TITLE: **Catering services and HACCP: temperature assessment and surface hygiene control *before* and *after* audits and a specific training session**

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ABSTRACT

Proper application of HACCP in catering services involves monitoring decisive critical points. The purpose of this study was to assess food temperatures and surface hygiene control in two catering services in Navarra (Spain) at two different time periods: the first one after implementation of the HACCP system and the second period, after the initial supervision through audits and a specific training session regarding temperatures of products and hygienic conditions of surfaces and equipment because the majority of detected nonconformities were related to these parameters. The recorded temperatures of 650 cooked food products within the first period showed that only 65.1% of the hot dishes had a temperature higher than 65 ºC, in accordance with Spanish legislation, and 12.9% of them showed a risky holding temperature (<55 °C). However, the percentage of noncomplying dishes was reduced by a half after the training session (p<0.001). Since the significant differences observed in recorded temperatures were related to the type of meal (with or without sauces) and the type of cooking procedure, a lower safe criterion for the retention of hot dishes was suggested if the temperature is continuously maintained over 55ºC until serving. With regard to cleaning and disinfection, 18.3% of the 600 analyzed surfaces did not meet the established cleaning criterion (≤ 100 CFU/25 cm^2) in the first period, while in the second period this percentage was reduced to 13.6% in both catering businesses (p=0.021). The dirtiest surfaces were equipment such as cutting boards and meat slicing machines (>26%) compared to utensils for distribution (12.0%). As the impact of dirty surfaces on the hygienic quality of a finished product will depend on which step was being taken during dish elaboration when equipment or utensil was used, it is suggested that more restrictive limits be established regarding utensils and equipment that are in direct contact with the finished product (≤1 CFU/cm^2). Results of the study demonstrate that a specific training session on these items has improved the temperature control of prepared meals and the effectiveness of cleaning and disinfection, essentials for guaranteeing the hygienic quality of prepared foods.

KEYWORDS: Catering, HACCP, food safety, temperatures, surfaces

1. Introduction

Catering businesses must provide foods that are gastronomically acceptable, covering the nutritional needs of the population they are intended for and conforming to a given price. But above all, they must be safe for the consumer and in no way should they serve as a route of risk to human health which could lead to disease. This is particularly relevant when one considers the high quantity of prepared meals served daily by the catering industry to children in schools, hospital patients, and elderly people living in nursing homes (FEADRS, 2009).

Among the different types of catering services, the “cook-serve” system is the most extended type in Spain, as well as in other European countries (Marzano & Balzaretti, 2011). This procedure is based on a daily preparation of meals that are distributed and served with a minimum holding period (Light & Walker, 1990). Food processing by heat requires the center of the product to reach 70 °C (WHO, 2006), followed by appropriate holding temperatures between elaboration and consumption to prevent the growth of any possible surviving microorganisms (Bouëtard & Santos, 2009). Spanish legislation establishes four preservation procedures for cooked prepared meals (BOE, 2001): ≥ 65 °C (thermal retention, for consumption within a few hours), ≤ 8 °C (refrigerated storage for meals consumed within 24 hours); ≤ 4 °C (refrigerated storage for meals with a shelf life longer than 24 hours); and ≤ -18 °C (frozen storage for an extended shelf life). Thermal retention is the most common election for Spanish “cook-serve” catering facilities due to the high acceptance of these meals as being “fresh” and just like “homemade food”, and because required equipment are more economical than those used in refrigerated systems. However, inconveniences regarding staff organization and temperature loss from isothermal receptacles during the holding period must be solved, especially when prepared foods are transported to external centers at a later time.

