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Evaluation of food safety training on hygienic conditions in food establishments

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ABSTRACT

Food handlers' training is fundamental in order to ensure the safety of the foodstuff. However, the success of training programs that provide only information is unclear and changes in improper food practices are not usually achieved. Food training programs based on theoretical as well as practical activities have been revealed as an important tool in which food handlers can put information into practice. Thus, the objective of this study was to assess the influence of food safety training, based on both theoretical and practical approaches, on the microbiological counts of food contact surfaces, food tools, food equipment surfaces and hand washing in canteens and cafes of one university campus. After food safety training, total plate counts decreased about 60% in the case of canteens and almost 45% in cafes while moulds and yeasts decreased approximately 65% in canteens and 55% in cafes. In terms of location, the microbiological reductions observed were higher for food equipment in canteens and for food tools in cafes. The microbiological counts of food handlers' hands decreased after both food safety training and disinfection. Food safety training influenced the reduction of overall microbiological parameters. Parametric *t*-tests (after *vs* before training) indicated that reductions were statistically significant before and after disinfection for total plate counts. The decrease observed for total coliforms and *Enterobacteriaceae*, were statistically significant only before disinfection. The food safety programs cannot be based entirely on a theoretical approach but also on adequate training which includes a practical approach. The success of the microbiological reductions in the study was associated to the practical lessons which let the handler put into practice the knowledge acquired in the theoretical part.

1. Introduction

Food-related infections constitute an important health problem in both developed and developing countries. Nowadays, food establishments in Europe must comply with strict food legislation which requires them to have food safety systems in place based on HACCP principles (Reg. N° 852/2004). Various studies demonstrated that implementation of HACCP plans and pre-requisite programs improved the safety of meals served (Cenci-Goga et al., 2005; Soriano, Rico, Moltó, & Mañes, 2002), however, foodborne outbreaks still occurred. In addition, the successful implementation of the procedures based on the HACCP principles requires the full cooperation and commitment of food business employees. Food handlers' training is fundamental in order to ensure the safety of the products (Jevsnik, Hlebec, & Raspor, 2008). However, current evidence suggests that food handlers are one of the main vehicles for contamination of foodstuffs and may also be asymptomatic carriers of food-borne microorganisms (Greig, Todd, Bartleson, & Michaels, 2007). Moreover, factors including but not limited to contaminated raw materials, poor hygiene of equipment, food tools, facilities, as well as improper practices also contribute to the occurrence of food-borne outbreaks (Jianu & Chis, 2012). The increase of the food safety standards implies food safety education, which is essential to any food safety system where the presence of food handlers with poor hygienic practices and/or food safety training could be a real threat to the safety of food (Kaferstein, Motarjemi, & Bettcher, 1997). Several authors stated that the success of training programs providing only information is unclear and changes in improper food practices are not usually achieved (Clayton, Griffith, Price, & Peters, 2002; Seaman & Eves, 2008). To avoid this problem, food training programs based on theoretical and practical activities have revealed to be important tools in which

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food handlers can put acquired knowledge into practice. The effects of food safety training on food handlers' knowledge have been previously described (Martins, Hogg, & Otero, 2012; Soares, Almeida, Cerqueira, Carvalho, & Nunes, 2012), however, the information about the real impact on food safety by practical food safety training is scarce.

The aim of this study was to assess the influence of theoretical-practical food safety training based on the microbiological counts on food contact surfaces, food tools, food equipment surfaces and hand washing by handlers in canteens and cafes of a university campus.

2. Material and methods

2.1. Food establishment characterization

The influence of food training on the microbiological counts on equipment, food tools and surfaces was studied at 5 canteens and 6 cafes on the campus of a university in northern Portugal. Canteens presented different areas to prepare each group of products (meat, fish and vegetables), the kitchen, pastry area, serving area and washing area. The canteens' main activity is to serve lunch and dinner, approximately 200 thousand meals per year (meat, fish and vegetarian). On the other hand, the cafes were smaller than the canteens and held no specific areas as presented as described above. Their main activity is to serve fast food, pastry, sugar drinks and/or juices and coffees. At the moment of study, all food establishments had already implemented a food safety system based on the HACCP methodology, according to the national food law. As a part of the study, all of the food establishment's handlers were individually interviewed to obtain systematic information on gender, age, education, professional experience and any previous food safety training.

