

Chapter 2

Food Supply Chains vs. Food Supply Nets

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2.1 Introduction

Today's food industry and its sophisticated processing and distribution technology produce a variety of foodstuffs available to the consumer at rapidly growing commercial centres. Development of food and related sciences and technologies provides a more in-depth knowledge of health risks; however, the ongoing interventions in technology and the distribution of food innovations are causing new risks.

Federal and international agencies are acting to encourage better public health protection. One of the principal actions has been the development of HACCP (Hazard Analysis and Critical Control Point) based regulations or recommendations by federal agencies and the United Nations Codex Alimentarius Commission (Sperber 1998). To control and comprehend safety in European Union (EU), «White Paper on Food Safety» is an important document that was published in January 2000 (EC 2000). After that regulation 178/2002/EC and decision 97/579/EC were published, which exactly define «European Food Safety Authority». The use of HACCP principles at all levels of the food chain is however compulsory under EU Directive 93/43/EEC and Regulation 852/2004/EC (EU 1993; EC 2004). There will be soon new EU legislation on food control. The new food safety legislation package provides a modernized and simplified, more risk-based approach to the protection of health and more efficient control tools to ensure the effective application of the rules guiding the operation of the food chain. It is a responsibility of all

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included parties in the food chain to ensure food traceability and food safety by internal control in all production phases.

Since April 2004, when the European Parliament adopted Regulation (EU) No 853/2004 on the hygiene of foodstuffs, through its adoption on 1 January 2006 by all food operators, there has been a strong focus on the system of food safety management. The main change to the law relates to food safety management systems, i.e. risk-based methodologies to ensure the safety of food. Successful implementations of the procedures based on HACCP principles require the full cooperation and commitment of food business employees. To this end, employees should undergo training (EC 2004; Jevšnik et al. 2008c; Raspor 2008).

‘Food safety’ is a broad term, which means an assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use. Providing the consumer with safe and healthy food is, in the age of globalization, linked with different styles of food habits and responsibilities and represents an ongoing endeavour in developed and developing countries. Currently, food systems represent a historical collection of knowledge and skills, which are necessary to handle food ‘from stable to table’, ‘from farm to fork’ and ‘from spring to drink’ (Raspor 2004a, b, 2006) what also reflects in professional and communication language and courses substantial problems in communication in food safety area (Ambrožič et al. 2010).

Food safety is of crucial importance to the consumer, the food industry and the economy of each country. Despite significant investment, the incidence of Food-Borne Diseases (FBD) continues to increase. FBD caused by microbiological hazards are a public health problem in Europe and throughout the world.

The inability to effectively improve the situation is a matter of major concern despite the significant resources allocated to the problem of FBD. A closer look at the field of food, from the technical sciences to the social sciences, yields a broad spectrum of possibilities on how to completely maintain food safety. Food safety represents a cross section of four important fields: food regulation, food technology, analytics, and finally, public food safety knowledge and awareness. The purpose of these four fields is to protect human health. Today, we master food safety with different good practices, which are the products of human culture, history and lifestyle. If we analyse good practices in the broad spectrum of the food, we could arrange them in three categories. The first category is directly connected with food technology (i.e. Good Manufacturing Practice (GMP)). The second category is indirectly connected with food issues (i.e. Good Research Practice (GRP), Good Educational Practice (GEP), Good Training Practice (GTrP)). The third category deals with all the activities regarding consumers’ handling of food (Good Housekeeping Practice (GHKP)).

Tradition, practice and a wide variety technical and scientific knowledge have helped shape principles and techniques of how to achieve acceptable food safety in a given environment. Heterogeneous environmental conditions, a wealth of different materials, a diversity of cultures and ways of practical work have helped shape the principles, some of which were later included in legislation. Today, we manage food safety through the good practices at different levels of food production, cater-

ing, distribution and consumption. The current maintenance of food safety in food supply chain can easily break down because of the different kinds of barriers or simple misunderstandings amongst the people involved in food supply chain, including consumers (Raspor and Jevšnik 2008; Jevšnik et al. 2008a, b). The HACCP system, supported with good practices, represents the clearest example of this development (Raspor 2004b). The previous quality control system was based on the finished product. A new food safety philosophy is based on the appropriateness of the technological process in the chain through which food passes, which significantly reduces the risk of inadequate health final product (Sperber 2005a, b; Raspor and Jevšnik 2008). Food safety, synonymous with food hygiene, embraces anything in the processing, preparation or handling of food to ensure it is safe to eat (Griffith 2006), therefore the emphasis of this review paper on food hygiene.

Finally, food safety has not been mastered according to the 'from farm to fork' concept, because consumers are not properly connected to the food supply chain (Raspor and Jevšnik 2008; Raspor 2008).

This chapter clusters the main issues and consequently outlines new platform within food safety area based on networking structure and not any longer on linear food supply chain approach. Such systemic approach is underpinned with comprehensive and critical review of relevant publications in the last decade enriched with author's own findings in research and practice.

2.2 Food-Borne Diseases Arising from Food Supply Chain

FBD are associated with microbial pathogens, biotoxins and chemical contaminants in food. According to the WHO definitions, a 'food-borne disease' is any disease of an infectious or toxic nature caused by the consumption of food, whilst a 'food-borne disease outbreak' is classified as the occurrence of two or more cases of a similar food-borne disease resulting from the ingestion of the same food. A 'food-borne outbreak' is also defined by the European Union Directive 2003/99/EC as an incidence, observed under given circumstances, of two or more human cases of the same disease and/or infection, or a situation in which the observed number of human cases exceeds the expected number and where the cases are linked, or are probably linked, to the same food source. Whereas, 'food' is defined in Regulation (EC) No 178/2002 as any substance or product, whether processed, partially processed or unprocessed, intended to be, or reasonably expected to be, ingested by humans; this definition also includes drinking water and covers single food items as well as meals consisting of various types of food (Ambrožič et al. 2010).

