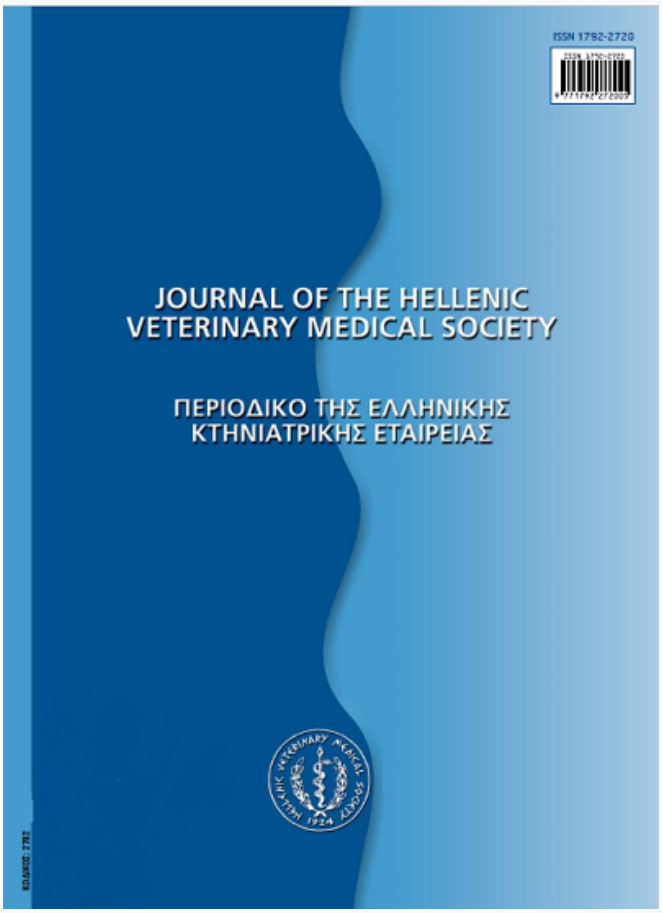
Journal of the Hellenic Veterinary Medical Society

Vol 63, No 4 (2012)



Factors influencing HACCP implementation in the food industry

K. MILIOS (Κ. ΜΗΛΙΟΣ), E. H. DROSINOS (Ε. ΔΡΟΣΙΝΟΣ), P. E. ZOIOPOULOS (Π.Ε. ΖΩΪΟΠΟΥΛΟΣ)

doi: 10.12681/jhvms.15442

J HELLENIC VET MED SOC 2012, 63(4): 283-290
ΠΕΚΕ 2012, 63(4): 283-290

Review article
Ανασκόπηση

Factors influencing HACCP implementation in the food industry

Milios K.[1], Drosinos E.H.[2], Zoiopoulos P.E.[3]

[1]*Veterinary Service, Regional Administration of Western Greece, Patras, Greece.*

[2]*Laboratory of Food Quality Control and Hygiene, Department of Food Science and Technology, Agricultural University of Athens, Athens, Greece.*

[3]*Laboratory of Animal Science, School of Management of Natural Resources and Enterprises, University of Western Greece, Agrinio, Greece.*

Παράγοντες που επηρεάζουν την εφαρμογή του HACCP στη βιομηχανία τροφίμων

Μήλιος Κ.[1], Δροσινός Ε.[2], Ζωϊόπουλος Π.[3]

[1]*Διεύθυνση Κτηνιατρικής Περιφέρειας Δυτικής Ελλάδας, Πάτρα.*

[2]*Εργαστήριο Ποιοτικού Ελέγχου και Υγιεινής Τροφίμων και Ποτών, Τμήμα Επιστήμης και Τεχνολογίας Τροφίμων, Γεωπονικό Πανεπιστήμιο Αθηνών, Αθήνα.*

[3]*Εργαστήριο Ζωικής Παραγωγής, Τμήμα Διοίκησης Επιχειρήσεων Αγροτικών Προϊόντων και Τροφίμων, Πανεπιστήμιο Δυτικής Ελλάδος, Αγρίνιο.*

