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The performance of food safety management systems in the raspberries chain

Andreja Rajkovic [a, b, *], Nada Smigic [a], Ilija Djekic [a], Dragana Popovic [a], Nikola Tomic [a], Nada Krupezevic [a], Mieke Uyttendaele [b], Liesbeth Jacxsens [b]

[a] Department of Food Safety and Quality Management, Faculty of Agriculture – University of Belgrade, Nemanjina 6, 11080 Zemun-Belgrade, Serbia
[b] Laboratory of Food Microbiology and Food Preservation, Department of Food Safety and Quality, Faculty of Bioscience Engineering – Ghent University, Coupure Links, 9000 Ghent, Belgium

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ABSTRACT

The Food Safety Management System – Diagnostic Instrument (FSMS-DI) was used to determine context factors, core control and assurance activities, as well as food safety outputs for three Global G.A.P. certified and six Non Global G.A.P. certified orchard raspberries farms, and eight cold stores (all of them having certified FSMS systems, often in combination with BRC, IFS and/or FSSC 22000 standards). Examined orchard farms operate at moderate to high-risk context. High risk is mainly related to the microbiological and pesticides contamination of raspberries and open cultivation system, which can provoke additional contaminations (e.g. bird droppings). However they differed in chain and organizational characteristics. Non Global G.A.P. certified orchard farms were mainly characterised by low to basic performance of the FSMS combined with low food safety outputs, while in Global G.A.P. orchard farms moderate performance of FSMS resulted in moderate to advanced food safety outputs. Cold store companies represent the subsequent link in the raspberries chain, with the raw material food safety risks directly connected with the orchard farms final product. This is related to the production process of frozen raspberries without any physical or chemical intervention step which might reduce the level of potentially present microorganisms or chemicals in raspberries. The core control and assurance activities in the FSMS present in the cold stores are mainly at medium to high level, resulting in medium to advance food safety outputs.

1. Introduction

The Serbian cultivated berry sector, especially raspberries and blackberries, has been a driving force in the national agricultural economic growth for the last three decades. More than 80,000 farms, 250 cold stores, and 100 processing factories are involved in this sector (USAID, 2008). Republic of Serbia is one of the biggest producers and exporters of raspberries in the world with the annual production of over 60,000 tons (70310 tons in 2012, 68458 tons in 2013 and 61,715 tons in 2014). This fruit was grown on 11,996 ha, 12,024 ha and 11,040 ha, respectively (Serbia, 2016). The total production value in 2014 is estimated at 47 million EUR. Only about 1 million EUR came from the trade of raspberries on the domestic market. Raspberries are grown on 70,000 farms, located mainly in West Serbia, which accounts for nearly 55% of the total raspberry production; Central Serbia, where 35% of the total raspberry output is produced; and South-West Serbia that produces the remaining 10% (Leposavic et al., 2013; Nikolic, Ivanovic, Milenkovic, Milivojevic, & Milutinovic, 2008). Over 90% of Serbian raspberries are the "Willamette" variety, followed by varieties "Meeker", "Tulameen" and "Glen Ample" (Nikolic & Milivojevic, 2015). The family owned farms' average size is 1ha (from 20 acres to 5 ha) (Buric, 2003; Nikolic & Milivojevic, 2015), which is easy to manage, since raspberry farming requires much manual labour (raspberries are almost exclusively manually picked). The yield varies from 5 to 20 t/ha depending on the agricultural practice in place, local climatic and weather conditions (Nikolic & Milivojevic, 2015). Statistical average for the period 2012–2014 was about 5.73 t/ha (Serbia, 2015).

* Corresponding author. Department of Food Safety and Quality Management, Faculty of Agriculture – University of Belgrade, Nemanjina 6, 11080 Zemun-Belgrade, Serbia.
E-mail address: Andreja.Rajkovic@UGent.be (A. Rajkovic).

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Rapid Alert System for Food and Feed (RASFF) of the European Commission shows currently 70 notifications (mainly alerts) involving raspberries of different origin, 17 of these indirectly or directly involving Serbia (RASFF, 2016). Out of 70 notifications, 39 were classified as pathogenic microbial contamination, mainly norovirus, but also caliciviruses, *Escherichia coli* and *Shigella* spp. Reported outbreaks with raspberries involve also *Cyclospora cayetanensis* (Caceres et al., 1998; Gibbs et al., 2013; Herwaldt & Ackers, 1997). However the viral contamination remains the most prominent, causing the largest number of reported outbreaks (Bouwknegt et al., 2015; Sarvikivi et al., 2012; Verhaelen et al., 2013). This in general corresponds to the opinion of 54 experts who considered bacterial as the most important food safety issue for fresh produce in general, followed by foodborne viruses, pesticide residues and mycotoxins (Van Boxstael et al., 2013).

Fresh produce may be contaminated pre-harvest due to irrigation with reclaimed wastewater, crop fertilization with sewage sludge or faecal pollution of the production areas (Chigor et al., 2012; Forslund et al., 2010) and pesticides spraying (Stine, Song, Choi, & Gerba, 2011; Verhaelen et al., 2013). During harvest, food may be contaminated by workers at the field, as was suspected in several outbreaks of Norwalk-like virus, and other enteric viruses from raspberries, leafy vegetables, etc. (Berger et al., 2010; Cotterelle et al., 2005). Fresh produce may be also contaminated during postharvest phases, including product handing, preparation and packaging (Lynch, Tauxe, & Hedberg, 2009; Richards, 2001). Due to the inherent difficulties in detection of viruses in raspberries, one cannot rely on sampling and end-product analysis for any effective control measures, therefore the key efforts must be placed on preventive pre-harvest and post-harvest measures.