Consumer concern about the threats associated with food is growing. Due to recent food crises in Europe, food quality and food safety have become a hot topic in mass media. Food safety is of crucial importance to the consumer, food industry and economy. It is commonly known that the levels of FBD are increasing in both developed and developing countries. The calculation of annual cases of salmonellosis and campylobacteriosis shows that the yearly number of cases in Europe is

likely to exceed five million, demonstrating that the economic losses and human distress resulting from food-borne diseases can no longer be neglected (Raspor 2004a). Food contamination creates an enormous social and economic burden on communities and their health systems. The incidence of food-borne diseases is rising in developing countries, as well as in the developed world (Redmond and Griffith 2003). The cause can be found in changing lifestyles, increasing consumption of ready-to-eat foods, consumers neglecting the principles of GHKPs, improved laboratory diagnostics and an increasing number of infections involving new or more virulent types (Tauxe 2002; Smole Možina and Hočevar Grom 2004; Jevšnik et al. 2008b, 2011). According to epidemiologists, the recent emergence of infectious diseases can be considered a third epidemiological transition, characterized by a globalization of human disease ecology and the evolution of considerable technological and social–economic changes. The changing epidemiology of food-borne diseases and the increase in knowledge concerning emerging food-borne pathogens require a re-examination of food safety educational messages to ensure that the guidance given to consumers is appropriate for controlling pathogens that are prevalent in the food supply chain (Hillers et al. 2003).

Correct handling of food during all stages of its preparation and storage is vital in reducing the incidence of food-borne diseases. To achieve satisfactory level of food safety at home, consumers should be well informed regarding basic principles of food safety practice (Raspor and Jevšnik 2008). Despite significant advances in public health, in 2010, the European Food Safety Authority (EFSA 2012) registered in total 5262 (1.1/100,000) reported food-borne outbreaks, in which 43,473 people were affected, amongst which 4695 were hospitalized, and 26 died. Apart from households, the most common settings of outbreak were restaurants/cafes and similar premises. Nevertheless, these numbers probably do not reflect the real epidemiological picture, because only reported outbreaks are recorded in the official reports. Therefore, the importance of unreported cases should not be ignored, whilst people with mild medical symptoms often do not seek medical assistance and are therefore not registered in official statistics.

In the current organization of everyday life, there is an increased prevalence of eating away from home and the use of partly or fully cooked food (Haapala and Probart 2004; Byrd-Bredbenner et al. 2007), which is more a reaction to daily time constraints than a result of any increasing popularity of such foodstuffs (Tivadar 2003).

Consumers need knowledge and skills for effective food handling, but also they have to be motivated to act upon that knowledge as a precondition to behaviour change (Hillers et al. 2003; Redmond and Griffith 2003). It is obvious that consumers are not provided with sufficient and easy-to-understand information (Banati and Lakner 2006).

The field of food science and technology is a part of the natural sciences and is thus mainly researched with quantitative methodology (Jevšnik et al. 2006). It is understandable that complex behavioural barriers require detailed diagnostic tools and matching interventions to effectively overcome them, especially in the field of food safety. Behavioural research offers an innovative, yet logical approach to the

problems existing within the field of food safety management, and one that has thus far been mostly untouched (Gilling 2001; Gilling et al. 2001). People do not react to external signals automatically but individually interpret their meaning. Consequently, it is important to learn in detail about various ways of signal interpretation, which can be done with qualitative research techniques. Quantitative and qualitative methodologies have their advantages and disadvantages; neither of the two methodological techniques can assure completely valid and reliable data, but if combined, they can provide important insights into the dynamics of a society. In general, quantitative data offer more static insights but enable the research of basic patterns and structures. Qualitative data, in contrast, are less appropriate for determining patterns and structures in general but enable a more thorough and in-depth understanding of the process of changes in social life (Haralambos and Holborn 1999). Therefore, further multidisciplinary food safety research should be encouraged to comprehend the importance of individual people in units of the food chain. Formal and informal organizational structures and relationships should be taken into strong consideration. Due to a significant increase in the volume of information that scientists from different fields are facing today, a systematic approach to the analysis of published discoveries has become essential. A multidisciplinary approach, including experts for food safety, food technology, psychology, sociology and public health, is thus of great importance (Jevšnik et al. 2006).

2.3 Food Supply Chains vs. Food Supply Nets

Globalization and increased urbanization, especially in developing countries, influence the organization of food supply chains and networks with increasingly complex relationships. Globalization is a historical process that began as early as the first movement of people out of Africa into other parts of the world. Migrants and merchants, who travelled short and gradually longer distances, have always taken their ideas, customs and products into new lands. The global food supply system has undergone dramatic changes in recent decades. The increasing integration of both cross-border and local food supply chains can be considered both a threat and a challenge for food safety (Ambrožič et al. 2010).

Porter (1990) and Selvan (2008) described the meaning of supply chains. Supply chains are understood as transformation processes from inputs through primary production, processing and marketing to the final consumption (Porter 1990). A food supply chain is a network of food-related business involved in the creation and consumption of food products, through which food products move from farm to table (Selvan 2008). Supply chain management is the integrated planning, coordination and control of all business and activities in the supply chain to deliver superior consumer value at the lowest cost to the supply chain as a whole whilst satisfying the variable requirements of other stakeholders in the supply chain, such as governments and NGOs (van der Vorst 2006). In this definition, the supply chain is a series of physical and decision-making activities connected by material and information

flows and associated flows of money and property rights that cross organizational boundaries. The supply chain includes all parties involved in any operation within food circle from production to consumption. Only one insufficient or truncated piece of information or just simply miscommunication in the supply chain can result in unsafe and dangerous food. For this reason, transparency and traceability along food supply chain is one of the most important elements in the food supply chain in order to ensure product and process integrity, improve consumer trust and maintain quality and safety standards (Ambrožič et al. 2010).