ABSTRACT. HACCP application in food processing plants could improve food safety and lead to a reduction of food-borne diseases. Apparent lack of HACCP implementation in several food businesses may be due to presence of various technical barriers. The aim of this review is to explore the lists of motives and barriers to implementation of the HACCP system as outlined in the published literature and to evaluate respective impact. Lack of awareness of HACCP, no perceived benefits, lack of training, management regressions, variability of production lines and individuality of each product, variability of the consumers' demands and small size of an enterprise have been found to have negative effects on implementation and performance of a HACCP system. Also, costs of development, as well as application and maintenance of the system seem to constitute a severe constraint. According to the authors' opinion, lack of management commitment, in addition to lack of personnel training and costs are the main constraints to appropriate implementation of HACCP. On the other hand,

Correspondence: K. Milios,
Veterinary Service, Regional Administration of Western Greece,
Zaimi 21, 26110 Patras, Greece. E-mail: milios@aitnia.gr
Αλληλογραφία: Κ. Μήλιος,
Διεύθυνση Κτηνιατρικής Περιφέρειας Δυτικής Ελλάδας,
Ζαΐμη 21, 26110 Πάτρα. E-mail: milios@aitnia.gr

Date of initial submission: 27 September 2012
Date of revised submission: 20 November 2012
Date of acceptance: 26 November 2012

Ημερομηνία αρχικής υποβολής: 27 Σεπτεμβρίου 2012
Ημερομηνία αναθεωρημένης υποβολής: 20 Νοεμβρίου 2012
Ημερομηνία αποδοχής: 26 Νοεμβρίου 2012

motivation for HACCP application provides an improvement of processing procedures' efficiency, decrease of recalls, regulatory demands, enhancement of firm reputation, costs reduction, customers' demands, previous experiences with food safety issues, trained staff and management decision. Finally, legislation cannot provide adequate motivation for appropriate HACCP implementation, so that market motivation is, in our view, the key factor that can lead to management commitment.

Keywords: carcass quality, food safety management, HACCP, slaughterhouse hygiene

ΠΕΡΙΛΗΨΗ. Η εφαρμογή του συστήματος HACCP σε εγκαταστάσεις παραγωγής τροφίμων μπορεί να βελτιώσει την ασφάλεια των προϊόντων και να οδηγήσει σε μείωση των τροφιμογενών νοσημάτων. Η ατελής εφαρμογή ενός συστήματος HACCP σε κάποιες περιπτώσεις μπορεί να οφείλεται σε ύπαρξη τεχνικών εμποδίων. Σκοπός του παρόντος άρθρου είναι η ανασκόπηση των ενδεχόμενων ανασταλτικών παραγόντων για την εφαρμογή HACCP σε κάποια επιχείρηση παραγωγής τροφίμων, καθώς και του οφέλους που προκύπτει από την εφαρμογή αυτού. Η έλλειψη ενημέρωσης γύρω από το HACCP, τα μη αντιληπτά αποτελέσματα, η έλλειψη εκπαίδευσης, οι παλινδρομήσεις της διοίκησης, η ποικιλομορφία των γραμμών παραγωγής και η ιδιαιτερότητα κάθε προϊόντος, το εύρος των απαιτήσεων των πελατών και το μικρό μέγεθος των επιχειρήσεων είναι παράγοντες που μπορεί να επηρεάσουν αρνητικά την αποτελεσματική εφαρμογή των συστημάτων HACCP. Επίσης, εμπόδιο μπορεί να αποτελέσει και το κόστος ανάπτυξης, εφαρμογής και διατήρησης του συστήματος. Κατά τη γνώμη μας, τα σημαντικότερα εμπόδια που μπορούν να εντοπιστούν είναι η έλλειψη δέσμευσης της διοίκησης προς την κατεύθυνση παραγωγής ασφαλών τροφίμων, η έλλειψη επαρκούς εκπαίδευσης του προσωπικού και το κόστος που σχετίζεται με το σύστημα. Από την άλλη πλευρά, κίνητρα για εφαρμογή του συστήματος μπορούν να αποτελέσουν η βελτίωση της αποτελεσματικότητας των διαδικασιών παραγωγής, η μείωση των αποσύρσεων προϊόντων από την αγορά, οι απαιτήσεις της νομοθεσίας, η προστασία της φήμης της επιχείρησης, η μείωση του κόστους παραγωγής, οι απαιτήσεις των πελατών, η προηγούμενη εμπειρία σε σχέση με θέματα ασφάλειας τροφίμων, η παρουσία ήδη εκπαιδευμένου προσωπικού και η αποφασιστικότητα της διοίκησης. Τέλος, οι νομοθετικές απαιτήσεις δεν μπορούν να αποτελέσουν επαρκές κίνητρο για την ορθή εφαρμογή του συστήματος HACCP. Το σημαντικότερο κίνητρο για τη δέσμευση της διοίκησης αποτελούν, κατά την άποψή μας, οι απαιτήσεις της αγοράς.