In order to obtain safe food, catering services have to implement a food safety management system based on the principles of Hazard Analysis and Critical Control Points (HACCP) (CAC, 2003). However, the difficulties in implementing this system in small and medium catering enterprises are well-known (Bas, Yuksel, & Cavusoglu, 2007; Garayoa et al., 2011; Herath & Henson, 2010; Shih & Wang, 2011; Taylor, 2008a). Therefore, a flexible application of HACCP has been proposed (Taylor, 2008b; Valcarcel Alonso, 2009), promoting the Good Manufacturing Practices established in prerequisite programs such as cleaning and disinfection procedures for surfaces and equipment, and controlling truly decisive critical limits such as temperature/time during and after food processing. It has also been demonstrated that training is an essential part of self-control systems in order to improve food handlers' knowledge regarding food safety (Pontello et al., 2005; Salazar et al., 2006). Therefore, the need for training catering personnel is recognized by European legislation (EC, 2004) and by international organizations (CAC, 2003). In addition, other factors such as supervision may have a stronger effect on the employees' performance in safe food handling than training sessions alone (Ashraf et al., 2008).

Thus, the overall objective of this work was to evaluate the food safety of meals prepared in two catering services in Navarra (Spain), by the surveillance of the following parameters: holding temperatures of cooked meals and sanitary operations for utensils, equipment and work surfaces. For this purpose, both parameters were evaluated at two different time periods: the first one was carried out immediately after implementation of the HACCP system and the second period was after the initial supervision through audits and once a training session took place.

2. Materials and methods

2.1. Description of catering establishments

Two catering services (A and B) were monitored in Navarra, Spain. These businesses had already implemented the HACCP system and were providing an average of 3,000 to 4,500 meals per day, respectively, to satellite centers (nurseries, school cafeterias, day centers and work cafeterias). All meals were prepared, distributed and consumed the same day they were prepared. The meals were transported in isothermal containers so as to maintain temperatures, using special vehicles for this purpose. The time that elapsed between preparation and consumption ranged between 2 and 4 hours, and during this time the prepared meals remained in airtight sealed containers.

The study was carried out over a four-year period, divided into two terms which ran from 2008 to 2009 and from 2010 to 2011. The first term corresponded to the initial stage of implementation of the HACCP system and the second covered the period subsequent to the analysis of the first audit reports and a staff training session.

2.2. Audits and training session

Annual audits were conducted in both catering services, recovering data in a standardized template regarding the following issues: general information (number of meals, number of workers, etc.), implementation of prerequisites (maintenance of facilities and equipment, cleaning and disinfection, pest control, selection of suppliers, staff training, traceability, waste management and water control), food hygiene practices (staff uniform, hand washing, defrosting, disinfection of vegetables, cleaning and disinfection of facilities, temperature control of elaboration, proper maintenance of raw materials and warm and cold dishes, etc.) and documentation (HACCP manual, control records, etc.). Information was collected by direct observation (facilities and food handler's behavior) and interviewing the manager or person in charge at the time of the visit. Upon completion of the audit, a report was issued pointing out the strong points, weak points and objectives established for behavior improvement.

In addition, before beginning the second period of the study, a training session was conducted for the food handlers of both catering services. The purpose was to review the food hygiene basics, with special emphasis on the importance of observing the prerequisite programmes, as well as, controlling critical points, and recording correctly the performed control activities. Therefore, a one hour session was given to the workers in a participative way, including slides presentations, practical examples to record data in basic templates and open questions to verify if they had understood the main concepts. Some of the topics covered in this session were: *Food handlers. Safe foods. Microorganisms. Pathogenic bacteria. Foods as substrate for microorganisms. Problematic products. Measures for controlling microorganisms. Heating, cooling and cleaning. Safe work practices: Good Hygiene Practices. HACCP*.

2.3 Sample collection

2.3.1. Ready-to-eat hot meals

Prepared meals with thermal treatment were taken every two weeks from each of the two kitchens (n = 650 in each period). On the very same day of elaboration, 5 to 7 samples were collected under aseptic conditions using sterile containers and utensils. Food temperatures and food samples were taken at the time of filling into isothermal containers which are used for transporting dishes to the dining satellites. Food temperature was recorded in the center of the food, using a calibrated thermometer with an accuracy of 0.1 °C (Foodcare, HANNA Instruments). Samples were transported to the laboratory under refrigerated conditions, and the analyses were initiated on the very same day that the samples were collected. The food was kept in refrigeration (3 °C ± 2 °C) until the start of the microbiological analyses.