Assessing all interactions within food supply chains, we see that many contact points do not receive the attention that they deserve. This complexity raises the question of how we discuss food safety management in food chains. Specifically, we comprehend current food systems running on a linear basis. We know from daily practice that this is not the case. Therefore, we shall start to redesign our approach in thinking, and we shall start to think about food supply networks. It is very common to speak about networking when discussing people, organizations, companies, various subjects in different areas of expertise. With regard to food, nutrition and health, however, there seems to be a desire for a one-dimensional or linear system that would be very practical to handle. Unfortunately (or fortunately), this is not the case. We should implement at least a two-dimensional principle. This shows that we can connect activities in food supply area via activities at contact points, which represent the fusion of some activities on facing sides. This implies that we have active node that integrates the activities of all relevant sides and consequently to more dimensions of activities with different professional stakeholders.

This calls for a network. The network approach is so much more relevant to interconnecting all nodes existing in current food supply systems. Three groups of good practices are controlling food of plant and animal origin within production, processing, storage and distribution, trade and catering. Food supply network is controlled by regulated elements (environment, food premises, conveyances and containers, working utensils and equipment, water supply, pests, food waste and food handlers) and is of crucial importance for stabilizing particular food path in food supply continuum (Fig. 2.1).

When will we include this thinking in practice? Moreover, when will we adopt this practice in flexible thinking?

2.4 Personnel as Main Food Safety Actor

The acceptance of food safety systems has put employee training under the spotlight (Collis and Winnips 2002). Under the personnel programme of HACCP, employees must be trained in areas such as food safety, manufacturing controls and personnel hygiene. Once HACCP plans have been established, employees must be trained to manage any critical control points (CCPs). Though numerous companies have developed, documented and implemented training programmes, few understand why employee training is important, what their training requirements are or how to

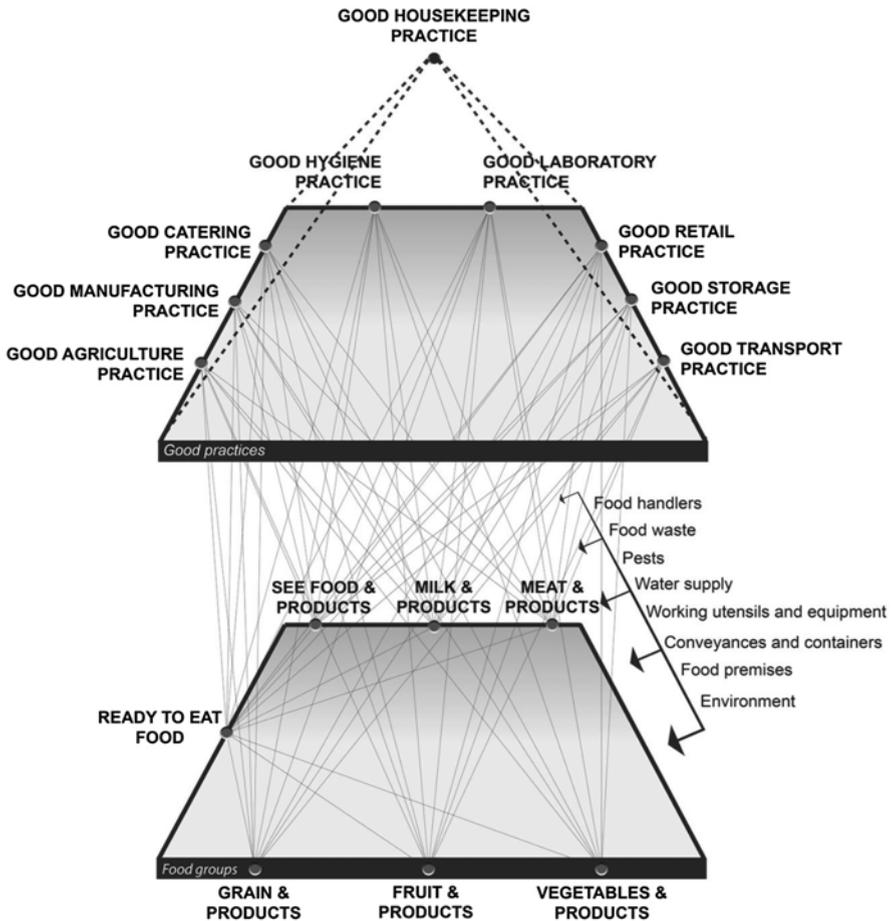


Fig. 2.1 Systems approach in food safety management asks for integration of food chains into food supply networks. Activities are transparently connected via nodes to complex structure of traceable food supply network

assess the effectiveness of in-house training programmes. Thus far, most publications about HACCP training have described what should be done, but little has been written about the effectiveness of such training or how to motivate employees to follow all food safety requirements. Food business operators have to engage with these issues in their own way, as every company has its own specific ways of ensuring safety. HACCP has been described as a philosophy in theory and a tool in practice (Gilling et al. 2001). Bryan (1981) pointed out: ‘It should therefore come as no surprise that there can be different opinions on how it should be applied.’

HACCP problems are a complex mix of managerial, technical and behavioural issues requiring specific remedies (Gilling 2001). By taking a psychological approach and utilizing practical experience and theoretical knowledge of HACCP,

Gilling et al. (2001) identified 11 key barriers and organized them around knowledge, attitude and behaviour frameworks. The proposed Behavioural Adherence Model, therefore, acts as a diagnostic tool, identifying progressive stages to successful HACCP guideline adherence. The authors emphasized that the model should be of significant help to those offering advice and guidance to food operators undertaking HACCP implementation.