Λέξεις ευρετηρίασης: διαχείριση ασφάλειας τροφίμων, ποιότητα σφαγίων, υγιεινή σφαγείων, HACCP

INTRODUCTION

It has been well documented that proper application of the Hazard Analysis Critical Control Points (HACCP) system has positive results and benefits to food safety (Gillespie et al. 2001, Mantovanelli et al. 2001, Little et al. 2003, Consuelo et al. 2006, Naugle et al. 2006, Khatry and Collins 2007, Violaris et al. 2008). HACCP system implementation in food industry increases involvement, understanding and commitment towards a perspective of hazard control in food production. In addition, there are further factors that influence performance of a HACCP system. Lack of awareness of HACCP, no perceived benefits, lack of training, management regressions, variability of the production lines and individuality of each product, variability of the consumers demands (Panisello et al. 2000, Ward 2001, Adams 2002, Griffith 2006) and small size of an enterprise adversely affect performance of a HACCP system. Moreover, costs of development, application and maintenance of the system also appear to be constraints (Bata et al. 2006, Semos and Kontogeorgos 2007).

On the other hand, motivation for HACCP application brings about improvement of processing procedures efficiency (Mazzocco 1996, Jensen et al. 1998), reduction of product recalls (Mortajemi and Kaferstein 1999), regulatory demands, enhancement of firm reputation, costs reduction, customers demands, previous experiences with food safety issues, trained staff and management decision (Khatri and Collins 2007).

The objective of the present article is to review the literature about the motives and constraints to implementation of an HACCP system, as well as the impact of each of these.

REVIEW OF FACTORS WHICH HAVE BEEN DESCRIBED TO AFFECT HACCP IMPLEMENTATION IN THE FOOD INDUSTRY

Much research has been made in recent years to describe factors that may affect HACCP systems implementation in the food industry. Semos and Kontogeorgos (2007) in a study performed in Greek food industries, attempted to assess the costs associated with the preparation and implementation of the system. They obtained data from 91 food enterprises in Northern Greece by using a questionnaire. Factors were grouped, based on previous studies (Henson et al. 1999), within the following categories: staff training, investment in new equipment, external consultancy service, prerequisites implementation, structural changes to plant and buildings, employing new staff (costs of implementing HACCP) and product testing, spending managerial time, staff training, quality department operational cost and record keeping (costs of operating HACCP). According to their results, the most significant costs during implementation of the system were staff training and investment in new equipment, while the most significant costs during operation were product testing and managerial time. Another interesting result from that work was that, in most cases, the final overall cost was higher than that initially expected.

The same authors (Semos and Kontogeorgos, 2007) investigated possible difficulties encountered during HACCP operation. They included in their questionnaire the need to re-train production staff, the motivation of production staff, the reduced flexibility of production process, the reduced staff time available for other tasks, the reduced flexibility of production staff, the need to retrain managerial staff, the motivation of managerial staff and, finally, the reduced flexibility to introduce new products. According to the results, the major difficulties involved were staff training and motivation, as well as product flexibility reduction. Other researchers have also reported that staff limitations might be a barrier to proper HACCP implementation (Henson et al. 1999, Eves and Dervisi 2005, Fotopoulos et al. 2011). Finally, Semos and Kontogeorgos (2007) investigated also managerial opinions regarding potential benefits of HACCP implementation. Increased ability to improve production procedures, reduced microbial counts on products, increased ability to attract new customers, access of new markets and retain of existing customers, reduction of warranties and refunds, increase in product sale, reduction in product wastage and production costs, as well as increase in product prizes were all included in the questionnaire. The analysis of the obtained data revealed that potential benefits from HACCP implementation were mainly an upgrading of production procedures followed by improvement of safety characteristics of the product, resulting to the increase of product's self-life.