2.3.2. Food-contact surfaces

A total of 1201 surfaces in contact with food were analyzed (*n* = 600 in the first period, *n* = 601 in the second period). Analyzed surfaces included cutting boards, slicers, knifes, steel pallets and spatulas, stainless steel gastronorms and plastic recipients for the distribution of food. Sampling was carried out after regular cleaning procedures according to the established cleaning and disinfection plan and before the beginning to work (using the products, dosage and frequencies suggested by the suppliers of usual detergents and disinfectants for catering services). Rodac PCA + Neutralizing agar contact plates (BioMérieux, Marcy l'Etoile, France) were used, pressing down on the agar on the surface to be studied for 10 seconds. Samples were transported to the laboratory under refrigerated conditions and incubated immediately on arrival at the laboratory.

2.4. Microbiological analysis

Microbiological tests were carried out on food samples according to the current Legislation in each period. In the first one, the following microorganisms were investigated according to the Spanish Legislation (BOE, 2001): total microorganisms, coliforms, *Staphylococcus aureus, Escherichia coli*, *Salmonella* spp. and *Listeria monocytogenes*. This normative was annulled in February 2010 (BOE, 2010), and according to the Commission Regulation (EC) No 2073/2005 (EC, 2005), only research of *Salmonella* spp. and *L. monocytogenes* was performed in the second period. All samples were analyzed according to standard official methods (ISO) in an accredited laboratory following the standard ISO/IEC 17025:2005.

In the case of the surface samples, Rodac agar plates were incubated at 30 ± 1 °C for 72 ± 3 hours (Heraeus Instruments, Germany). After incubation, the colonies were counted and the result was expressed in CFU/25 cm^2. Surfaces were considered to be dirty when the plates contained >100 CFU/25 cm^2.

2.5 Statistical analysis

Continuous variables were expressed as means and (standard deviations). Categorical variables were expressed as percentages. Proportion differences between periods and categories of surfaces were assessed using Fisher's exact test. Statistical analyses were performed using STATA version 12.1 (College Station, Texas USA). All *P* values are two-tailed and statistical significance was set at the conventional cut-off of $P < 0.05$.

3. Results and discussion

3.1. Audits: prerequisites and HACCP deviations

The level of compliance of prerequisite programs and HACCP system was verified in both catering services by inspection of facilities and evaluation of records. More specifically, the following work programs were checked: maintenance of the facilities and equipment; food handling; cleaning and sanitizing; pest control; systematic supplier selection; product traceability; personnel training; waste management and water control. The first audit was conducted before training session. We found that the compliance of personnel to the training program in both catering services was very high, because 100% of the examined workers had a food handler card for this type of work (BOE, 2000) or had undergone specialized training provided by the company (EC, 2004). In contrast, recurrent deviations were observed when applying the traceability programs due to the considerable volume and variety of raw materials that were used in these central kitchens. Regarding compliance of HACCP, the majority of nonconformities were related to the temperature of cooked products and cleaning and disinfection procedures. With regard to the former, temperature control and temperature recording were deficient during the phases corresponding to the storage of raw materials, food processing, and preservation of the prepared foods, primarily because temperatures had not been recorded every day. This fact has also been pointed out by other authors (Bas, Ersun, & Kivanc, 2006; Jianu & Chiş, 2012; Taylor, 2008a) and highlights the lack of risk awareness with regard to a highly vulnerable issue. Compliance and monitoring of cleaning and disinfection programs was also found to be deficient. On occasion, in spite of having carried out the established cleaning and sanitizing tasks, said activities had not been recorded in the corresponding control sheets. The absence of records was justified due to lack of time on the part of the personnel. This lack of time for carrying out necessary basic work tasks in the kitchen has also been described by other authors (Fielding et al., 2011; Herath & Henson, 2010; Taylor, 2008a). We also found a lack of commitment and adherence to the HACCP system. This deficiency greatly hindered the effective implementation of HACCP as reported by Mortimore (2001).