A problem that has considerable influence on the acceptance of the introduced 'new' food safety system, especially at the beginning, was the way of presenting HACCP and the qualification of trainers. Mortimore and Smith (1998) mentioned that many trainers had been willing to provide HACCP training without considering the scope (what had to be taught and what need not have been) and the depth of coverage. They also described that a wide disparity in content and quality between courses. Moreover, several authors suggested that most managers in the food industry have limited understanding of the global food safety strategy (Ehiri et al. 1995; Mortimore and Smith 1998; Khandke and Mayes 1998; Williams et al. 2003). MacAuslan (2003) who wrote that the majority of food businesses do not have satisfactory training policies for all their staff. He emphasized that too much reliance is placed upon attaining a certificate rather than attention paid to achieving competency in food hygiene practice. He suggested that greater emphasis and more resources be diverted towards assisting managers to become highly motivated food hygiene managers who develop and maintain a food safety culture within their business. A small business owner may be tempted to place the burden of training responsibility on an external employer, and not shoulder any responsibility themselves. According to MacAuslan (2003), the problem can have two sides: firstly, the employer lacks key management skills in leadership, motivation, training and evaluation; secondly, going for a training course just to obtain a certificate. The responsibility for food safety has been put on food business operators, who do not have sufficient knowledge and skills for human resource management.

Factors that have a significant impact on employers' behaviour are correlated with the organizational climate in the company, the level of job satisfaction and labour conditions, and with relations between employees. Marolt and Gomišček (2005) described a new management approach to employees, one which stimulates employees to take initiative, to learn, to be devoted to the company, to be self-confident, to achieve higher efficiency and better teamwork, which all contribute to the greater success and effectiveness of the organization. They emphasized the function of leadership, which plays a key role in realization of the new principles into practical work and can, therefore, significantly contribute to better usage of existent resources. A leader should persuade employees to fulfil their needs and desires by working effectively and should enable them to reach their potential, and by doing so to contribute to achieving the goals of the team and organization. It would be ideal if people were motivated to such level that they would not work just because they have to but would work with eagerness and with trust. For efficient food safety management, Jevšnik et al. (2007) suggested that food business operators follow the model of 'four elements analysis' for efficient hygiene-technical situation management in food processing plants. The model includes equally important

elements, in which each requires the involvement of a competent and trained person. The model's benefit is the importance of the human factor in food safety assurance. The first element includes an estimation of the current hygiene-technical situation in the food processing plant. Hygiene-technical deficiencies and/or irregularities have to be analysed, and a plan of improvements has to be made. The second element includes the establishing of hygiene basics, the so-called prerequisite programmes, which are the basis for establishing the HACCP system, i.e. a tool for food safety management. The third element includes the planning and execution of periodical training and education, adapted to specific work tasks, for employees at all food hygiene levels. The fourth element notifies employees' knowledge about food handling of an individual worker at a specific work task. This requires a professionally trained, competent person who possesses adequate technical and pedagogical knowledge, practical experiences and knowledge of human resource management. Various techniques and methods of training involvement and control of the work process performance are also required. With the fourth element, the human factor as a risk for food safety assurance is indicated. In the future, a discussion of the human risk factor as being equal to the other risk factors in production processes (biological, chemical and physical) is suggested.

Based on the results of the Jevšnik et al. (2007) research, it is determined that hygiene education and individual awareness are the most important tools for food safety assurance; therefore, every food handler requires a complex and individual management. The human factor must be discussed equally amongst all the other risk factors, e.g. hygiene, technical and technological factors. For food safety, it is essential that every person in the food supply chain understands and fulfils his responsibilities and relies upon the previous and the next step in the chain.

2.5 Human Resources (Personnel Management and Education)

We are facing both insufficient knowledge and awareness of food safety issues amongst food workers and with insufficiently informed consumers about food safety principles at home. It is truly astonishing that so much activity has been invested in this area from childhood onward, but the effect somehow remains minor (Ovca et al. 2014).

In daily practice, most of the critical points depend on a particular person at a particular place. If we do not perform adequate training and appropriate education within human resources, we cannot expect to have professionals with highly developed skills or high knowledge; this makes the control and documentation of food handlers by human resource management relevant (Jevšnik et al. 2006, 2008c).

Human resource management and education of food safety managers on food premises has not captured any significant attention of researchers until recently (Jevšnik et al. 2008c). The strict performance of working procedures in accordance with HACCP system principles and food hygiene is essential for the prevention of

food-related diseases and the efficient assurance of safe food. To achieve this purpose, two basic conditions must be assured: (1) a suitable working environment from the hygienic-technical perspective, and (2) motivated, satisfied and qualified personnel as indicated by Latham and Ernst (2006). It is interesting that many understand the HACCP system as a novelty 15 years ago, when in fact it is a much more complete approach to food safety assurance, as stated by Ehiri et al. (1995). The HACCP system assures more structured surveillance over determined hazards than was the case with the typical type of surveillance. Hazards and corrective actions are not something new. What is new is how separate activities and procedures are logically arranged. The approach is multidisciplinary. It requires personal responsibility, monitoring of documents and records, and rapid action when non-conformities are discovered. It also enables traceability. Its greatest ability lies in responding to changes and in enabling continuous checking and efficiency confirmation. It brings changes to thinking, organizing, managing, education and training at all levels, from employers to employees (Likar et al. 2001; Likar and Jevšnik 2004). The system becomes efficient when it is understandable to employees and when the responsible parties perform their duties. Then the requirements of the system are not considered to be irrational, unnecessary or burdensome, but as a desire for the continuous improvement of one's own work. Consequently, training, from top management to all employees, is crucial for food safety what was already indicated in 1988 by Bryan.

Legislative changes in 2004 required that all food premises provide food hygiene training appropriate for the work activities of their staff (EC 2004, EC (2014)). Jevšnik et al. (2008c) showed that training carried out by company experts and by supervisors directly in working place is the most efficient. Mortlock et al. (2000) suggested that it is also important to recognize that whilst formal training might ensure greater consistency and quality (Manning 1994), improper training could present a greater risk to food safety than no training at all. In a study by Cohen et al. (2001), the impact of an in-house food sanitation training programme on the performance of a catering company was analysed. It was concluded that for a fully effective sanitation programme, the different environments and circumstances in which the departments operate must be taken into consideration. It is very important that those performing any training have suitable food safety knowledge as well as skills in pedagogical/andragogical field. Such people have to be competent experts in their field, so that adequate knowledge and skills can be passed on to the employees.

