.	**7 – 8**
Target characteristics allow for a 30 to 60% probability that sufficient amounts of an agent can be added into a target to reach the goal.	**5 – 6**
Target characteristics allow a moderate probability (10 - 30%) that sufficient amounts of an agent can be added into a target and reach the goal.	**3 – 4**
Target characteristics make it unlikely (less than 10%) that a sufficient amount of agent will reach the target.	**1 – 2**

Vulnerability is determined by the properties of the target (e.g. the ease of introduction of the agent, the ability to mix the agent with target product equally) and in environmental characteristics (e.g. the ability to enter the agent unnoticed, the time available for the introduction of the agent).

Effect is the percentage of productivity rate of an attacked food system on one facility/ operation and is conversely related to the number of facilities that produce the same food product (Table 5).

Table 5. Effect on food system and related food systems (FDA, 2009)

Effect – criteria	Scale
More than 50% of the food production system is affected	**9 – 10**
25 – 50% of the food production system is affected	**7 – 8**
10 – 25% of the food production system is affected	**5 – 6**
1 – 10% of the food production system is affected	**3 – 4**
Less than 1% of the food production system is affected	**1 – 2**

Recognisability is the degree to which an attacker can identify a target without replacement with other targets or system components (Table 6).

Table 6. Recognisability of a food product as a target (FDA, 2009)

Recognisability – criteria	Scale
Target is clearly recognizable and requires less training or no training for recognition.	**9 – 10**
Target is easily recognizable and requires less training for identification.	**7 – 8**
Target is difficult to identify or may be confused with other targets or components of the target and requires recognition training.	**5 – 6**
Target is difficult to identify. It is easy to get confused with target components or other targets, which requires extensive recognition training.	**3 – 4**
The target cannot be recognized under any circumstances except by experts.	**1 – 2**

Shock is a combined parameter of health, psychological and collateral national economic impacts of a successful attack on the targeted system (food product, food facility). Shock is considered to possess a national level of interest. The psychological impact of a successful attack on a food chain will be greater if there are a large number of deaths or the target of the attack has a historical, cultural, religious or other symbolic meaning to people.

Table 7. Shock for the inhabitants from European and Croatian perspective (FDA, 2009; adjusted)

Shock – criteria	Scale
The target has great historical, cultural, religious or other symbolic importance. Loss of over 20000 (**120**) lives. Great influence on sensitive subpopulations, for example children or the elderly. The impact on the national economy is more than 80 (**0.3**) billion euro.	**9 – 10**
The target has great historical, cultural, religious or other symbolic importance. Loss of life between 2000 (**12**) and 20000 (**120**). Significant impact on sensitive subpopulations. The impact on the national economy is between 8 (**0.03**) and 80 (**0,3**) billion euro.	**7 – 8**
The target has a medium historical, religious or other symbolic value. Loss of life between 200 (**1-2**) and 2000 (**12**). Medium effect on sensitive subpopulations. The impact on the national economy is between 0.8 (**0.003**) and 8 (**0.03**) billion euro.	**5 – 6**
The target has small historical, cultural, or other symbolic value. The loss of life would be less than 200 (**1-2).** Low impact on sensitive subpopulations. The impact on the national economy is between 80 million (**0.3**) and 0.8 (**0.003**) billion euro.	**3 – 4**
The target has no historical, cultural, religious or symbolic value. The loss of life would be less than 20 **(0.1)**. There is no effect on sensitive subpopulations. The impact on the national economy is less than 80 **(0.3)** million euro.	**1 – 2**
Value – this value is for European Union perspective (incl. the UK) regarding the differences in GDP and number of inhabitants compared with US. **A 2.0 coefficient was used for life loss; a 0.8 coefficient was used for economic loss.** **Value – this value is for Croatian perspective regarding the differences in GDP and number of inhabitants compared with US. A 0.012 coefficient was used for life loss; a 0.003 coefficient was used for economic loss.** **Data for the USD conversion to EUR was extrapolated from the European Central Bank.** **Data for the number of inhabitants was extrapolated from www.worldmeters.info and https://data.worldbank.org** **Data for the GDP comparison from http://data.worldbank.org**	

The Shock factor is closely related to the Criticality factor, and therefore shock as a factor slightly changes the overall estimate for each critical point.