3.2. Specific training session

Taking into account the results obtained in the aforementioned audit, a decision was made to hold a training session in each one of the two kitchens, putting special emphasis on the basic aspects of the HACCP system and more specifically, on both observed deficient parameters: temperature and disinfection. In addition to the importance of the information to be covered in the training sessions (Martins, Hogg, & Gestal Otero, 2012), aspects such as the duration of the program and the language to be used (for easy comprehension on the part of the food handlers) should also be taken into account (Seaman, 2010). Therefore, it was decided to give a one hour session focusing on the monitoring and accurate recording of food holding temperatures and the cleaning of equipment and utensils. Very simple templates for recording the data, with easy application to a worker's daily routine, were presented to the personnel.

The session was considered to be a success based on the improved results that were obtained for the two aforementioned parameters in both catering businesses during the second study period (increase of recorded activities and compliance with criteria for food temperature holding and microbiological surfaces counts, as reported in the next paragraphs).

3.3. Temperatures of cooked meals

Table 1 shows the recorded holding temperatures of 1300 cooked food products measured at the time of filling into isothermal containers. The temperatures were grouped into ranges ≥65 °C, 64-55 °C and <55 °C, being assessed as safe, tolerable and unacceptable, respectively, following the criteria of Garayoa et al. (2011). It was observed that the training session at the start of the second period had a positive influence on the control of this critical point, because the percentage of meals with risky holding temperature (<55 °C) decreased significantly from 12.9% to 6.0% (p<0.001). In general terms, it should be noticed that 72.5% of the recorded temperatures in both periods (n = 942) complied with Spanish legislation (≥65 °C) (BOE, 2001), while 18.1% (n = 235) had temperatures in the range 64-55 °C, which is considered to be inadequate from the legislation point of view. However, these temperatures would not represent a health risk to consumers because they still provide protection against the growth of microorganisms, as long as the meals are properly maintained within that range until serving. In this sense, WHO sets the limit at ≥60º (WHO, 2006) and even a barrier of 55 ºC has been proposed by several authors (Bryan, McNaught, & Blehm, 1980; ICMSF, 1991; Garayoa et al., 2011). The proposed criterion of ≥55 ºC would result in a higher level of compliance (90.5% of the analyzed samples in this study would be correct). However, the need to observe this limit throughout the entire retention period (even if transport containers are required) must be stressed in order to guarantee food safety.

In addition, there were significant differences in temperature retention, based on the type of food and the type of cooking. While liquid foods or sauces (soups/creams, vegetables/legumes and meals with sauce) recorded the highest temperatures, meals without sauces or subjected to short heat treatments (grilled and roast) had the lowest temperatures (p<0.001), coinciding with other previously reported studies (Garayoa et al., 2011; Irigoyen & García-Jalón, 1992; Lago, Vitas, & García-Jalón, 2001). Therefore, catering services should avoid cooking procedures or meals that are not able to maintain 55 ºC until serving, especially when transport to dining satellites is required.

It should be noted that temperatures were taken at the time that food was distributed into isothermal containers, which also produces heat loss in terms of the time that elapses before reaching the dining rooms and cafeterias (Irigoyen & García-Jalón, 1992). Therefore, several proposals were made with regard to different measures to be taken so as to improve heat retention. For example, one measure involved preheating the containers before introducing the food; another measure, in the cases in which the product and cooking technique would permit it, was to introduce the food into the containers at much higher temperatures than established limits; and a third measure was to maintain the isothermal containers, loaded with the food, in heated cupboards until their transfer to the satellite dining rooms and cafeterias. In any case, we think that cooking techniques such as frying are not suitable for heat retention, meaning that in the case that caterers want to provide food cooked this way to satellite cafeterias, the cafeterias themselves should have the appropriate equipment available so as to be able to fry the food *in situ*.