A problem is found in small and medium-sized enterprises whose owners are usually the responsible persons for food safety programmes, including training. Because of a lack of time or poor knowledge, such trainings are not carried out as required by the law. The results of the Jevšnik et al. (2008c) study show poor knowledge about microbiological hazards and their control amongst employees in retail, catering and food production units. MacAuslan (2003) emphasized the importance of helping managers to understand what is expected of them, and of giving them support in managing effective food hygiene. He pointed out that too much reliance has been placed upon certificates and not enough on competence. In his opinion,

this is defined as the ability of an individual to demonstrate the activities within their workplace, or to function to the standards expected in a food business.

The purpose of internal surveillance is to identify specific hazards in a particular company and then to establish a strategy of efficient control or successive elimination of the hazards, as stated by Jevšnik et al. (2008c).

Strict performance of working procedures in accordance with HACCP system principles and food hygiene is essential for the prevention of food-related diseases and the assurance of efficient safe food. A novel food safety concept for safe food separate activities and procedures is logically arranged. The approach is multidisciplinary, and it requires personal responsibility, monitoring of documentation and records, and rapid action when non-conformities are discovered. It also enables traceability. Its greatest ability lies in responding to changes as well as in enabling continuous checking and efficiency confirmation. It brings changes in thinking, organizing, managing, education and training at all levels, from employers to employees (Likar et al. 2001; Likar and Jevšnik 2004; Jevšnik et al. 2008c).

2.6 Current Limitations in Food Safety Management

The occurrence of intense globalization and urbanization is having a major impact on food systems worldwide. Food systems are changing and consequently resulting in consistent quality, enhanced safety, greater availability and diversity of broad assortments of products throughout the year. Consumers have become increasingly concerned and demanding about the quality and safety of food they are eating. The increased demand for safer food has resulted in the development and introduction of quality management systems, which are used to control the quality and safety of products, such as standards and good practices (Raspor and Ambrožič 2012). Food safety requirements with changes in food supply chains, social, health and demographic situations, lifestyle and environmental conditions have led to significant efforts in the development of quality management system in agribusiness and food industry worldwide. Because quality systems differ in several aspects, they are combined or integrated to assure more aspects of food quality. Quality is divided into aspects of product safety, product quality and total quality, which embrace products' safety and quality (Raspor and Jevšnik 2008; Veflen Olsen and Motarjemi 2014).

At present, quality assurance systems, such as GMP, HACCP, International Organization for Standardization (ISO), British Retail Consortium (BRC) and International Food Standard (IFS), are applied for assuring food safety (van der Spiegel et al. 2003; Raspor and Ambrožič 2012). Each quality assurance system is focused on a particular one. For example, GMP and HACCP were specifically developed to assure food safety (Hoogland et al. 1998; Raspor 2004b). Like HACCP, BRC deals with food safety and product quality but also evaluates management aspects (like ISO does) and facility condition (like GMP does). Additionally, ISO and Total quality management (TQM) focus more on management aspects, whereas GMP and HACCP focus on technological aspects (Barendsz (1998), Hoogland et al.

1998; ISO 9000:2005 (2005), Moy and Motarjemi 2014). Food manufacturers have to decide which quality assurance system is most suitable to their situation and how this system should be implemented. In recent years, a large number of companies have implemented quality assurance systems and TQM systems in order to introduce effective quality systems and consequently produce and distribute high-quality products (Raspor 2008). The vast numbers of laws, regulations, standards, good practices and codes can be quite confusing, even for those who are working in the field on a regular basis and are forced to keep up with the developments (Ambrožič et al. 2010). The challenge for the food supply chain is to satisfy and meet consumers' needs, wants and even their desires. The food supply chain embraces a wide range of disciplines. The creation, operation and evaluation of food supply chains are key dimensions in food safety management (Motarjemi 2014).

In most Small Enterprises (SEs), there are specific limitations (e.g. insufficient training, inadequate or insufficient control of a catering process, inadequate cleaning of working utensils and equipment), and they are not constructive-technically suitable for performing food-related activities (Baş et al. 2006, Jevšnik et al. 2007). In small plants, technical and hygiene conditions for handwashing were estimated as being inadequate and of concern. A non-negligible share (14 %) of small plants did not meet even minimal hygiene-technical requirements for food handling (e.g. wash-hand basin is missing or is not installed properly, thereby enabling cross-contamination between high- and low-risk areas; unsuitable and worn-out materials do not enable efficient sanitation and maintenance). Aarnisalo et al. (2006) summarize the results of many studies that have shown that food processing equipment could be a source of contamination, e.g. *Listeria monocytogenes*. Hygiene problems in equipment are caused when microorganisms become attached to surfaces and survive on them and later become detached from them, thereby contaminating the product (Aarnisalo et al. 2006). In some medium enterprises (MEs) as well as in some SEs, the basins for handwashing do not prevent cross-contamination between high- and low-risk areas. Hygienic equipment of basins is inadequate mainly in SEs, since in more than a third of (39 %) plants necessary hygienic equipment by the basins was missing (e.g. liquid soap, paper towels). In regulation (EC) No 852/2004, it is stated that an adequate number of basins is to be available, suitably located and designated for cleaning hands. Washbasins for cleaning hands are to be provided with hot and cold running water and materials for cleaning hands and for hygienic drying. Where necessary, the facilities for washing food are to be separated from the handwashing facility (EC 2004).

