INSTITUTO POLITÉCNICO
DE VIANA DO CASTELO

Ana Isabel Barbosa Lopes

Avaliação-Diagnóstico a Cantinas Escolares

Mestrado em Gestão da Qualidade e Segurança Alimentar

Trabalho efetuado sob a orientação

Orientadora

Professora Doutora Joana Santos Guerreiro

Coorientadora

Professora Doutora Helena Santos Rodrigues

Maio, 2015

Agradecimentos

Com muita satisfação que aqui expresso os mais sinceros agradecimentos e o meu apreço a todos que tornaram a realização desta tese possível, apesar de ser um trabalho individual.

Desde o início, contei com a confiança, disponibilidade e apoio de muitas pessoas e organizações. Sem estes contributos destas pessoas e instituições esta investigação não teria sido possível.

Em primeiro lugar, gostaria de agradecer à Doutora Joana Guerreiro, orientadora da tese, sem ela nunca teria conseguido escrever esta tese. É difícil agradecer o seu apoio, dedicação, carinho, preocupação, confiança depositada e pelos conhecimentos transmitidos. Agradeço ainda a disponibilidade e os incentivos ao longo da tese de mestrado.

À Doutora Helena Rodrigues, pela preciosa ajuda na análise estatística dos dados, correção do artigo e com a disponibilidade que o fez e pelo seu apoio.

À Eng. Carla Ramos, pela sua disponibilidade, apoio e preciosa ajuda na compilação dos dados e na análise estatística.

Aos responsáveis organizacionais que autorizaram a realização deste estudo, à Câmara Municipal de Viana do Castelo, aos Serviços de Ação Social do Instituto Politécnico de Viana do Castelo, bem como aos manipuladores de géneros alimentícios das cantinas que se mostraram sempre recetivos, pela sua disponibilidade, simpatia com que me receberam e pelo tempo que prescindiram para responder a qualquer questão durante as auditorias e ao questionário.

À Damiana Matos pelo seu apoio e disponibilidade que teve comigo para me acompanhar a algumas cantinas do IPVC para a recolha dos indicadores de higiene e a realização de questionários.

Agradeço aos bons e sempre amigos do IPVC, especialmente à Diana, Liliana Maria José e Daniela, pelo apoio e incentivo no decorrer deste trabalho.

Finalmente, a todos os meus amigos e familiares, especialmente às minhas irmãs, ao meu irmão, ao meu cunhado, à minha cunhada e aos meus sobrinhos e ao meu pai, pela força e apoio que me deram, ao longo destes anos, e pela

paciência de me ouvirem, durante todo este tempo, sempre a falar do meu trabalho.

O meu profundo e sentido agradecimento a todas as pessoas que contribuíram para a concretização desta tese, estimulando-me intelectualmente e emocionalmente.

Resumo

Atualmente as empresas do sector alimentar necessitam de possuir sistemas de segurança alimentar devido às imposições legais, para satisfazerem as expectativas dos consumidores, necessidades do mercado, mas principalmente para garantir a qualidade dos géneros alimentícios e prevenir as doenças de origem alimentar. Nos dias de hoje as doenças de origem alimentar (DOA) são uma preocupação ao nível de saúde pública e para as evitar é importante que todos os manipuladores de géneros alimentícios recebam formação específica em Higiene e Segurança Alimentar (HSA), com vista a não fornecer géneros alimentícios prejudiciais à saúde e impróprios para o consumo. Assim é fundamental, existir uma avaliação contínua e individualizada, da eficácia, das práticas de higiene e segurança alimentar no sector da restauração. O público das cantinas escolares pertence a um dos grupos de risco onde as questões relacionadas com a segurança alimentar são críticas, as crianças e adolescentes.

O objeto deste estudo passou pela avaliação das condições de higiene e segurança alimentar em 17 cantinas escolares do ensino básico, do 1º ciclo e jardins-de-infância do concelho de Viana do Castelo, em dois períodos distintos, separados por sete anos bem como o estudo da correlação entre o grau de conhecimento em questões de HSA pelos manipuladores com a avaliação microbiológica de superfícies/ utensílios e mãos dos manipuladores em 26 cantinas escolares.

Para avaliar as condições de higiene e segurança alimentar utilizou-se como instrumento de recolha durante as auditorias uma lista de verificação baseada na legislação Portuguesa e Europeia. Através da aplicação da lista de verificação nas cantinas obteve-se uma % de conformidade em 2007 entre 47% e 67% e em 2014 registou-se um aumento do número de conformidades variando entre 62% e 80%. As condições de higiene e segurança alimentar em 2007 foram consideradas não aceitáveis e aceitáveis, em 2014 aceitáveis e boas.

O estudo realizado para avaliar o conhecimento dos manipuladores sobre as questões de Higiene e segurança alimentar envolveu 86 manipuladores de géneros alimentícios. Aplicou-se um questionário realizado utilizando o método

da entrevista face a face aos manipuladores e recolheram-se amostras das mãos dos manipuladores e de superfícies/utensílios para a realização de análises microbiológicas. Todos os resultados foram transformados numericamente numa escala de 1 a 5 e aplicada uma técnica de quimiometria, o Partial Least Square (PLS) para avaliar a correlação entre o conhecimento sobre questões de higiene e segurança alimentar, os hábitos de higiene e os resultados microbiológicos.

Após a análise estatística dos resultados dos questionários, em conjunto com os resultados das análises microbiológicas aos operadores e superfícies/equipamentos, pode-se concluir que o nível de conhecimento sobre questões de Higiene e Segurança Alimentar tem influência tenua nos hábitos de higiene e por consequência nos resultados de avaliação microbiológica. Relativamente aos resultados dos indicadores de higiene observou-se que 97,6% superfícies/utensílios e 75,6% dos manipuladores (mãos) apresentavam resultados satisfatórios.