3.4. Evaluation of the hygienic quality of prepared meals

A total of 99.9% of the analyzed meals complied with the current food legislation of each period. Only one positive sample for *Salmonella* spp. was detected (first period). It was isolated in a roast chicken with a recorded holding temperature of 35 °C, which signifies a potential risk of pathogen growth. In addition, *E. coli* was also present in this prepared meal and the coliforms number was higher than the allowed level (1.7 x 10^3 CFU/g).

Despite the fact that the pathogenic bacteria *L. monocytogenes* and *Salmonella* spp. were not detected in any other meal, it should be pointed out that five samples analyzed during the first period were contaminated with *E. coli* and coliforms (>10^2 CFU/g), suggesting poor hygiene practices during processing operations. The recurrent kind of contaminated samples (sliced roasted meat), suggests post thermal treatment contamination during cutting operations and distribution. Note that these five samples also had holding temperatures <55 °C. No data is available regarding bacterial indicators during the second study period as current legislation for ready-to-eat food (in which prepared meals are included) only contemplates the absence of pathogens during their shelf-life (EC, 2005). In agreement with other authors (Rodriguez et al., 2011), we consider that it would be convenient to establish limits for other microorganisms for evaluating possible incorrect hygiene practices, regardless of whether or not the presence of pathogens is investigated (which are not usually isolated).

3.5. Assessment of surfaces hygiene

Cleaning work surfaces, equipment and utensils is the key to preventing microorganism contamination that can subsequently multiply in prepared foods, reaching unacceptable levels. Microbiological analysis of surfaces has been proven to be an effective tool for assessing the cleaning practices that are carried out in a kitchen and for improving hygienic behaviors in food handlers and making them more permanent. Therefore, coinciding with the opinion of other authors, we propose regular monitoring of work surfaces by means of microbial counts because this demonstrates the level of cleanliness more objectively than by means of visual inspection (Kassa et al., 2001). However, there are currently no existing microbiological criteria in Spain for evaluating hygiene of surfaces in catering kitchens. In addition, no unified criteria were found among the various publications that were reviewed (Cosby et al., 2008; Forsythe & Hayes, 1998; Henroid, Mendonca, & Sneed, 2004; Marzano & Balzaretti, 2013; Sneed et al., 2004; Solberg et al., 1990). Therefore, a limit of ≤ 100 CFU/25 cm^2 (≤ 0.6 log_{10} CFU/cm^2) was used in this study for determining that a work surface is clean, based on the experience of over 3000 surfaces analyzed in the catering business and on the fact that the Rodac plate count method does not provide reliable results when the count exceeds 100 CFU/plate (25 cm^2).

As shown in Table 2, the percentage of dirty surfaces was significantly reduced in the second period of study in both catering businesses (18.3% versus 13.6%, p=0.021). This suggests that, after the training session, the food handlers realized the importance of cleanliness as a key prerequisite for the application of HACCP in these companies. It should be pointed out that although the established criterion is more demanding than that recommended by Henroid et al. (2004) for the food industry and used in other studies (< 1.3 log_{10} CFU/cm^2), the cleanliness of the surfaces examined was higher than that obtained by other authors. Thus, our study showed that only 15.9% of the surfaces exceeded the limit 0.6 log_{10} CFU/cm^2, while Domenech-Sanchez et al. (2011) found counts greater than 1.3 log CFU/cm^2 in 26% of samples and in the remaining 76%, the mean count was 0.62 log cm^2.