Khatri and Collins (2007) conducted a similar study focusing in the meat industry in Australia. They tried to assess the costs and benefits of HACCP implementation, the barriers and motives, as well as novel verification methods. The interview used in 41 meat enterprises was divided in four parts concerning (a) possible motivating factors in the HACCP implementation, (b) possible constraints to adopting HACCP, (c) possible costs and benefits of HACCP implementation and (d) novel verification procedures. It was concluded that the primary motivations were the regulatory requirements, the customers' demands and the management decision. The constraints recognized by the enterprises in this study were capital costs of the system, costs of developing the system, training and implementation costs, lack of awareness, no perceived benefits, risk assessment schemes and even inadequacy of regulators. However, it should be noted that, according to those authors, capital costs barrier was greater for small or medium scale enterprises due to structural changes needed for the prerequisite program implementation, given that large scale enterprises had already adequate facilities available. Moreover, according to the same authors (Khatri and Collins, 2007), the one-off costs were not seen as a crucial issue by the enterprises. In contrast, operating costs, such as costs of employing new individuals, training costs, audit and verification costs were appreciable. All firms reported that were unable to pass HACCP cost to their customers and thus had to absorb it as part of overheads. This could be an important issue in a competitive industry with low margins of profit. In addition, according to the enterprises' opinion regarding benefits of HACCP implementation, most of those responding reported that fewer rejects and reworked products, reduction in customers complaints and improved morale were the major benefits. On the other hand, increase in sales, customers and markets were not specifically attributed to HACCP, but as a consequence of it.

Eves and Dervisi (2005) conducted a study explor-

ing implementation and operation of HACCP in the foodservice sector through interviews with seven foodservice outlets in England. The results highlighted a number of barriers. The most important barrier was considered to be the inadequate hazard identification during the HACCP system development. Panisello et al. (1999) had previously reported also inadequate hazard identification as a major drawback to effective implementation of HACCP. This problem seems to arise, because of a lack in understanding the hazards and how to identify and incorporate into the system. Use of external consultants to perform the assessment, produce the manuals, perform the initial training of the employees and produce the training manual, could be a solution to the problem (Khandke and Mayes, 1998; Panisselo and Quantick, 2001). Generic HACCP plans adoption could also be a solution, whereas, in several cases, it is difficult to cover the necessity of accommodation to specific requirements of the company. Furthermore, the study identified inadequate personnel training, time constraints and excessive documentation required as major barriers to HACCP implementation. Similar approaches had also been reported in previous studies (Mortlock et al., 1999; Panisselo et al., 1999; Mortimore, 2001; Panisselo and Quantick, 2001; Ward, 2001). Time-related issues, in correctly applied monitoring procedures and control, were noticed by the companies, especially at busy times. At such periods, staff tend to forget to complete documentation or care of its personal hygiene.

It should be noted also that Eves and Dervisi (2005) came to the conclusion that prior to application of any food safety system, its importance and perceived benefits must be acknowledged. In that way, commitment from senior managers down to operation staff may be achieved. This is believed by a number of authors as a prerequisite to implementation of HACCP in this field (Khandke and Mayes, 1998; Mortlock et al., 1999; Motarjemi and Kaferstein, 1999; Mortimore, 2001; Panisselo and Quantick, 2001; Wallace and Williams, 2001). In addition, cost implications of applying HACCP were also reported in this study. The costs included set-up costs, training costs and documentation. It is interesting to notice that, according to Unnevehr and Jensen (1999), the HACCP implementation costs cannot be reduced, but can constitute a long-term benefit concerning reduction of product wastage or re-work.