Pode-se concluir que existiu uma evolução durante os sete anos nas cantinas escolares, no entanto ainda existem não conformidades importantes para serem corrigidas. As não conformidades existentes poderão ser eliminadas com o empenho das escolas e da entidade gestora, para que as cantinas possam aumentar os seus padrões de higiene e segurança alimentar.

Quanto ao conhecimento dos manipuladores sobre questões de HSA os resultados não foram ao encontro do expectável uma vez que não se evidenciou, através o que de alguma forma é assumido que é a influência do conhecimento em questões de HSA sobre os hábitos e os resultados microbiológicos.

Palavras-Chave: Higiene e segurança alimentar, cantinas escolares, HACCP, surtos de origem alimentares, manipulador de géneros alimentícios, surtos alimentares, conhecimento e indicadores de higiene

Abstract

Currently the food businesses need to have food safety systems due to legal constraints, to meet consumer expectations, market needs, but mainly to ensure food quality and prevent food-borne diseases. These days the foodborne diseases are a concern in terms of public health and to avoid this it is important that all food handlers receive specific training in food safety, with a view to not provide food unfit for consumption. So it is critical that there is a continuous assessment and individualized, efficiency, hygiene practices and food safety in the catering sector. The public from school canteens belongs to one of the risk groups where issues related to food security are critical: children and adolescents.

The object of this study went through evaluation of hygiene and food safety in 17 school canteens of basic education, first cycle and kindergartens of the municipality of Viana do Castelo, in two distinct periods, separated by seven years. Also a study was developed to assess the food handler's knowledge of hygiene and food safety using a face-to face application of a questionnaire in 26 school canteens. Microbiological samples were also taken from the handlers' hands and from work surfaces/utensils. The results were subsequently converted into a scale of 1 to 5, making it possible to correlate the knowledge of hygiene and food safety, hygiene practices and the microbiological results to the hygiene indicators using a chemometrical tool (Partial least squares). Partial least squares (PLS) is an approach to structural equation modelling (SEM) that is extensively used in the social sciences to analyse quantitative data. However, as far as we know, this statistic methodology isn't used in food safety studies.

To evaluate the conditions of hygiene and food safety was used as an instrument for collecting during the audits a checklist based on Portuguese and European legislation. Through the application of the checklist in canteens obtained a% of compliance in 2007 between 47% and 67% in 2014 and there was an increase in the number of compliance ranging from 62% and 80%. The conditions of hygiene and food safety in 2007 were considered acceptable and not acceptable in 2014 acceptable and good.

The study conducted to evaluate the knowledge of issues of hygiene and food safety involved 86 food handlers. A questionnaire was carried out using the method of face-to-face interview to handlers and collected samples from the hands of manipulators and surfaces/tools for microbiological analyses. All results are processed numerically on a scale of 1 to 5 and applied a technique of chemometrics, the Partial Least Square (PLS) to assess the correlation between knowledge on issues of hygiene and food safety, hygiene and microbiological results.

After statistical analysis of the results of the questionnaires, together with the results of microbiological testing to operators and surfaces and equipment, it can be concluded that the level of knowledge on issues of hygiene and food safety has influence and hygiene habits tenua result in microbiological assessment results. With regard to the results of hygienic indicators showed that 97.6% 75.6% surfaces/utensils and handlers (hands) presented satisfactory results.

It can be concluded that there was a trend for seven years in school canteens, however there are still major non conformities to be corrected. The existing non-conformity can be eliminated with the commitment of schools and of the Fund Manager, to the canteens may increase their standards of hygiene and food safety.

As for the knowledge of issues of HSA the results were not to the since it is not highlighted, through which somehow is assumed to be the influence of knowledge on issues of HSA on the habits and the microbiological results.

Keywords: Hygiene and food safety, school canteens, HACCP, food-borne outbreaks, food handler, food outbreaks, knowledge and hygiene indicators

Lista de abreviaturas

ASAE – Autoridade de Segurança Alimentar e Económica

AVE – Average Variance Extracted

BP – Boas Práticas

CAC – *Codex Alimentarius Comission*

CDC – Centers for Disease Control

CR – Composite Realibity

DOA – Doenças de Origem Alimentar

EFSA – European Food Safety Authority

ECDC – European Center for Disease Prevention and Control

FAO – Food and Agriculture Organization of the United Nations

FIFO - First In, First Out (Primeiro a entrar, primeiro a sair)

HACCP – Hazard Analysis and Critical Control Points (Análise de Perigos e Controlo de Pontos Críticos)

HSA – Higiene e Segurança Alimentar

ICMSF – International Commission on Microbiological Specifications for Foods

INSA – Instituto Nacional de Saúde Dr. Ricardo Jorge

ISO – International Organization for Standardization

NP – Norma Portuguesa

PCC – Ponto de Controlo Crítico

PPR – Programa Pré-Requisito

WHO – World Health Organization

Índice

Índice de Tabelas

1. Introdução

A Segurança Alimentar, nos últimos anos tornou-se num dos assuntos mais preocupantes e com impacto na opinião pública e tem ganho uma maior importância quer para as entidades regulamentadoras, os operadores do setor alimentar e também para os consumidores. Estes últimos esperam consumir géneros alimentícios seguros mas que ao mesmo tempo satisfaçam as suas necessidades e expectativas (Bolton & Maunsell, 2004; Osimani, Aquilanti, Tavoletti, & Clementi, 2013; Quali, 2015a; Silva & Martins, 2015).

Segundo o *Codex Alimentarius* a Segurança Alimentar é a garantia de que os géneros alimentícios, não provocarão danos ao consumidor desde que sejam, preparados e ingeridos de acordo com a sua utilização prevista, estando intrinsecamente ligada à higiene dos géneros alimentícios (*Codex Alimentarius,* 2003*)*. Assim, a higiene dos géneros alimentícios, segundo o Regulamento (CE) nº 852/2004, é o conjunto de medidas e condições necessárias para controlar os perigos e assegurar que os mesmos são próprios para consumo humano.