Depending on the different uses, the analyzed work surfaces were classified into three groups: equipment and work utensils, utensils for distribution, and distribution containers. As shown in Table 3, the dirtiest surfaces were found in the first group (19.4%). Cutting boards, mixers, meat slicing machines and work countertops were dirtier than the rest of the utensils analyzed, coinciding with the findings reported by other authors (Domenech-Sanchez et al., 2011; Garayoa et al., 2011; Irigoyen & García-Jalón, 1992). Furthermore, we have also observed that the degree of cleanliness of equipment and utensils is influenced by their place of storage. Utensils that were located below work areas were dirtier than those placed on high shelves or separated from working areas. In addition, the equipment and utensils that were not used that often were also found to be dirtier (data not shown). This suggests the importance of washing them before each use, even if they appear to be clean. With regard to the distribution containers, significant differences were found in terms of the types of containers. Thus, containers referred to as “thermos” (deep isothermal container for transport) and “gastronorms” (container to maintain temperature in the satellite kitchen) showed worse results than trays. This could possibly be due to the depth of the containers because the deeper the container, the more difficult it is to completely dry it after washing. Different studies (Beumer & Kusumaningrum, 2003; Grinstead & Cutter, 2007) reported moisture as a main factor in the rapid growth of microorganisms and our studies showed the same results. The thermos and gastronorm containers were found to be humid more often than the trays (data not shown). Therefore, we suggest emphasizing the importance of drying within the clean-up procedures.

The impact of dirty surfaces on the hygienic quality of a finished product will depend on the step of dish elaboration in which the equipment or utensil was used. If an instrument of the first group would show a high microorganism count, the hygienic quality of the dish could still be guaranteed if the subsequent cooking techniques were effective. However, the dirty conditions of the equipment and utensils from the second and third groups will always directly contaminate the food already cooked and being ready-to-eat. Therefore, the importance of these cleaning levels should be stressed until the dirty conditions are virtually reduced to “zero”. Thus, taking into account these assumptions and the aforementioned results, we suggest establishing differences in the tolerable limits in terms of type of service, establishing more restrictive limits on utensils and equipment that are in direct contact with the finished product than those located in pre-processing areas. Our proposal is to set a limit of ≤1 CFU/cm^2 for utensils, crockery and cutlery, while the criteria would be kept at ≤4 CFU/cm^2 for work surfaces and equipment, provided that subsequent sanitizing treatment is carried out. In a similar way, the Canadian government establishes benchmarks for the evaluation of the cleanliness of work surface areas, being more restrictive for utensils and tableware (maximum 1 CFU/cm^2) than for the actual work surfaces, equipment and apparatus in contact with food, allowing maximum levels of mesophilic aerobic bacteria of 100 CFU/cm^2 (MAPAQ, 2009). Table 4 shows the hypothetical results of our study if the new proposed criterion was applied. The data suggest that training in cleaning and sanitizing procedures should be made emphasizing the relevance of surface contamination depending on the type of equipment and utensils, with special attention to those used in the meals distribution.

In conclusion, verification of compliance of HACCP system through audits has helped to identify areas in which controls must be improved. Specific training sessions on holding temperatures of cooked prepared meals and on equipment and utensil cleaning procedures have improved the understanding and behavior on the part of the food handlers in catering services. However, more realistic limits for both parameters be established in order to improve the level of compliance but at the same time, guaranteeing the hygienic quality of prepared foods.

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References

Ashraf, H. R. L., Atwood, S., Bloom, J., Blaise, D., & Salazar, J. (2008). Efficacy of HACCP-Based Food Handling Training Program for Front-Line Foodservice Workers: A Report on a Collaborative Work Between Regulatory Agencies and Academia. *Journal of Culinary Science & Technology*, *6*(1), 63-76.

Bas, M., Ersun, A. S., & Kivanc, G. (2006). The evaluation of food hygiene knowledge, attitudes, and practices of food handlers' in food businesses in Turkey. *Food Control, 17*(4), 317-322.

Bas, M., Yuksel, M., & Cavusoglu, T. (2007). Difficulties and barriers for the implementing of HACCP and food safety systems in food businesses in Turkey. *Food Control*, *18*(2), 124-130.

Beumer, R. R., & Kusumaningrum, H. (2003). Kitchen hygiene in daily life. *International Biodeterioration & Biodegradation, 51*(4), 299-302.