Panisselo and Quantick (2001) investigated the technical barriers representing all those practices, attitudes and perceptions that adversely affect understanding of the HACCP concept and hence appropriate and effective implementation and maintenance of HACCP principles. These authors mentioned that the HACCP plan should be built on four basic 'pillars': (a) commitment, (b) education and training, (c) availability of resources and (d) external pressures. It should be noted that none of these may be included within the seven principles of HACCP, whereas, according to their opinion, key to a successful implementation of HACCP, will depend on how these pillars are prioritized.

As mentioned above, management commitment is a driving force towards the acquisition of all basic prerequisite programs, which represent the foundation of HACCP, the application of the seven principles of the system and its continuous maintenance (Khandke and Mayes, 1998; Mortlock et al., 1999; Motarjemi and Kaferstein, 1999; Mortimore, 2001,; Wallace and Williams, 2001). Panisselo and Quantick (2001) in order to overcome this problem, suggested the integration of HACCP systems into quality management systems, such as the ISO 9000 series. Indeed, in 2005, International Standards Organization issued ISO 22000: 2005 standard for HACCP systems (ISO, 2005).

Furthermore, food safety training and use of educational aids (videos, training seminars, guidelines, manuals etc.) assist in implementation of the HACCP system, providing HACCP teams, managers and food handling staff equipped with the additional technical skills required. According to Panisselo and Quantick (2001), adequate resources, such as funding, time, human resources, monitoring equipment and training aids must be provided to supervisory personnel in order to develop, monitor and verify an effective HACCP system.

It should also be stressed that a critical factor for correct HACCP implementation is the action of different sectors of external pressure such as government, customers, authorized officers and media (Mortimore and Wallace 1998). Governments across the world are increasingly adopting mandatory HACCP-based regulations, as the best system to ensure food safety. Furthermore, companies are closely monitored by their customers, because they wish to be confident that food purchased is safe. Authorised officers are also a source of pressure to companies, since they are responsible

for inspections of premises to check compliance with the law. Last but not least, an important source of pressure corresponds to the media. Food safety scares are always covered by the press. Documentation of HACCP systems and record keeping are essential to defend due diligence in the case of liability (Mortimore and Wallace, 1998).

According to Panisselo and Quantick (2001), success in implementing and maintaining HACCP systems will largely depend on how the four 'pillars' described above are prioritized and organized in a company. Management commitment and training should be the first priorities and the bases of the motivation for proper HACCP implementation, whereas availability of resources and, finally, external pressures should follow. Change of priorities may not allow the successful implementation of HACCP, as it is mainly driven by a high level of external pressure, with minimally or untrained staff and little commitment towards the use of HACCP systems.

Panisselo and Quantick (2001) also identified constraints in HACCP implementation, which represent practices, attitudes and perceptions that negatively affect the understanding of the HACCP concept and hence the proper and effective implementation and maintenance of HACCP principles. First of these, is a perception of control by improperly trained managers, because they may be unaware of potential risks in handling raw materials and processing operations, thus rely mainly on their experience. Mortlock et al. (1999) found that the majority of surveyed businesses identified themselves as low-risk and were significantly less likely to implement HACCP than businesses perceived as high-risk by their managers. People tend to underestimate risks involved with familiar activities and make their risk evaluations based on what they believe to be true and not on complete or correct information. Moreover, risk assessments are often performed optimistically, hence people believe they have increased control over a potentially hazardous situation.

Another barrier in HACCP implementation can be company size. It has been shown that relatively big companies find it easier to secure resources and technical assistance, whereas small businesses are less likely to invest in hygiene and food safety and prefer to invest in other areas. in order to improve product quality and quantity. Furthermore, type of product can affect HACCP implementation. It has been reported (Mortlock et al., 1999) that businesses processing products monitored by a small number of Critical Control Points, such as canning industry, are more likely to be using HACCP than businesses handling products with a more complex processing procedure, such as businesses involving both raw and cooked meat or fish products.