O crescimento da população mundial, desenvolvimento de novas tecnologias que alteram como os géneros alimentícios são produzidos, processados e distribuídos, alterações dos hábitos alimentares (refeições semi-preparadas, fast-food e mais refeições fora de casa), alterações climáticas, aparecimento de novos microrganismos associados à globalização do comércio internacional, alterações do estilo de vidas das sociedades tornou a cadeia alimentar complexa e levou ao surgimento de novos perigos e/ou agravamento de alguns já existentes (Quali, 2015d; Silva & Martins, 2015).

Ao longo da história, os perigos alimentares (microbiológicos, químicos e físicos) tem sido referenciados como um problema para a saúde humana. No entanto as entidades governamentais tem efetuado um esforço, para promover a melhoria da segurança na cadeia alimentar, mas as doenças de origem alimentar (DOA), continuam a ser um problema de saúde pública, quer nos países em desenvolvimento quer nos países desenvolvidos. Estima-se que, anualmente, 1.8 milhões de pessoas morram devido a DOA, na maioria dos casos

relacionadas com a ingestão de alimentos ou água contaminados (Amorim, Novais, Correia, & 2008; WHO, 2014).

As doenças de origem alimentar são uma preocupação atualmente devido às consequências que podem advir destas para as pessoas infetadas, que podem ficar com sequelas graves ou até mesmo morrer. No entanto, também trazem consequências económicas quer diretas (indeminizações para as pessoas infetadas e possíveis multas de acordo com a legislação ao estabelecimento onde foi comprado o produto) ou indiretas (tem um efeito mais longo, tornando-se num efeito negativo em termos de imagem e confiança dos consumidores para com as empresas) (Baptista & Saraiva, 2003).

Os operadores do setor alimentar são responsáveis por assegurar que em todas as fases de produção, transformação e distribuição, os géneros alimentícios cumprem todos os requisitos de legislação alimentar, e devem também verificar o cumprimento desses requisitos. Assim, estes são os principais responsáveis pela segurança dos géneros alimentícios (Quali, 2015e).

Os manipuladores de géneros alimentícios tem de ter formação para garantir que todos os procedimentos de higiene e segurança alimentar são compreendidos e aplicados por todos os colaboradores, independentemente da tarefa que desempenham. A formação deve ser dada antes ou na admissão, devendo ser aplicada de forma contínua ao longo dos anos (Oliveira, 2007).

1.1. HACCP

O sistema HACCP (Hazard Analysis and Critical Control Points) é internacionalmente reconhecido como sendo o mais eficaz e cuja metodologia é de aplicação obrigatória, como é descrito no Regulamento (CE) nº 852/2004, em todas as fases da produção, manipulação, transformação e distribuição de géneros alimentícios. A sua implementação deve ser guiada por evidências científicas de riscos para a saúde humana (Osimani et al., 2013; Quali, 2015c).

Esta legislação relativa à higiene dos géneros alimentícios só começou a ser aplicável a 1 de Janeiro de 2006, no entanto veio trazer a obrigatoriedade para os operadores do setor alimentar de implementarem sistemas de auto controlo,

baseados nos princípios de HACCP, tendo como referência o *Codex Alimentarius* (Novais, 2006). Apesar do sistema HACCP ser obrigatório, existem ainda numerosas entidades que não o têm implementado, é o que sucede com algumas cantinas escolares.

Antes de implementar o sistema HACCP em qualquer empresa do setor alimentar, o operador deverá assegurar que os princípios gerais de higiene e boas práticas estão devidamente implementados e que são cumpridos (Afonso, 2006; Quali, 2015c). O sistema HACCP é um método reconhecido internacionalmente baseado na identificação e avaliação de perigos relacionados com a Segurança Alimentar, aplicável a qualquer fase da cadeia alimentar, desde a produção primária até ao consumo final e a sua aplicação deve ser guiada por evidências científicas de acordo com os danos que podem causar para a saúde dos consumidores (Afonso, 2006; Osimani et al., 2013; Quali, 2015c) e assim prevenir doenças de origem alimentar. Assim, o HACCP é um sistema preventivo de controlo de qualidade dos géneros alimentícios, identificando os perigos (químicos, físicos e microbiológicos) que tem impacto no consumo, determinando as medidas preventivas a adotar para evitar os perigos, permitindo assim identificar as fases sensíveis dos processos que podem levar à falta de segurança do produto e os Pontos Críticos de Controlo (PCC), mantendo-os sobre vigilância (Afonso, 2006; Azevedo, 2009).

Um sistema HACCP para ser válido tem que gerar dados consistentes sobre a incidência, eliminação, prevenção e redução dos riscos encontrados nos processos. As análises microbiológicas (a alimentos, zaragatoas a superfícies, equipamentos, utensílios e mãos dos manipuladores) são uma ferramenta importante para recolher dados para o desenvolvimento e verificação de um sistema HACCP, mas também, para avaliar a eficácia das operações de higiene das instalações e operadores, avaliar a conformidade dos ingredientes recebidos com critérios de segurança e determinar a segurança de produtos finais (Oliveira, 2007; Osimani et al., 2013). Além destas ferramentas, as auditorias são úteis para examinar a aplicação de todas as medidas de controlo previstas por um sistema HACCP. Como é descrito na NP EN ISO 19011/2012 é um processo sistemático, independente e documentado para obter evidências de auditoria e respectiva avaliação objectiva, com vista a determinar em que medida os

critérios de auditoria são satisfeitos. Assim, as auditorias internas podem ajudar na redução dos riscos para a saúde, sendo uma ferramenta importante para empresas de restauração/cantinas escolares (Osimani et al., 2013).