BOE (2000). Real decreto 202/2000, de 11 de febrero, por el que se establecen las normas relativas a los manipuladores de alimentos. *Boletín Oficial del Estado*, num. 48.

BOE (2001). Real decreto 3484/2000, de 29 de diciembre, por el que se establecen las normas de higiene para la elaboración, distribución y comercio de comidas preparadas. *Boletín Oficial del Estado,* num. 11.

BOE (2010). Real decreto 135/2010, de 12 de febrero, por el que se derogan disposiciones relativas a los criterios microbiológicos de los productos alimenticios. *Boletín Oficial del Estado,* num. 49.

Bouëtard, J., & Santos, J. J. (2009). Sistemas de producción y distribución, *In La línea fría completa. Organización de cocinas centrales* (pp. 135-194). Salamanca: Editorial Innova Concept Ingeniería SL.

Bryan, F., McNaught, K., & Blehm, K. (1980). Time-temperature survey at a restaurant that specializes in barbecued food. *Journal of Food Protection, 43*(8), 595-600.

CAC (2003). Recommended International Code of Practice, General Principles of Food Hygiene. CAC/RCP 1-1969. Rome: FAO/WHO.

Cosby, C. M., Costello, C. A., Morris, W. C., Haughton, B., Devereaux, M. J., Harte, F., & Davidson, P. M. (2008). Microbiological analysis of food contact surfaces in child care centers. *Applied and Environmental Microbiology, 74*(22), 6918-6922.

Domenech-Sanchez, A., Laso, E., Perez, M. J., & Berrocal, C. I. (2011). Microbiological levels of randomly selected food contact surfaces in hotels located in Spain during 2007-2009. *Foodborne Pathogens and Disease, 8*(9), 1025-1029.

EC (2004). Regulation (EC) No. 852/2004 of the European Parliament and the Council of 29 April 2004 on the hygiene of foodstuffs. *Official Journal of the European Union L 139.*

EC (2005). Commission Regulation (EC) No. 2073/2005 of 15 November 2005 on microbiological criteria for foodstuffs. *Official Journal of the European Union L 338.*

FEADRS 2009. La función social de la restauración colectiva. *Distribución y consumo, 103*, 50-57.

Fielding, L., Ellis, L., Clayton, D., & Peters, A. (2011). An evaluation of process specific information resources, aimed at hazard analysis, in Small and Medium Enterprises in food manufacturing. *Food Control, 22*(8), 1171-1177.

Forsythe, S. J., & Hayes, P. R. (1998). *Food hygiene, microbiology and HACCP*. Maryland: Aspen Publication.

Garayoa, R., Vitas, A. I., Díez-Leturia, M., & García-Jalón, I. (2011). Food safety and the contract catering companies: Food handlers, facilities and HACCP evaluation. *Food Control, 22*(12), 2006-2012.

Grinstead, D. A., & Cutter, C. N. (2007). Controlling *Listeria monocytogenes* in a retail setting. *Food Protection Trends, 27*(1), 22-28.

Henroid, D. H., Mendonca, A. F., & Sneed, J. (2004). Microbiological evaluation of food contact surfaces in Iowa schools. *Food Protection Trends, 24*(9), 682-685.

Herath, D., & Henson, S. (2010). Barriers to HACCP implementation: evidence from the food processing sector in Ontario, Canada. *Agribusiness, 26*(2), 265-279.

ICMSF. (1991). *El sistema de análisis de riesgos y control de puntos críticos. Su aplicación a las industrias de alimentos*. Zaragoza: Editorial Acribia, S. A.

Irigoyen, A., & García-Jalón, I. (1992). Estudio higiénico y establecimiento de puntos de control críticos en comedores colectivos. *Alimentaria, 231*, 45-48.

Jianu, C., & Chiş, C. (2012). Study on the hygiene knowledge of food handlers working in small and medium-sized companies in western Romania. *Food Control, 26*(1), 151-156.