Additionally, the industry sector may influence HACCP implementation. According to Mortlock et al (1999), food manufacturers were five-fold more likely than retailers and four-fold more likely than caterers to be using HACCP. Application of HACCP system to these sectors presents unique challenges, due to the lack of well-defined product flow, wide diversity of the work force, constant turnover of the employees with different levels of education, diversity of products and variations in potential demand. Therefore, in those industry sectors, HACCP must be flexible to adapt to the different types of industries and methods of food processing. Thus, in such situations, HACCP should be used as a means of managing food safety, rather than strictly complying with the seven principles defined for the food industry. It should be added also, another barrier in HACCP implementation is the company's customers that do not demand use of the system. In most cases, company customers require their suppliers to provide evidence that HACCP is being implemented. Usually, this means going through an inspection or audit process (Mortimore and Wallace, 1998). For example, companies supplying supermarkets are more likely to have HACCP systems implemented and fully operative than those that do not supply supermarkets (Panisselo et al., 1999).

Lack of HACCP program leadership concerning reinforce awareness, review of efficacy of controls, provision of examples for implementation of the system and co-operation with enforcement authorities is a primary constraint in proper HACCP implementation (Panisselo and Quantick, 2001). Staff's persistence of old habits and attitudes and the belief that there is no justification in changing their current procedures when these procedures have worked well and enabled them to produce 'safe' food products in the past, could be a significant barrier, too. Robbins and McSwane (1994) reported this to be staff's attitude after introduction of a new, more extensive, sanitation program in a retail food store meat department.

Moreover, staff's lack of time to accomplish

HACCP is another constraint to proper HACCP implementation in fast-moving environments, such as in a processing plant. There is always lack of time. HACCP implementation is time consuming for all personnel involved, especially during the early stages. Therefore, it is not surprising that people always prioritize tasks according to their own perception of importance (Panisselo and Quantick, 2001). Staff motivation is also important, as personnel must be an 'active participant' in HACCP implementation (Tompkin 1994). Supervision is also necessary for employees at every level.

In many cases, lack of monitoring equipment, such as temperature-measuring devices, could be another issue in HACCP implementation. Discontinuous monitoring could be used, but this type of monitoring requires employer time, training and responsibility on taking and recording data correctly.

Good manufacturing and hygiene practices are prerequisites, for proper HACCP implementation. Therefore, according to Panisselo and Quantick (2001), incorrect plant layout and poorly designed equipment may become a significant constraint for Food Safety Management System implementation. Well-designed and structured premises, with reliable equipment, will help in protecting food products, maintaining hygienic conditions, improving cleanliness and cleaning effectiveness and controlling pest infestations. Design and layout of factories and equipment is also important to eliminate, prevent or control hazards and reduce the amount of critical control points

Panisselo and Quantick (2001) have also reported that difficulties in validation and verification of HACCP plans could be barriers for the proper implementation of the system. Validation procedures should be carried out at the completion of HACCP plan prior to implementation and it involves the review of scientific data and other relevant information, such as reports on surveillance of food-borne diseases to which enterprises have limited access. Furthermore, verification demands resources such as time, training and money.

Finally, Panisselo and Quantick (2001) have put into discussion the lack of equivalence between HACCP plans or programs of each industry sector, mentioning diversity of industries, countries and people managing the food safety. To establish equivalence between two similar HACCP plans, it is necessary to be capable to measure their efficacy by incorporating quantitative risk-based decisions during the process of implementation and relating HACCP plans to public health goals, such as reducing food-borne diseases (Orris, 1999).

Fotopoulos et al. (2011) have reported the results of a study, which explored motives and constraints to implementation of the HACCP system in the literature (1995-2008) on food safety. The authors concluded that 11 elements represent most of the motives and constraints identified, these being the 'vital few' factors instrumental for implementation of HACCP system. Factors for constraints are as follows: (a) limited knowledge and skills for HACCP implementation, (b) lack of commitment to food safety by employees, (c) resistance to change and attitudes of employees, (d) increase in financial resources and cost, (e) lack of employee training, (f) length of time to develop and implement HACCP, (g) lack of technical expertise and support, (h) low availability of human resources, (i) excessive paperwork and documentation and (j) improper organization infrastructure. The main motive is the need to satisfy stakeholders and consumers. According to the authors, it is important that food companies understand the significance of above factors and take them into account in order to develop, implement and maintain an effective food safety management system.