1.1.1 Princípios e etapas do sistema HACCP

O sistema HACCP no início baseava-se apenas na aplicação de três princípios propostos pela companhia Pillsbury, esta metodologia foi evoluindo ao longo dos anos. Atualmente o sistema HACCP assenta num conjunto de 7 princípios fundamentais (AESBUC, 2014; ASAE, 2014b; Baptista & Antunes, 2005; FAO, 1997; Vaz, Moreira, & Hogg, 2000).

Princípio 1 - Análise de perigos

A análise de perigos consiste em identificar potenciais perigos em todas as etapas do processo, ou seja, desde as matérias-primas até ao consumidor final. Pertencente à análise de perigos encontra-se a avaliação da probabilidade de ocorrência e da severidade dos perigos identificados, mas também a análise de medidas preventivas criadas para o seu controlo para determinar a significância dos mesmos (ASAE, 2014b; Baptista & Antunes, 2005).

Princípio 2 - Determinação dos pontos críticos de controlo (PCC)

Identificar os pontos críticos de controlo (PCC) na fase ou fases em que o controlo é essencial para evitar ou eliminar o perigo ou minimizar a probabilidade de ocorrência. Um PCC consiste num ponto, procedimento, operação ou etapa na qual se deve aplicar controlo, sendo principalmente para prevenir, reduzir para níveis aceitáveis ou eliminar o perigo relacionado com a inocuidade dos géneros alimentícios (ASAE, 2014b; Baptista, Pinheiro, & Alves, 2003).

Princípio 3 - Estabelecimento de limites críticos

Estabelecer limites críticos nos pontos críticos de controlo, que separem a aceitabilidade da não aceitabilidade com vista à prevenção, eliminação ou redução dos riscos identificados (ASAE, 2014b).

Princípio 4 - Estabelecimento de um sistema de monitorização

Consiste em estabelecer e aplicar processos eficazes de vigilância em pontos críticos de controlo (ASAE, 2014b).

Princípio 5 - Estabelecimento de ações corretivas

Consiste no estabelecimento de medidas corretivas quando a vigilância indicar que um ponto crítico não se encontra sob controlo. A perda de controlo consiste num desvio do limite crítico do controlo de um PCC (ASAE, 2014b; Baptista & Antunes, 2005).

Princípio 6 - Estabelecimento de procedimentos de verificação

Assenta no estabelecimento de procedimentos de verificação para serem efetuados regularmente, a fim de verificar se as medidas referidas nos princípios de 1 a 5 funcionam eficazmente (ASAE, 2014b).

Princípio 7 - Estabelecimento de documentação e registo

Prossupõe a elaboração de documentos e registos adequados à natureza e dimensão das empresas, a fim de demonstrar a aplicação eficaz das medidas referidas nos princípios 1 a 6. Os registos são a evidência da realização de atividades associadas à operacionalidade do Sistema HACCP (ASAE, 2014b; Baptista & Antunes, 2005).

Os 7 Princípios do Sistema de HACCP podem ser implementados através de 14 passos lógicos e sequenciais (AESBUC, 2014; Afonso, 2006; FQA & DCTA/ESAC, 2002; Vaz et al., 2000):

1. Definir os objetivos (âmbito do Plano de HACCP), estratégias e recursos necessários;

2. Formação da equipa HACCP;

3. Descrever do produto;

4. Identificar o uso pretendido do produto;

5. Elaborar o fluxograma do processo;

6. Verificar (in loco) o fluxograma do processo;

7. Identificar os perigos e medidas preventivas associadas a cada passo (Princípio 1);

8. Identificar os pontos críticos de controlo (Princípio 2);

9. Estabelecer os limites críticos para os PCC's (Princípio 3);

10. Estabelecer os procedimentos de monitorização (Princípio 4);

11. Estabelecer as ações corretivas (Princípio 5);

12. Estabelecer os procedimentos de verificação (Princípio 6);

13. Estabelecer os sistemas de registo e arquivo de dados que documentam o plano de HACCP (Princípio 7);

14. Revisão do plano de HACCP.

1.1.2 Pré-requisitos

O sistema HACCP não é por si só, suficiente para garantir a segurança alimentar, assim torna-se importante que cada operador implemente um conjunto de atividades que controlem as condições operacionais e ambientais necessárias à produção de géneros alimentícios seguros, ou seja, devem implementar os programas de pré-requisitos (PPRs) (Silva & Martins, 2015).

Os pré-requisitos são uma base para uma aplicação efetiva do sistema HACCP e devem ser definidos anteriormente à implementação deste. Em geral os pré-requisitos devem controlar os perigos associados com a unidade de restauração, como a localização, estruturas, serviços, pessoal, instalações e equipamentos.

Já o sistema HACCP centra-se em controlar os perigos associados com os processos dos géneros alimentícios (armazenamento, preparação, confeção, etc) (Bolton & Maunsell, 2004; Novais, 2006).

Segundo o Regulamento (CE) nº 852/2004 e o *Codex Alimentarius* são considerados os seguintes pré-requisitos do HACCP: instalações e equipamentos, receção e armazenagem de matérias-primas, transporte, rastreabilidade, controlo de resíduos e pragas, limpeza e desinfeção, controlo da água, saúde e higiene pessoal, formação e embalagem e rotulagem.