In observing employees during their work, the fact that most of workers in both groups do not wash their hands after performing any dirty work (e.g. when changing between high- and low-risk phases of work, after handling packaging) or do not wash hands properly (e.g. they do not use liquid soap, negligent handwashing technique) was determined. It was concluded that employees do not understand the meaning of proper handwashing and are not aware of microbiological hazards that can occur due to dirty hands. The causes for the latter can be found amongst insufficient hygiene training, negligent, insufficient employees' knowledge and/or inefficient control by supervisors (Jevšnik et al. 2007; Jianu and Goleţ 2014; Pichler et al. 2014).

Ambrožič et al. (2010) summarized research results regarding hand hygiene and pointed out that microorganisms are always present on hands because they are a part of the normal microflora of the human body; nevertheless, in food production and trade, the presence of some bacteria is not allowed. In the research, blood agar plates were used for bacteriological analyses of hands, which enabled the quick estimation of hygiene condition in the selected plants. In further analyses, a selective growth medium would be used only for bacteria considered dangerous; this would show the hygienic status of food processing plants. It was determined that on the right hands of employees there were fewer microorganisms than on the left hands. When studying an individual person, in most of the cases it was observed that they have either low or high bacteria count on both hands. Therefore, it may be wise to take swabs from workers' hands more frequently and to communicate the results, which could be a motivation for better hand hygiene at work. However, as shown in previous studies of food handlers' beliefs and self-reported practices (Clayton et al. 2002), food handlers were aware of the food safety behaviours they should be carrying out, but 63 % of respondents admitted that they did not always carry out these behaviours. Food handlers also reported carrying out food safety practices, particularly handwashing, much more frequently than they actually implemented them (Manning and Snider 1993; Walker et al. 2003; Jianu and Goleţ 2014; Pichler et al. 2014). This suggests that food handlers could be carrying out food safety practices less frequently than the self-reported data implies (Clayton et al. 2002). Shojaei et al. (2006) cited the fact that many authors emphasized that the hands of food handlers are an important vehicle of food cross-contamination and that improved personal hygiene and scrupulous handwashing would lead to the basic control of faces-to-hand-to-mouth spread of potentially pathogenic transient microorganisms. Lues and Van Tonder (2007) summarized the results of several studies in which it was established that various bacteria, amongst others *Staphylococcus aureus*, *Escherichia coli* and *Salmonella* sp., survive on hands and surfaces for hours or even days after initial contact with the microorganisms.

Every person working in a food-handling area is to maintain a high degree of personal cleanliness and is to wear suitable, clean and (where necessary) protective clothing (EC 2004). It was determined that personal hygiene is significantly poorer in SEs than in MEs. More than a third (36 %) of workers in SEs did not wear clean and suitable overalls, and more than half (52 %) performed work with no head-covering. The cause of the problem contributing to the stated results in SEs is lack of control by trained and responsible persons. Workers are to a large extent left on their own; moreover, the owners do not provide necessary means for the safe food handling. In MEs, the situation regarding personal hygiene is better (Jevšnik et al. 2007). In most of the MEs, there is a responsible person authorized by management, who is responsible for hygiene and has required professional education. A periodical training for workers is performed in accordance with a plan, and work performance is checked daily. The main problem identified amongst food handlers in SEs is related to the fact that they receive no specific or insufficient knowledge about food hygiene (Jevšnik et al. 2007).

Knowledge and training for working according to the HACCP system were estimated using questions that had been designed prior to the research. By asking the question: 'How do you record temperatures in cooling appliances and during heat treatment?', it was determined that in 12 % of SEs and in 20 % of MEs temperatures in cooling appliances were registered in advance (e.g. as it seems to be the next day) or for the past (e.g. the person responsible for monitoring the temperature value forgot to write the temperature of cooling appliances) (Jevšnik et al. 2007). From the results, it is concluded that the majority of workers follow instructions, but are not familiar with or do not understand why they are necessary and are not aware of hazards in case of hygiene violations and non-fulfilment of the requirements. This finding was consistent with the findings of Panisello and Quantick (2001), Vela and Fernández (2003), Yapp and Fairman (2006) in which they established that smaller companies may lack knowledge and expertise in HACCP and appropriate resources to obtain knowledge, both resulting in insufficient understanding of functions of HACCP principles. It was established that education and training is not efficient mainly in SEs, since it is carried out by incompetent persons without suitable professional and pedagogical knowledge. Yapp and Fairman (2006) pointed out that in some cases SEs do not realize that they are breaking the law and often do not understand what is required of them. It is particularly evident when recording parameters according to an HACCP plan. It was determined that documentation regarding prerequisite programmes in both types of food enterprises is incomplete, but in SEs the situation is worse. Mitchell (1998) stated that the HACCP plan is sometimes a 'paper exercise' that overburdens the needs of small and medium-sized enterprises and it is not implemented in practice.

With Regulation (EC) No 852/2004, the responsibilities for food safety lay entirely on food business operators, which mean that operators are also responsible for education and training of their employees (EC 2004).

Which training type will prove to be more effective in the future remains a question. Irrespective of that, the most important fact according to Seaman and Eves (2007) is that the training will only lead to an improvement in food safety if the knowledge imparted leads to desired changes in behaviour in the workplace. For conscientious hygiene, it is not important in which enterprise people work, but it does depend upon hygiene awareness and education of an individual person.

2.7 Consumers: A Neglected Link but Essential Node in Food Supply Chains vs. Food Nets

Ensuring safe food for the consumer is, in the era of globalization, the responsibility of every link in food supply chain and constant task in developed and developing countries. Definitions of food safety are generally written, thereby allowing the possibility of many interpretations (Raspor and Jevšnik 2008). A variety of dictionary items and interpretations from different perspectives could be cited, but the point is

that we do not treat food safety as a food safety cycle ‘from the farm to the table’, because we often focus on it partially (only individual segments of the food chain), and we neglect consumers. Each of us is a consumer, regardless of which stage of the food chain we enter the safety cycle (Jevšnik et al. 2011).