Milios et al. (2011) conducted a research project evaluating the Food Safety Management System (HACCP - type system) implemented in 33 Greek slaughterhouses, examining the techno-managerial factors influencing its application according to enterprises' opinion and correlating answers to the HACCP evaluation results. According to results of that study, managers of companies which considered benefits of HACCP implementation to be important, fully understood potential problems, e.g., emerging costs, and had best results at HACCP evaluation. In contrast, companies that could not identify the benefits to be important, had poor scores in HACCP evaluation, especially in implementation and preliminary steps. Additionally, their performance with regard to prerequisites and maintenance of system sectors was better, due to the fact that they were obliged to by the regulatory demands. Furthermore, some companies that identified a few benefits did not seem to have understood the core of the system function and, therefore, had low performance in HACCP principles implementation.

The results of the same study also showed that enterprises implement HACCP systems mainly for legal compliance, with neither real understanding of

potential benefits nor clear management commitment to increasing safety of food production. According to the responses, verification and installation costs are the most important. Furthermore, staff training on food safety does not seem to be considered as a factor of significant importance by managers, although it is essential for correct implementation of the system (Milios et al., 2011).

Several Greek slaughterhouses also provide only rendering services to the industry, with no involvement in trading. Therefore, market motivation for HACCP implementation does not have the same value as for other businesses in food production. On the other hand, slaughterhouses that trade also meat under their firm, seem to implement HACCP systems more effectively, because of the direct trading responsibility for the quality of the product. This conclusion outlines the importance of market motivation for correct food safety management system application, despite regulation and authorities inspections. These results differ from those of similar surveys in the rest of the food industry and, therefore, the slaughterhouse sector should be treated with a different perspective.

CONCLUDING REMARKS

HACCP application in food processing plants could improve food safety and lead to a reduction of foodborne diseases. The apparent lack of HACCP implementation in a number of businesses may be due to the existence of several technical barriers. Lack of awareness of HACCP, no perceived benefits, lack of training, management regressions, variability of production lines and individuality of each product, variability of consumers' demands and small size of the enterprise adversely affect performance of HACCP system. Also, costs of development, application and maintenance of the system seem to be a constraint. On the other hand, motivation for HACCP application brings about improvement of processing efficacy, reduction of recalls, regulatory demands, enhancement of firm reputation, costs reduction, customers' demands, previous experiences with food safety issues, trained staff and management decision.

The HACCP barriers should be clearly defined, their importance assessed and their impact evaluated over the implementation of HACCP. This is one of the priorities that food safety agencies in European Union, as well as the European Union legislation would need to address. To our view, lack of management commitment, lack of personnel training and costs are the main constraints for proper HACCP implementation. In 2005, DG SANCO published a guidance document on implementation of procedures based on the HACCP principles and on facilitation of the implementation of the HACCP principles in certain food businesses, aiming at assisting everybody involved in the food chain to better understand HACCP implementation and HACCP flexibility (EC DG SANCO, 2005). According to that document, it is important, when applying HACCP, to be flexible where appropriate, given the context of the application, taking into account the nature and size of operation. Furthermore, management commitment and training is necessary for the implementation of an effective HACCP system.

In our opinion, that DG SANCO guidance document outlining the need for HACCP flexibility and the necessity of management commitment, addresses the main barriers to HACCP implementation and, therefore, is very useful.

REFERENCES

Adams CE (2002) Hazard analysis and critical control point-original 'spin' Food Control 13:355-358.

Bata D, Drosinos EH, Athanasopoulos P, Spathis P (2006) Cost of GMP improvement and HACCP adoption of an airline catering company. Food Control 17:414-419.

Consuelo RD, Brandao SCC, Barbosa da Silva CA (2006) Costs and investments of implementing and maintaining HACCP in a pasteurized milk plant. Food Control 17:599-603.

EC DG SANCO (2005) HACCP Guidance Document. SANCO/1955/2005 Rev. 3 16 November 2005. Brussels.

Eves A, Dervisi P (2005) Experiences of the implementation and operation of hazard analysis critical control point in the food service sector. Intern J Hosp Manag 24:3-19.

Fotopoulos C, Kafetzopoulos D, Gotzamani K (2011) Critical factors for effective implementation of the HACCP system: a Pareto analysis. Brit Food J 113:578-597.