Instalações do sector alimentar

Segundo o Regulamento (CE) nº 852/2004 e o *Codex Alimentarius*, as instalações do sector alimentar devem ser mantidas limpas e em boas condições, no entanto pela sua disposição relativa, conceção, construção, localização e dimensões devem:

- Permitir a manutenção e a limpeza e/ou desinfeção adequadas, evitar ou minimizar a contaminação por via atmosférica e facultar um espaço de trabalho adequado para permitir a higienização de todas as operações;
- Evitar a acumulação de sujidade, o contacto com materiais tóxicos, a queda de partículas nos géneros alimentícios e a formação de condensação e de bolores indesejáveis nas superfícies;
- Possibilitar a aplicação de boas práticas de higiene e evitar qualquer contaminação, em especial, o controlo das pragas;
- Sempre que necessário, proporcionar condições adequadas de manuseamento e armazenagem a temperatura controlada, com capacidade suficiente para manter os géneros alimentícios a temperaturas adequadas e registadas (Regulamento (CE) nº 852/2004; *Codex Alimentarius*, 2003).

Também devem existir instalações sanitárias em número suficiente, munidas de autoclismo e ligadas a um sistema de esgoto eficaz, não devem contactar diretamente para os locais onde se manipulam os géneros alimentícios

Deve ainda existir um número adequado de lavatórios devidamente localizados e indicados para a lavagem das mãos. Estes devem estar equipados com água corrente quente e fria, materiais de limpeza das mãos, com torneiras de acionamento não manual e dispositivos de secagem higiénica e sempre que necessário, as instalações de lavagem dos géneros alimentícios devem ser separadas das que se destinam à lavagem das mãos.

Deve ser prevista uma ventilação natural ou mecânica adequada e suficiente evitando o fluxo mecânico de ar de zonas contaminadas para zonas limpas. As instalações do sector alimentar devem dispor de luz natural e/ou artificial adequada. O pessoal, sempre que necessário, deverá dispor de vestiários adequados e os produtos de limpeza e os desinfetantes devem ser armazenados

num local fechado e identificado e onde não são manipulados géneros alimentícios.

Todas superfícies (tetos, portas, paredes, pavimento e janelas) devem ser de material adequado (de modo a evitar-se a acumulação de sujidade e permitir uma fácil higienização).

As janelas e outras aberturas que possam abrir para o exterior devem estar equipadas com redes de mosquiteiras de forma a evitar a entrada de pragas/ insetos. As redes mosquiteiras devem ser amovíveis e de fácil limpeza (Regulamento (CE) 852/2004; *Codex Alimentarius,* 2003)

Equipamentos, utensílios e superfícies

As superfícies (incluindo as dos equipamentos) das zonas onde os géneros alimentícios são manuseados, mais propriamente as que entram em contacto com os géneros alimentícios, devem ser mantidas em boas condições e de higienização fácil e sempre que necessário, desinfetadas. Para este efeito, deverão ser utilizados materiais lisos, laváveis, resistentes à corrosão e não tóxicos.

Sempre que necessário, devem existir instalações adequadas para a limpeza, desinfeção e armazenagem dos utensílios e equipamento de trabalho. Também devem ser previstos meios adequados para a lavagem dos alimentos, ou seja todos os lavatórios ou outros equipamentos do mesmo tipo destinados à lavagem de géneros alimentícios devem dispor de um abastecimento adequado de água potável quente e/ou fria.

Todos os utensílios, aparelhos e equipamentos que entrem em contacto com os géneros alimentícios devem estar efetivamente limpos e, sempre que necessário, desinfetados, com uma frequência suficiente para evitar qualquer risco de contaminação, ser fabricados com materiais adequados e mantidos em boas condições de arrumação e bom estado de conservação, de modo a minimizar qualquer risco de contaminação e ser instalados de forma a permitir a limpeza adequada do equipamento e da área circundante (Regulamento (CE) nº 852/2004; *Codex Alimentarius*, 2003).

Receção e armazenamento de matérias-primas

Não se deve aceitar matérias-primas ou ingredientes num estabelecimento se houver conhecimento de que contêm parasitas, microrganismos indesejáveis, pesticidas, medicamentos veterinários ou substâncias tóxicas, decompostas ou estranhas que não se prevê virem a ser reduzidas para um nível aceitável através do processamento. Apenas devem se utilizar matérias-primas de fornecedores qualificados, de forma a garantir a qualidade dos produtos. Na receção destas deverá existir registos para verificarem as condições do veículo de transporte, dos requisitos de embalagem (estado de embalagem, prazos de validade, rotulagem e códigos), da temperatura de transporte, entre outros a fim de concluírem que se encontram em condições para serem processadas (Baptista & Antunes, 2005). As matérias-primas devem ser armazenadas em locais próprias conforme a sua temperatura de armazenamento. Todos os produtos intermédios e acabados que sejam suscetíveis de permitirem a reprodução de microrganismos patogénicos ou a formação de toxinas não devem ser conservados a temperaturas de que possam resultar riscos para a saúde. A cadeia de frio nunca deverá ser interrompida. Os stocks de matérias-primas e ingredientes devem ser sujeitos a uma rotação eficaz, conforme a regra FIFO (Regulamento (CE) nº 852/2004; *Codex Alimentarius*, 2003).

Controlo da água

Deve ser usado um abastecimento de água potável adequado, a qual deve ser utilizada sempre que necessário para garantir a não contaminação dos géneros alimentícios (Regulamento (CE) nº 852/2004) e segundo a legislação portuguesa a utilização da água nas indústrias alimentares para o fabrico, transformação, conservação ou comercialização de produtos ou substâncias destinadas ao consumo humano, mas também que seja utilizada na limpeza das superfícies, objetos e materiais que podem entrar em contacto com os géneros alimentícios, exceto a utilização dessa água não afeta a salubridade dos géneros alimentícios na sua forma acabada (Decreto-lei 306/2007).

Rastreabilidade

As embalagens dos géneros alimentícios devem estar etiquetados com a data de produção, o tipo de género alimentício, o nome do estabelecimento onde foi produzido e o número de lote de modo a permitir a rastreabilidade (*Codex Alimentarius,* 2003).