Kassa, H., Harrington, B., Bisesi, M., & Khuder, S. (2001). Comparisons of microbiological evaluations of selected kitchen areas with visual inspections for preventing potential risk of foodborne outbreaks in food service operations. *Journal of Food Protection, 64*(4), 509-513.

Lago, B., Vitas, A. I., & García-Jalón, I. (2001). Valoración de la microbiota de platos preparados retenidos en caliente. Relación entre temperatura y calidad microbiológica. *Alimentaria, 328*, 19-24.

Light, N., & Walker, A. (1990). *Cook-chill catering: Technology and management*. Crown House, Linton Road, Barking, Essex IG11 8JU, England: Elsevier Science Publishers LTD.

MAPAQ. (2009). Lignes directrices et normes pour l'interprétation des résultats analytiques en microbiologie alimentaire. Comité sur l'élaboration des critères microbiologiques dans les aliments (CECMA). Gouvernement du Québec.

Martins, R. B., Hogg, T., & Gestal Otero, J. (2012). Food handlers' knowledge on food hygiene: The case of a catering company in Portugal. *Food Control, 23*(1), 184-190.

Marzano, M. A., & Balzaretti, C. M. (2011). Cook-serve method in mass catering establishments: Is it still appropriate to ensure a high level of microbiological quality and safety? *Food Control, 22*(12), 1844-1850.

Marzano, M. A., & Balzaretti, C. M. (2013). Protecting child health by preventing school-related foodborne illnesses: Microbiological risk assessment of hygiene practices, drinking water and ready-to-eat foods in Italian kindergartens and schools. *Food Control, 34*(2), 560-567.

Mortimore, S. (2001). How to make HACCP really work in practice. *Food Control, 12*(4), 209-215.

Pontello, M., Dal Vecchio, A., Doria, M. G., & Bertini, I. (2005). Ristorazione pubblica: Indagine campionaria in due AASSLL dell'area milanese. Nota 2: Grado di preparazione del personale. *Annali Di Igiene: Medicina Preventiva e di Comunita, 17*(3), 253-260.

Rodriguez, M., Valero, A., Posada-Izquierdo, G. D., Carrasco, E., & Zurera, G. (2011). Evaluation of food handler practices and microbiological status of ready-to-eat foods in long-term care facilities in the Andalusia region of Spain. *Journal of Food Protection, 74*(9), 1504-1512.

Salazar, J., Ashraf, H. R., Tcheng, M., & Antun, J. (2006). Food service employee satisfaction and motivation and the relationship with learning food safety. *Journal of Culinary Science & Technology, 4*(2-3), 93-108.

Seaman, P. (2010). Food hygiene training: Introducing the food hygiene training model. *Food Control, 21*(4), 381-387.

Shih, K. M., & Wang, W. K. (2011). Factors influencing HACCP implementation in Taiwanese public hospital kitchens. *Food Control, 22*(3-4), 496-500.

Sneed, J., Strohbehn, C., Gilmore, S. A., & Mendonca, A. (2004). Microbiological evaluation of foodservice contact surfaces in Iowa assisted-living facilities. *Journal of the American Dietetic Association, 104*(11), 1722-1724.

Solberg, M., Buckalew, J. J., Chen, C. M., Schaffner, D. W., O'Neill, K., McDowell, J., Post, L. S., & Boderck, M. (1990). Microbiological safety assurance system for foodservice facilities. *Food Technology, 44*(12), 68-73.

Taylor, J. Z. (2008a). HACCP for the hospitality industry: A psycological model for success. *International Journal of Contemporary Hospitality, 20*(5), 508-523.

Taylor, E. (2008b). A new method of HACCP for the catering and food service industry. *Food Control, 19*(2), 126-134.

Valcarcel Alonso, S. (2009). Flexible strategies for the implementation of APPCC-HACCP. *Alimentaria, 405*, 106-110.

WHO (2006). *Five keys to safer food manual*. Geneva: WHO Department of Food Safety, Zoonoses and Foodborne Diseases.