The principal objective of the general and specific hygiene rules is to ensure a high level of consumer protection with regard to food safety (EU 2004). Foodstuffs can become a risk factor for consumers if they are not handled and treated along the food supply chain in accordance with the principles of good practices and the HACCP system. The food supply chain does not exclude consumers, but the question is whether consumers are sufficiently informed to assure food safety at the end of the food supply chain. Redmond and Griffith (2003) demonstrated that multiple food safety responsibilities are held by consumers, because consumers not only purchase and receive products but also process and provide foods for themselves and for others. They also emphasized that the implementation of proper food-handling practices can prevent cases of food-borne disease, and the way in which consumers handle food in the kitchen affects the risk of pathogen multiplication, cross-contamination to other products and the destruction of pathogens via thorough cooking procedures (Redmond and Griffith 2003; Griffith and Redmond 2014).

What do consumers know about food safety principles and what do they do to protect themselves from food-borne diseases? The meaning of the term ‘Food Safety’ is well known and defined in expert circles, but, when analysing how it is interpreted by consumers, new dimensions are opening, which can be used as a guide in preparation of educational material for consumers. Jevšnik et al. (2008a, b) analyse statements made by consumers when answering the question, ‘How do you interpret the term food safety?’ The findings show considerable terminological diversity amongst statements made by respondents regarding a description of the term ‘safe food’. The results show a connection between 38.4 % of consumers’ statements in Category A, (harmless for health), and a definition of food safety that mentions the term ‘without hazards’. The results of food safety consumer studies concerning knowledge and practices have shown that consumers are aware of and are thinking about food safety, although there are also many gaps in food safety knowledge and practices that may result in food-borne diseases (Jevšnik et al. 2008a, b; Badrie et al. 2006; Medeiros et al. 2004; Patil et al. 2004; Marklinder et al. 2004; Redmond and Griffith 2003).

Epidemiologic surveillance summaries of food-borne diseases clearly indicate that consumer behaviours, such as the ingestion of raw/undercooked foods, and poor hygienic practices are important contributors to outbreaks of food-borne diseases (Patil et al. 2004). Unusan (2007) reported that people of all ages seem to think they know how to handle food safely, but their self-reported food-handling behaviours do not support this confidence. A review of the consumer food safety literature indicates many gaps that have an impact on food-borne diseases at home (Unusan 2007; Kenedy et al. 2005; Garayoa et al. 2005; Kendall et al. 2004, 2013; Marklinder et al. 2004; Redmond and Griffith 2003; Hillers et al. 2003; Li-Cohen and Bruhn 2002; Yang et al. 2000; Jay et al. 1999a, b; Ergönül 2013). Wilcock et al. (2004) demonstrated that, overall, consumer attitudes towards food safety in general differ accord-

ing to demographic and socio-economic factors, such as gender, age, educational level and economic status. Consumers need to know which behaviours are most likely to result in illness in order to make decisions about food handling and consumption behaviours (Hillers et al. 2003), and then need to be motivated to act on that knowledge as a precondition for behavioural change (Medeiros et al. 2004).

It is very important to investigate consumers' knowledge, behaviour and attitudes towards food safety. Redmond and Griffith (2003) noted that targeted social marketing of food safety strategies is required, because they found differences in perceived responsibility between males and females and consumers from different age groups. They also emphasized that consumers need to perceive interventions as personally relevant for there to be effective food safety education (Griffith and Redmond 2014).

One important perspective is to educate the public about safe food handling and the preparation of foods through different kinds of educational models (Griffith and Redmond 2014), which emphasize hazardous food handling techniques and the microbiological causes of food-borne disease.

Teaching food hygiene on a primary level is crucial, because such behaviour is more easily changed at that stage and also more resistant to alterations later on. Learning about food hygiene and food safety in schools makes it possible to influence children's behaviour with systemic measures, whilst school-based education (on a primary level) as a rule reaches all social classes in developed countries. Children educated in an effective way can also act as facilitators at home through the messages conveyed to family members (Egan et al. 2008) and will hopefully develop to adults who continue to implement proper behaviour at home as caregivers for family members or as employees in the food business. School is, therefore, recognized as an important institution for influencing this kind of behaviour (Moon et al. 1999); it must be noted that the key elements are qualified teachers and quality curriculum. Additionally, the food hygiene content has been restricted in some national curriculums or moved from compulsory to elective subjects and is therefore no longer mandatory for all (Griffith and Redmond 2001; Byrd-Bredbenner et al. 2007). A combination of problems regarding the organization of everyday life in the families and restrictions or even withdrawal of food hygiene content in schools could lead to extreme situations in which children will not be included at all or not in the correct way in food preparation, neither at home nor at school, and will, therefore, not value these topics in their future life (Ovca et al. 2014).

2.8 Good Housekeeping Practice: A key Node in Health Maintenance

To achieve global food safety, consumers should be well informed regarding basic principles of food safety practice at homes (food housekeeping practice), because food safety begins and ends with consumers' daily practices (Raspor and Jevšnik 2008).

To achieve adequate food safety, a coordinated plan is needed for all parties involved in the food chain, including primary and secondary production, distributors, and consumers (Garayoa et al. 2005), which requires a more comprehensive systemic approach. This can be delivered by a food network platform that includes nodes as active points and links as passive points in the food safety management structure. Jones (1998) emphasized that it is extremely important to pay attention to hygienic measures and that they can decrease numerous potential risk factors, which underlines the importance of acknowledging HACCP principles at home (Griffith and Worsfold 1994; Beumer 2003). In the previous 20 years, most of the work has been centred on hazard control in the production sector, but the government has not dedicated the same effort to improving food safety education of consumers. Effective risk communication to inform consumers of the possible health risks of food-borne illnesses and to encourage safer food handling practices in the home is probably the best way to ensure food safety at the consumer end of the food chain (Patil et al. 2005; Griffith and Redmond 2014).