Factors that contribute to higher food system vulnerability/risk are: open access to critical control points – ability to access food processes; poor internal control of the facility/ system – during food production; size of package – large enough packaging to withstand a dangerous amount of agent; short shelf life – also means faster consumption of the product by more consumers; fast product rotation at retail outlets – product purchased more often; rapid consumption of the product; the ability to hide the contaminant; more sensitive consumers – children or the elderly; lack of technological process/processing steps to deactivate the agent or reduce its action; production in large batches – means more contaminated packs; uniform mixing of product ingredients – effective distribution of agents in products; widespread food distribution network – potential mass poisoning (FSIS, 2018).

3.4. Food Defence and Mitigation Strategy

The answer for intentional food contaminations with CBRN agents and threats and vulnerability assessments is the implementation of food defence system principles into the food/water supply chain (FDA, 2018).

After the CARVER evaluation and detection of vulnerabilities in food/water supply chain system, the mitigation strategy should be implemented as a prevention of the food terrorist attack.

A mitigation strategy is a practice conducted to significantly reduce or eliminate the weaknesses previously identified in vulnerability and threat assessments. It can be carried out throughout the food production process, from agriculture, through processing to food distribution and retail. There are general and focused mitigation strategies (FDA, 2019).

General mitigation strategies have four categories:

1. **Outdoor space security** (*procedures related to outdoor facilities, buildings and vehicles, locked fence, walls or other physical obstacles, security patrols, security of primary entrances, emergency exits, loading docks and secondary entrances (windows, roof or ventilation systems), vehicle entry control – control, documentation and identification of vehicles entering and parking at the facility, setting zones between parking areas and entrances to food storage, processing and communal areas).*
2. **Indoor security** – includes practices that are required to protect areas within the facility (*sufficient lighting in the facility, including emergency lighting, alarms and security cameras; controlled access to restricted/sensitive areas (production, storage) and identification of authorized and unauthorized persons in those areas; availability of a blueprint (scheme) of the emergency facility; inspection of toilets, changing rooms, closets and storage for suspicious items; control of the storage of potentially hazardous*

chemicals and accessories and control of entry and keys for these protected areas), utilities (*control of heating, ventilation and air-conditioning systems; refrigeration systems; control of water supply system, electrical and sewerage system*), labs (*controlled access to the facility's laboratory; control of receipt and storage of chemicals delivered and control of chemical storage*) and computer systems (*protection of computer systems against unauthorized access and computer viruses*).

3. **Logistics, manufacturing and warehousing include those practices that protect foods, ingredients, materials and products:** suppliers (*food defence systems implemented at the suppliers' facility or certificate from suppliers*); transportation and reception of raw materials (*supervision of vehicles, trucks and trailers at the place of unloading; supervision of loading and unloading of raw materials from a transport vehicle*); receipt of incoming shipments (*schedules of delivery of raw materials and delivery time and control of delivery of raw materials; on loading ramps; control of full truck and partially full truck; inspection of seals / locks on consignments and inspection of documentation; inspection of shipments for possible unauthorized handling*); processing and production (*control over the storage of inventory, ingredients and materials*); outgoing shipments (*inspection of transport vehicles; inspection of seals / locks on outgoing shipments; review of documentation in the care chain of the product being transported*); returned products (Return) (*a place to review returned foods and keep track of returned food documentation*); ice/water/ required in food processing (*checking drinking water pipes; notifications of possible public water supply problems; access to water wells, storage facilities, treatment systems and ice making facilities)*; warehouses (*control of access to ingredients/materials/storage areas for finished products and temporary storage; security inspections of storage facilities; control of labels and product packaging; finished goods inventory*); hazardous materials/chemicals (access control and inventory of hazardous substances/chemicals).
4. **People** – this section includes staff and management as well as employees, contractors and visitors: staff safety (*security background checks on employees/contractors in sensitive areas of the manufacturing facility; training employees on security procedures; identification of employees / contractors for specific areas; access control of employees/ contractors entering the facility; access restrictions for temporary employees/ contractors; control of the list of people by shift; control of input of personal belongings in production areas; use of company clothing and/or safety equipment*); visitor safety (*visitor review, approval and documentation for the visit; visitor identification; control of visitors' access to sensitive areas*).