Controlo de pragas

As pragas representam uma séria ameaça à segurança e à adequação dos géneros alimentícios. As infestações por pragas podem ocorrer em locais que favoreçam a sua proliferação e onde exista uma fonte de alimento. Por isso devem ser empregues as boas práticas de higiene de forma a evitar a criação de um ambiente favorável ao desenvolvimento das pragas. Assim devem ser instituídos procedimentos adequados (ex: contrato com uma empresa de controlo de pragas) para controlar todos os parasitas e cumpridos de forma periódica, não esquecendo os respetivos registos. As áreas adjacentes e os estabelecimentos devem ser examinados regularmente para avaliar possíveis infestações e as instalações devem ser mantidas limpas (Regulamento (CE) nº 852/2004; *Codex Alimenatrius*, 2003).

Limpeza e Desinfeção

A higienização e desinfeção das superfícies e utensílios que estão em contacto com os géneros alimentícios e com as instalações, são uma forma de verificar se estes dois processos estão a ser realizados corretamente através de controlo microbiológico.

Os estabelecimentos e equipamentos devem ser mantidos em bom estado e em condições de higiene de modo a prevenir a contaminação dos alimentos. Os métodos e materiais de limpeza necessários dependerão da natureza do estabelecimento, mas deverão ser próprios para o setor alimentar. Os produtos químicos de limpeza devem ser manuseados e utilizados com cuidado e de acordo com as instruções do fabricante.

Para assegurar que é realizada uma higienização adequada devem ser desenvolvidos planos de limpeza e desinfeção. Um plano de higienização consiste num documento onde estão definidos os locais, equipamentos, produtos, frequência e pessoa responsável pela higienização nas instalações. Para verificara eficácia do plano devem ser realizadas análises microbiológicas as superfícies, equipamentos e utensílios (Regulamento (CE) nº 852/2004; *Codex Alimentarius*, 2003).

Controlo de resíduos

Devem ser adotadas medidas adequadas para a remoção e o armazenamento de resíduos, como coloca-los em caixotes de material adequado. Não se deve permitir a acumulação de resíduos nas áreas de manuseamento ou armazenamento dos alimentos, bem como noutras áreas de trabalho e no ambiente adjacente, salvo na medida em que tal seja inevitável para o adequado funcionamento da atividade. Os locais de armazenamento de resíduos devem manter-se adequadamente limpos (Regulamento (CE) nº 852/2004; *Codex Alimentarius*, 2003).

Saúde e higiene pessoal

Todas as pessoas que trabalhem num local onde são manuseados géneros alimentícios devem manter um elevado grau de higiene pessoal e deverão usar vestuário adequado (touca ou barrete, camisa/camisola ou bata, calças, calçado antiderrapante e impermeável, e eventualmente avental), limpo e, sempre que necessário, que confira proteção. Os vestuários devem ser de cor clara, exclusivo do local de trabalho, de forma a evitar eventuais contaminações Se alguma pessoa sofrer ou seja portadora de uma doença facilmente transmissível através dos géneros alimentícios ou que esteja afetada, por exemplo, por feridas infetadas, infeções cutâneas, inflamações ou diarreia será proibida de manipular géneros alimentícios e entrar em locais onde se manuseiem alimentos.

Como as mãos são um foco de contaminação de alimentos, devem ser lavadas e desinfetadas frequentemente a fim de evitar contaminações dos géneros alimentícios, a sua adequada e frequente lavagem tem uma grande importância

para garantir que não contribua para contaminar os alimentos. As unhas dos manipuladores devem manter-se curtas, limpas e isentas de verniz, sendo proibido o uso de unhas postiças. No entanto, também é proibido o uso de qualquer tipo de adornos (brincos, anéis, colares, etc.) por parte dos manipuladores, por representarem um perigo físico de contaminação dos alimentos, e eventual foco de contaminação cruzada (Regulamento (CE) nº 852/2004; *Codex Alimentarius*, 2003).

Formação

Os operadores das empresas do sector alimentar devem assegurar que todo o pessoal que manuseia os géneros alimentícios devem dispor de formação em matéria de higiene e segurança alimentar. A formação fornecida deve ser de cariz prático, ou seja, com frequentes exemplos práticos e atividades de demonstração. A fim de motivar os manipuladores a cumprir as regras e desempenhar as suas funções com elevados níveis de higiene e segurança alimentar. Caso os manipuladores não se sintam motivados, podem não manter altos padrões de higiene. Deverão ser efetuadas avaliações periódicas dos programas de treino e formação, bem como supervisões e verificações de rotina para assegurar que os manipuladores aplicam os procedimentos com eficácia (Regulamento (CE) nº 852/2004; *Codex Alimentarius*, 2003).

Para a verificação do cumprimento destes pré-requisitos recorre-se às listas de verificação (checklists) elaboradas de modo a permitir avaliar o nível de não conformidades. Através destas listas realiza se uma avaliação quantitativa, pelo cálculo da percentagem de cumprimento a cada requisito verificado, permitindo observar as situações em não conformidades e identificar os procedimentos em falta, sendo os aspetos para se verificar se estão reunidas as condições para a implementação do sistema HACCP (Novais, 2006).