Gillespie IA, Little CL, Mitchell RT on behalf of Local Authority Co-ordinating Body on Food and Trading Standards (LACOTS) and the Public Health Laboratory Service (PHLS) (2001) Microbiological examination of ready to eat quiche from retail establishments in the United Kingdom. Comm Dis Publ Heal 4:53-59.

Griffith CJ (2006) Food safety: where from and where to? Brit Food J 108:6-15.

Henson S, Caswell J (1999) Food safety regulation: an overview of contemporary issues. Food Policy 24:589-603.

ISO (2005) Food safety management system - Requirements for any organization in the food chain. ISO 22000:2005, ISO, Geneva.

Jensen HH, Unnevehr LJ, Gomez MI (1998) Costs of improving food safety in the meat sector. J Agr Appl Econ 20:83-94.

Khandke SS, Mayes (1998) HACCP implementation: a practical guide to the implementation of the HACCP plan. Food Control 9:103-109.

Khatri Y, Collins R (2007) Impact and status of HACCP in the Australian meat industry. Brit Food J 109:343-354.

Little CL, Lock D, Barnes J, Mitchell RT (2003). Microbiological quality of food in relation to hazard analysis systems and food hygiene training in UK catering and retail premises. Comm Dis Publ Heal 6:250-258.

Mantovanelli A, Marino M, Comi G, Vallavanti W, Dolzani L (2001) Use of microbial analysis to test HACCP systems in food industries. Ind Aliment 40:853-865.

Mazzocco M (1996) HACCP as a business management tool. Am J Agr Econ 78:770-774.

Milios K, Mataragas M, Pantouvakis A, Drosinos EH, Zoiopoulos P (2011) Preliminary survey on HACCP system application in the framework of slaughterhouses hygiene investigation. Proceedings of the 4th Greek Veterinary Medical Society Congress (Thessaloniki, Greece) pp. 381-390.

Mortarjemi Y, Kaferstein F (1999) Food safety, hazard analysis and critical control point and the increase in food-borne diseases: a paradox. Food Control 10:325-333.

Mortimore S (2001) How to make HACCP really work in practice. Food Control 12:209-215.

Mortimore S, Wallace CA (1998) HACCP: A Practical Approach. Aspen Publications, Gaithersburg.

Mortlock MP, Peters AC, Griffith CJ (1999) Food hygiene and hazard analysis critical control point in the United Kingdom food industry: practices, perceptions, and attitudes. J Food Prot 62:786–792.

Naugle AL, Barlow KE, Edlen DR, Teter V, Umholtz R (2006). US Food Safety and Inspection Service testing for Salmonella in selected raw meat and poultry products in the United States, 1998 through 2003: analysis of set results. J Food Prot 69:2607-2614.

Panisselo PJ, Quantick PC, Knowles JM (1999) Towards the implementation of HACCP: results of a UK regional survey. Food Control 10:87-98.

Panisselo PJ, Rooney R, Quantick PC, Stanwell-Smith R (2000) Application of food-borne disease outbreak data in the development and maintenance of HACCP systems. Intern J Food Microb 59:221-234.

Panisselo PJ, Quantick PC (2001) Technical barriers to hazard analysis critical control point (HACCP). Food Control 12:165-173.

Robbins M, McSwane D (1994) Sanitation doesn't cost, it pays: is it true and can we prove it? J Environ Health 57:14-20.

Semos A, Kontogeorgos A (2007) HACCP implementation in northern Greece. Brit Food J 109:5-19.

Tompkin RB (1994) HACCP in the meat and poultry industry. Food Control 5:153-161.

Unnevehr LJ, Jensen HH (1999) The economic implications of using HACCP as a food safety regulatory standard. Food Policy 24:625-635.

Violaris Y, Bridges O, Bridges J (2008) Small businesses - Big risks: current status and future directions of HACCP in Cyprus. Food Control 19:439-448.

Wallace C, Williams T (2001) Pre-requisites: a help or a hindrance to HACCP? Food Control 12:235-240.

Ward G (2001) HACCP: heaven or hell for the food industry. Quality World (March 2001):12-15.