2.2. Food handlers' training

A food safety training program was specially developed for all of the food establishment's handlers on the campus. Training was given by only one trainer. Food safety training consisting of 9 h (3 sessions of 3 h each) per group and was divided into three parts per session: (1) General concepts of hygiene and food safety, (2) practice and (3) *in-situ* application of the knowledge acquired. The first part consisted of a theoretical approach of concepts such as personal hygiene, temperature control, pest-control, cleaning and disinfection, food hygiene, food microbiology, traceability and HACCP, all according to the specifications of the Training Manual on Food Hygiene and the Hazard Analysis and Critical Control Point (HACCP) System (FAO, 2002). Training sessions were given to small groups of 4 food handlers belonging to canteens and groups of 2 food handlers belonging to cafes to better achieve a strict interaction between trainer and handler. During the theoretical part, several slides, pictures and videos were presented to the participants and were used for in-depth explanation of several food safety practices. The second part consisted of practical training in order to consolidate the knowledge acquired in the first part. In this section, the instructor demonstrated the practical aspect of each HACCP pre-requisite. For example, how cross contamination occurs, the effectiveness of hand washing, temperature checking, correct record of temperatures, cleaning, disinfection and traceability, identification *in-situ* of critical control points, deviation procedures as well as others, were shown to participants. This step reinforced the food safety concepts previously discussed in the theoretical portion.

Finally, *in-situ* application of the previously acquired knowledge consisted of an audit done by the food safety trainer in order to verify the procedures performed by the food handlers during the workday. Throughout this procedure, corrective measures were applied in cases of inappropriate hygiene and/or food safety procedures detected. The objective was to enhance the theoretical knowledge learnt during the first part of the training program and then also apply it daily.

2.3. Microbiological sampling of surfaces, food equipment, food tools and food handlers' hands

A total of 504 microbiological samples of surfaces, food tools and food equipment were taken in the establishment of the study after cleaning and disinfection. Half were taken before the food handlers' food safety training and the other half fifteen days after food safety training. Food contact surface samples included walls, shelves and food tables. Food equipment included all kinds of appliances, such as coffee machines, washing machines, ovens, microwave ovens, roasters, fridges, freezers, slicers, gas and electrical hot points, squeezers. Food tools included all kinds of utensils used for food handling and/or food serving, such as cutting boards, cutlery, dishes, glasses, wine glasses, bowls, coffee cups, tea spoons, knives, clamps, ladles, casseroles, frying pans, slotted spoons, saucers, and lunch boxes. Food handlers' hygiene was evaluated by 480 microbiological samples of bare hands. 120 microbiological samples (60 of each hand) were taken before and after the food safety training as well as before and after the cleaning and disinfection of hands. The objective of the microbiological analysis of separate hands was to investigate the relationship between microbial load and the food handler's dominant and non-dominant hand.

Total plate counts, moulds and yeasts were evaluated on surfaces, food tools and food equipment. Initially, *Enterobacteriaceae* was randomly evaluated on 100 food contact surfaces, food tools and food equipment and, in all of them, counts were below the detection limit. In consequence, *Enterobacteriaceae* was not evaluated during all the studied period.

The hygiene of food handlers was assessed by the microbiological analysis of total plate counts, moulds and yeasts, *Enterobacteriaceae*, *Escherichia coli* and coagulase-positive *Staphylococcus aureus*.

The food contact surfaces, food equipment, food tools, and food handlers' bare hands samples were collected using the swab-rinse technique in duplicate. A sterile swab, moistened with tryptone salt solution, was rubbed for 20 s over the surface to be sampled. Sampling of food-contact surfaces, food equipment and food tools was carried out by using a sterile paper template of 10 cm^2, 25 cm^2 and 100 cm^2 that was used to outline a known area, inside which the swabbing was done. The swab was then placed in a tube containing 10 ml of tryptone salt, shaken and stored at 2 °C in an ice container and then analyzed within 2 h of arrival at the laboratory. Then, 1 ml (for coliforms, *Enterobacteriaceae* and *E. coli*) or 0.2 ml (for moulds, yeasts, and *S. aureus*) of the rinse fluid was poured in appropriate culture media onto 90 mm Petri dishes.

The total coliform counts were obtained after incubation on Violet Red Bile lactose agar (Oxoid, England) at 30 °C for 24 h, the *Enterobacteriaceae* counts were obtained after incubation on Violet Red Bile glucose (Oxoid, England) at 34 °C for 24 h. The total plate counts were obtained after incubation on plate count agar (Oxoid, England) at 30 °C for 24 h, the mould and yeast counts were obtained after incubation on Chloramphenicol glucose agar (Biokar diagnostics) at 25 °C for 3–5 days. The S. *aureus* counts were obtained after incubation on Baird-Parker agar (Biokar diagnostics) at 37 °C for 24 h, and the *E. coli* counts were obtained after incubation on Tryptone bile glucuronic agar (Biokard diagnostics) at 41.5 °C for 24 h. The enumeration of characteristic cell forming units for total coliforms (NP 788:1990), total plate count (ISO 4833:2003), mould and yeast (ISO 13681:1995) and *E. coli* (ISO 16649-2/2001) was