1.1.3 Benefícios do sistema HACCP

A implementação do sistema HACCP vai permitir um aumento da confiança e segurança do consumidor, facilita o cumprimento da legislação e o uso mais

eficiente de recursos na resposta imediata a questões relacionadas com a inocuidade de géneros alimentícios. Este sistema deve ser entendido como uma ferramenta de gestão de segurança alimentar que possui um conjunto de benefícios e não como uma facilidade de cumprimento de requeridos legais (Baptista & Antunes, 2005). Dos benefícios do sistema pode-se evidenciar (FQA & DCTA/ESAC, 2002):

- Aplica-se a toda a cadeia alimentar;
- Reforça a imagem da empresa e a confiança dos consumidores;
- Controla os perigos com origem nos géneros alimentícios;
- Promove uma filosofia de prevenção em detrimento do controlo baseado no produto final, reduzindo os desperdícios;
- Facilita as oportunidades de comércio dentro e fora da União Europeia;
- Providencia documentos que evidenciam o controlo do processo;
- Evidencia a conformidade com as especificações, códigos de boas práticas e/ou legislação;
- Direciona os recursos humanos e materiais para os pontos-chave do processo;
- Providencia os meios para prevenir erros na gestão da segurança alimentar que possam prejudicar a sobrevivência da empresa;
- Pode ser usado como prova de defesa contra ações legais.
- É recomendado por organizações internacionais que o considera um dos meios mais efetivos de controlar problemas na produção de géneros alimentícios.

1.2. Perigos Alimentares

Existem várias definições de perigos alimentares apresentadas por várias organizações de referência. Segundo a comissão do *Codex Alimentarius* consiste em “qualquer propriedade biológica, física ou química, que possa tornar um alimento prejudicial para o consumo humano” e a *International Commission on Microbiological Specifications for Foods (*ICMSF) aprofundou mais este conceito significa “Qualquer contaminação ou crescimento inaceitável,

sobrevivência de bactérias em alimentos que possam afetar a sua inocuidade ou qualidade (deterioração), a produção ou persistência de substâncias como toxinas, enzimas ou produtos resultantes do metabolismo microbiano em alimentos" (Baptista & Linhares, 2005; Baptista & Venâncio, 2003). Ou seja, um perigo é tudo aquilo que pode estar no alimento, de forma natural ou não e que pode afetar a saúde dos consumidores (Baptista & Linhares, 2005).

Existem muitos fatores que contribuem para os riscos alimentares. Os que mais contribuem estão normalmente associados ao incumprimento de boas práticas (BP) e a procedimentos que visam garantir a segurança dos géneros alimentícios. Alguns exemplos destes são, os resíduos de pesticidas por falta de cumprimento dos tempos de segurança (BP agrícolas), as temperaturas de armazenagem inadequadas (BP no produtor, transformador e distribuidor), tratamento térmico insuficiente (BP de fabrico na indústria transformadora, restauração e no consumidor), a contaminação cruzada de alimentos crus e cozinhados (BP de higiene na indústria transformadora, restauração e no consumidor), entre outros. Em todas as etapas da cadeia alimentar devem ser identificados os perigos específicos e controlados por cada tipo de operador (Afonso, 2008).

Os perigos alimentares podem ser classificados de acordo com a sua natureza e são normalmente 3 grupos: biológicos, químicos ou físicos.

1.2.1 Perigos Biológicos

Estes perigos são os que representam maior risco a inocuidade dos géneros alimentícios (Tabela 1). Nesta categoria incluem-se bactérias, fungos, vírus, parasitas patogénicos e toxinas microbianas (Baptista & Linhares, 2005). A má manipulação dos géneros alimentícios pelos manipuladores e os produtos contaminados que são utilizados como matéria-prima nas unidades são os fatores normalmente associados ao aparecimento destes organismos. Bastantes destes microrganismos ocorrem naturalmente no ambiente onde os géneros alimentícios são produzidos, no entanto alguns são destruídos por processos térmicos e muitos podem ser controlados por práticas de manipulação e

armazenamento apropriadas, boas práticas de higiene e fabrico e pelo controlo de tempo, temperatura dos processos (Baptista & Linhares, 2005; Baptista & Venâncio, 2003). As bactérias patogénicas, são responsáveis por um maior número de casos de doenças de origem alimentar (Baptista & Venâncio, 2003).

Tabela 1. Classificação dos perigos biológicos (ASAE, 2015).

Tipos de perigos	Exemplos de perigos	Exemplos de alimentos associados	Potenciais doenças
Bactérias	*Salmonella*	Ovos, aves, leite cru e derivados	Salmonelose
	Campylobacter jejuni	Leite cru, queijos, gelados, saladas	Campilobacteriose
Vírus	Rotavírus	Saladas, frutas e entradas	Diarreia
	Vírus da Hepatite A	Peixe, marisco, vegetais, água, frutos, leite	Hepatite A
Parasitas	*Toxoplasma*	Carne de porco, borrego	Toxoplasmose
	Giardia	Água, saladas	Giardose
Priões	Agente da BSE	Materiais de risco especificado de bovino	Variante da doença de Creutzfeldt-Jakob

A *Salmonella*, *Campylobacter*, *Listeria monocytogenes*, *Yersinia enterocolitica*, *Staphylococus aureus* e *Escherichia coli*, são bactérias que estão presentes no ambiente das cozinhas de restauração e têm sido detetadas em alimentos prontos a comer (Amorim & Novais, 2006). A manipulação inadequada dos géneros alimentícios crus ou o armazenamento impróprio contribuem para um maior aparecimento destes microrganismos ao longo do processo e assim se aumenta o risco de se obter um género alimentício perigoso, caso exista uma falha no processo (Baptista & Linhares, 2005; Baptista & Venâncio, 2003).

No entanto, o *Clostridium perfringens* e o *Bacillus cereus* também merecem igualmente referência, por ambos poderem causar graves problemas, caso os géneros alimentícios sejam mantidos a temperaturas inadequadas após confeção (Amorim & Novais, 2006).

1.2.2 Perigos Químicos

Na cadeia alimentar existe uma grande variedade de substâncias químicas indesejáveis que podem constituir um perigo para a saúde dos consumidores (Tabela 2). Os perigos químicos estão, tirando as exceções, relacionados com contaminações graves e ao contrário dos perigos biológicos, são responsáveis por problemas de saúde que não se manifestam de uma forma aguda, afetando geralmente menos indivíduos do que os perigos biológicos (Baptista & Linhares, 2005; Quali, 2015b).