Focused mitigation strategies should take place at three levels within the country, in order to be useful in adopting a mitigation strategy:

1. **Ministry level** – **policy and administrative assessment** (*monitoring the implementation of the adopted mitigation strategies based on the results of the vulnerability assessment, investigation of suspicious activities, use of a buddy system to control security steps*

within the system, vulnerability assessment and updating of mitigation strategies as needed).

2. **Procedural strategies** are technical processes or policies for staff, access areas and operations that can prevent malicious action (*establishment of check-in/check-out process for employees, visitors, suppliers, etc.; developing inspection procedures for equipment before and after use; developing recall procedures; developing a plan for using a friendly system in the steps of food production*).
3. **Physical strategies** are security measures that may include material and/or human obstacles that can prevent intentional contamination of food (*securing the location, structure and entrance of the facility, installing and monitoring security systems, providing internal and external security such as access controls, security guards, security cameras, etc.*).

Mitigation strategies are the first and fundamental component in creating a Food Defence Plan. They include security procedures for the system, screening procedures, materials and people. Understanding the different types of mitigation strategies will help evaluate existing practices and identify gaps or weaknesses (VACCP) in those practices.

Tools and resources for mitigation strategies are FDA's Food Defense Mitigation Strategies Database and Food Defense Plan Builder (2019).

The Food Defense Guidelines were also issued by the US Food and Drug Administration (FDA) for all food manufacturers, processors, and carriers, importers, bottlers, grocery and catering establishments, dairy, and cosmetics processors and carriers (FDA, 2019).

When a food terrorism attack occurs, the Government should have the mechanisms for reacting (risk management elaborated) as well as the damage control, and methods for conducting the investigation with clear perception about the jurisdiction (how to prevent the food terrorist attack, who will coordinate with emergency, who will be in command of the accident handling, who could determine the CBRN agent used, who will investigate the accident) (Figure 2).

The Government should be aware and confident in reliable food/water delivery routes complied with national food defence strategy and food defence systems incorporated (Jurica et al., 2019).

4. CONCLUSIONS

"Prevention is better than cure" is the premises that epidemiologists and physicians use in their work (hygiene practise) and it could be applicable in preventive actions regarding food terrorism. The Government should do everything in its power to prevent terrorist attack but should nevertheless be prepared if the attack occurs.

Protection of food and water supply chain critical infrastructures could be increased by control of other critical infrastructures such as production, storage and transportation

of hazardous substances (CBRN material) in and outside the country, and engagement of public services (intelligence agencies, police departments, defence departments, scientific institutes and ministries of health and agriculture) for the prevention of the food terrorism act as well as the governmental preparedness for an undesirable event. Preparedness is possible only through a governmentally elaborated Strategy (national response to the act of food terrorism, medical care for casualties, establishment of who will determine the CBRN agent, who will collect the evidence, who will conduct the criminal investigation and prosecution of perpetrators).

The state or every major city should have at least one food or water supply route that is reliable and secured. It is very important, at the time of a terrorist attack on a critical infrastructure, to know which supply chain is well secured and safe. Food/water supply systems can be well protected with the implementation of functional food/water defence systems that are periodically monitored and re-evaluated. Food defence principles can be implemented in large supply systems, just like in smaller systems for the production, processing, transportation and retailing of food/water, considering threats (TACCP) and risk assessments as well as vulnerability assessments (VACCP) and mitigation strategies.

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