In the classic food chain strategy, all relevant activities are taken for the benefit of human beings but the consumer is located outside the system. The consumer should be an integral part of food safety systems, because he/she is a vital link between retail and home. We expected that a well-informed consumer would start to follow 'Good Housekeeping Practice' (GHKP), which is a selection of the principles and techniques of food storage and preparation at home performed directly by consumer. Given the considerable number of food-borne diseases occurring in domestic food preparation (Ergönül 2013; Kendall et al. 2013), it is obvious that we do not have GHKP, and we neglect the fact that the consumer is crucial link in food supply chain. Consumer behaviour and attitudes towards food safety shows that the levels of understanding, motivation and trust need to be further cultivated. It has been shown that the present maintenance of food safety in the food chain can easily break down because of different kind of barriers or simple misunderstanding. Therefore, a new approach called 'Good Nutritional Practice' (GNP) should be adopted to enhance food safety (Raspor and Jevšnik 2008; Raspor 2008). In all of mentioned practices are HACCP elements that compose HACCP system as main system in food practice today. All practices are partial and are not connected in comprehensive system. For solving the existing barriers in implementing and maintaining food safety system in all steps in food chain, it is necessary to linkup all relevant good practices to the one, named GNP, which could solve many issues in it (Raspor and Jevšnik 2008; Raspor 2008).

Jones (1998) warned against focusing on particular (sensitive) groups and proposed applying HACCP to identify hygiene risks in the home. She suggested drawing up hygiene codes of practices and thus forming the basis of educational material aimed at different target groups. International studies indicated that a significant proportion of food-borne diseases arise from practices in home kitchens (Scott et al. 1982; Bryan 1988; Scott 1996; Wilcock et al. 2004; Patil et al. 2004; Unusan 2007; Jevšnik et al. 2008a, b, c; Nesbitt et al. 2014). Domestic food preparation can negate much of the efforts of primary and secondary food producers to provide safe food

(Oosterom 1998; Jay et al. 1999a, b). The fact is that household food safety education is needed to minimize the risk of exposure to food-borne pathogens.

2.9 Food Safety Management in the Future

As Raspor stated in 2008, food safety is a result of several factors: legislation should establish minimum hygiene requirements; official controls should be in place to check food business operators' compliance; food business operators should establish and operate food safety programmes and procedures. In theory, it seems that we manage food safety completely but practical experiences show some deviations. For that reason, we have to proceed to new solutions that are based on a synthesis of all relevant key factors included in food supply chain. One possibility is to link all relevant good practices in GNP (Raspor 2008; Raspor and Jevšnik 2008).

Currently, we master food safety with different good practices, which are the consequence of human culture, history and lifestyle. If we analyse good practices in the broad range of the food area, we could arrange them in three categories. The first category of good practices is directly connected with food technology (i.e. GMP). The second category is indirectly connected with food issues (i.e. GRP, GEP, GTrP). The third category deals with all the activities regarding consumers' food handling (GHKP). Consumers are currently not connected to food supply chain according to chain principles.

However, it has been shown that present maintenance of food safety in food supply chain can be easily broken down because of different kind of barriers or simple misunderstanding. Therefore, GNP was developed to manage food safety (Raspor 2008; Raspor and Jevšnik 2008). It is important to reconstruct the existent food safety system with GNP, which includes consumers, and that it be based on a model that covers subsystems from other good practices.

New techniques for reducing pathogen contamination in different kinds of food-stuffs are developed every day. It is difficult to cope with all the novelties and innovations since is not always totally clear what is actually new and what is merely an improvement of existing techniques or protocols. The compilations of different authors or authorities around the world are attempting to solve this issue. However, such information can provide a reference for processors worldwide searching for better ways to improve food safety in their plants. The new technologies have to bring significant improvements to the safety of food. Increased public and industry awareness of the new technologies being used could further promote their use, by small and very small plants in particular, towards improving the safety of food products. The new technologies listed should be viewed as information of the current state of the art (Raspor and Jevšnik 2009).

Global food safety will be achieved only when every single link in the food chain systems will master his/her particular area and will trust in the activity of both the previous and following links in the food safety circle 'from farm to table', not ignoring consumer as the one who should be aware of potential risks, proper handling and preparation of food for safe and balanced everyday meal (Raspor and Jevšnik

2008). For this advancement, we need education, training and regular practicing of all the basic principles of food safety.

2.10 Conclusion

Assessing all interactions within food supply chains, we see that many contact points do not have the attention they would deserve. This complexity opens questions: shall we really discuss the future of food safety management in food chain? This implies that we accept linearity as a key principle in current food systems. We know from daily practice that this is not the case. Thus, we shall start to redesign our approach and thinking, and we shall start to think about food supply networks. It is very common that we speak about networking when we speak about people, organizations, companies and various subjects in different areas of expertise.

It seems that the chain approach is slowly fading into history since it focuses primarily on food, food ingredients and food products as passive elements in the food system. These became more evident with the industrial revolution and even more with information revolution. The active player, i.e. the person, who has most important part in the traditional food chain, was pushed aside. People, with many different professions and educations, sometimes far from food, nutrition or health deep professional knowledge, monitor and decide on all actions and reactions in food supply chains. To mitigate this stage of development, it is essential to begin to see both sides passively and actively and simultaneously synchronized to the greatest degree as possible.

With the industrial approach, the primary contact was taken from man by machine. This will not change although the decision is drafted by people, realized by machines and even inspected by machines. This is why a food network active node system must be applied in all practices of current food and nutrition space. In particular is this the issue when we go to international or even global food trade. The challenge question is: When will we include systemic thinking into the practice? Or even more relevant: When will we adopt this practice in flexible thinking?

Finally, it is also important to be aware that people are active twice: once in producing and second in eating food. Do we always have this as primary challenge?

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