An effective Food Safety Management System (FSMS) has to be in place in order to control different hazards in the fruit/raspberry chain. It is the obligation for all food producers to have in place an effective system based on various good practices depending on their role in the food chain. Good agricultural practice is expected in primary production (orchards). Fruit processing (cold storage plants) has to comply with Good Manufacturing Practices (GMP) and the Hazard Analysis and Critical Control Points (HACCP) principles, as outlined in Regulation (EC) 852/2004 and in Serbian Ordinance on hygiene for producers (Serbia, 2010c). It is important to note that these requirements are generic regardless of the type and size of company and therefore should be tailored for the specific company and its business environment. Management system effectiveness assessment (including control and assurance activities) enables discovering of problems which are related to implementation, as well as tracking down the bottlenecks and possible ways for the improvements to the system at the specific company. A tool for the diagnosis of the effectiveness of food safety system was previously developed, in order to determine control activities and core assurance activities in a company's FSMS (Jacxsens et al., 2010; Luning, Bango, Kussaga, Rovira, & Marcelis, 2008; Luning et al., 2011; Luning et al., 2009). It is of note that the system output, being the safety and hygiene of processed fruits or food products, is not only dependent on the system design and operation, but also on the context wherein it operates, as this influences the overall risk (Kirezieva, Nanyunja, et al., 2013). This tool enables one to identify the riskiness of the company's contextual situation in relation to its food safety performance. The diagnostic instrument has been applied in animal food processing companies, within dairy (Sampers, Toyofuku, Luning, Uyttendaele, & Jacxsens, 2012) and meat (Osés et al., 2012; Sampers et al., 2010) industry. Within the European FP7 project Veg-i-Trade, FSMS-DI has been tailored for the fresh produce sector, including primary production, processing and trade (Kirezieva, Jacxsens, Uyttendaele, Van Boekel, & Luning, 2013). It has been applied in the mushroom production in South Africa (Dzingirayi & Korsten, 2016), the primary production of organic lettuce in Brazil (de Quadros Rodrigues et al., 2014), green bean farms in Kenya, hot pepper farms in Uganda (Nanyunja et al., 2015a) and fresh produce export processing companies in Kenya (Sawe, Onyango, & Njage, 2014).

Based on the hypothesis that Global G.A.P. certification ensures a better FSMS performance in orchard farms producing raspberries, and due to the restricted set of requirements, the risk-based approach and annual third party audits, the first objective of this study was to get an insight and to compare the status of FSMS in three Global G.A.P. certified and six Non Global G.A.P. certified farms in Serbia using FSMS-DI. In addition, a better FSMS performance is expected in downstream actor in the raspberries chain, i.e. the cold stores. Therefore, the aim was to determine FSMS performance in eight cold stores (all of them having certified HACCP systems, often in combination with BRC, IFS and/or FSSC 22000 standards), in view of their contextual situation and food safety output.

2. Material and methods

2.1. Profile of participants

A total number of 17 food business operators were included in the study, consisting of nine orchard farms growing raspberries (coded F1 to F9) and eight cold stores (coded CS1 to CS8) doing purchasing, freezing, packing and distributing berries. All orchard farms and cold stores were located in Central and West Serbia, corresponding to the area with about 90% of raspberry plots in Serbia. The data related to the practices regarding food safety management systems were collected in orchard farms and cold stores with the permission of the business operators.

The breakdown of food businesses that participated in this survey is presented in Table 1. All orchard farms (F1 to F9) involved in this study were the suppliers of three cold stores (CS1 to CS3). The other five cold stores (CS4 to CS8) have purchased raspberries from other farms.

2.2. Food safety system diagnosis

The Food Safety Management System – Diagnostic Instrument (FSMS-DI) was developed for each actor in the fresh produce chain within the European project Veg-i-Trade. FSMS-DI used for orchard farms consisted of 66 questions (Kirezieva, Jacxsens, et al., 2013; Kirezieva, Nanyunja, et al., 2013), while FSMS-DI used in cold stores consisted of 71 questions.

The data were obtained during face-to-face interviews with owners of the orchard farms or responsible QA (quality assurance) staff of the cold stores using the structured questionnaire. For each question/indicator, the interviewees had a possibility to grade a level that is the most representative for their business. Additional statements and explanations were provided for each question in the questionnaire to allow an easier selection of the most representative situation. Each interview lasted about 2–3 h and was followed by an on-site visit to confirm the initial assessment.

2.2.1. Diagnosis of riskiness in context

First part of FSMS-DI represents the context diagnosis with a set of indicators to assess the risk level of the context factors (being product, process, organizational and chain environment characteristics). For each indicator, three situational descriptors are given representing low (situation 1), moderate (situation 2) and high (situation 3) risk. Regarding product and process characteristics, low, moderate, and high risk situations correspond to low, moderate and high probability of microbial or chemical contamination,