Neste grupo de perigos existe um vasto conjunto de perigos que tem várias origens, desde perigos associados diretamente às características das matérias-primas até aos perigos criados ou colocados durante o processo, passando pelos que resultam de contaminação das matérias-primas utilizadas (Baptista & Linhares, 2005; Baptista & Venâncio, 2003; Quali, 2015b).

Dos perigos químicos destacam-se: os aditivos alimentares diretos se forem utilizados em concentrações indevidas, pesticidas químicos, medicamentos veterinários, metais pesados, alérgenos, substâncias naturais vegetais e químicos criados ou introduzidos no processo (por exemplo, os produtos de limpeza e desinfeção, lubrificantes) (Baptista & Linhares, 2005; Baptista & Venâncio, 2003).

Tabela 2. Exemplos de perigos químicos (ASAE, 2015).

Tipos de perigos	Exemplos de perigos	Exemplos de alimentos associados	Potenciais doenças
Toxinas naturais	Aflatoxinas	Frutos secos, milho, leite e derivados	Cancro, malformações congénitas, partos prematuros, alterações do Sistema imunitário, doenças degenerativas do Sistema nervosa, alterações hormonais,
	Solanina	Batata	
	Toxinas marinhas	Bivalves, marisco	
Poluentes de origem industrial	Mercúrio, cádmio e chumbo	Peixe	
	Dioxinas, PCBs	Peixe, gorduras animal	

Contaminantes resultantes do processamento alimentar	Acrilamida	Batatas fritas, café, biscoitos, pão	disfunção ao nível de diversos órgãos, alterações de fertilidade, doenças osteomusculares, alteração de comportamentos
	Hidrocarbonetos aromáticos policíclicos	Fumados, óleos vegetais, grelhados	
Pesticidas	Inseticidas, herbicidas, fungicidas	Legumes, frutas e derivados	
Medicamentos veterinários	Anabolizantes, antibióticos	Carne de aves, porco, vaca	
Aditivos não autorizados	Sudan I-IV, Para Red (corantes)	Molhos, especiarias	
Materiais em contacto com alimentos	Alumínio, estanho, plástico	Alimentos enlatados ou embalados em plástico	
Outros	Produtos de limpeza, lubrificantes		

A contaminação dos géneros alimentícios por resíduos dos produtos de limpeza e desinfeção e produtos de lubrificação usados na cozinha é prevenida, através do armazenamento correto (em local próprio, separados da zona de armazenamentos dos géneros alimentícios e adequadamente fechados) e métodos de aplicação adequados, processos estes que são controlados no âmbito dos pré-requisitos (Amorim & Novais, 2006; Baptista & Linhares, 2005).

1.2.3 Perigos Físicos

Os perigos físicos podem ter uma origem diversa, desde objetos que podem estar presentes nas matérias-primas até os que podem ser introduzidos nos produtos alimentares pela contaminação e/ou más práticas em vários pontos da cadeia produtiva, desde a colheita até o consumidor (Tabela 3) (Baptista & Venâncio, 2003; Quali, 2015b).

Este perigos podem ter origem em materiais de embalagem e/ou acondicionamento das matérias-primas, em produtos em curso de preparação

e/ou confeção ou de produtos finais, equipamentos, utensílios e através dos operadores (Baptista & Linhares, 2005; Baptista & Venâncio, 2003).

Tabela 3. Principais origens dos perigos físicos (Baptista & Venâncio, 2003).

Material	Principais origens
Vidro	Garrafas, jarras, lâmpadas, janelas, utensílios, proteção de medidores (ex.: termómetros)
Madeira	Produção primária, *paletes*, caixas, material de construção, utensílios
Pedras	Campo, material de construção
Metal	Equipamentos, campo, arames, operadores
Isolamento/revestimento	Material de construção
Ossos	Processamento inadequado
Plástico	Embalagens, equipamentos
Objetos de uso pessoal	Operadores/manipuladores

Este grupo de perigos podem ser controlados por uma inspeção cuidadosa e técnicas de vigilância aplicadas pelo produtor e pelo consumidor, no entanto, nas matérias-primas consiste principalmente, nos sistemas de controlo de segurança alimentar utilizados nas operações de abastecimento, ou seja nos processos que envolvem os fornecedores (Amorim & Novais, 2006).

1.3. Doenças de origem alimentar

As doenças de origem alimentar (DOA) abrangem um vasto espetro de doenças, sendo um problema crescente de saúde pública em todos os países (WHO, 2015), sendo mais grave nos países em desenvolvimento (Martins, Hogg, & Gestal Otero, 2012; Santos, Nogueira, Patarata, & Mayan, 2008; Soares, Garcia-Diez, Esteves, Oliveira, & Saraiva, 2013). As DOA são doenças vulgarmente de natureza infeciosa ou tóxica, provocada por agentes que penetram no corpo ou através da ingestão de água e/ou géneros alimentícios (ASAE, 2014a, 2014b; WHO, 2015). São o resultado da ingestão de géneros alimentícios contaminados por microrganismos patogénicos ou produtos químicos, mas a contaminação

microbiológica é a responsável pela maioria das DOA que se tem observado ao longo dos anos (Silva & Martins, 2015; WHO, 2014).

Os géneros alimentícios podem ser contaminados em qualquer fase da cadeia alimentar, desde o processo de produção até ao consumo (“Do campo à mesa”), podendo ser contaminados por contaminação ambiental, através da água, solo ou ar (WHO, 2015). No caso dos géneros alimentícios serem contaminados pelos microrganismos estes podem provocar várias alterações superficiais ou profundas nos produtos diminuindo o seu tempo de conservação e a sua qualidade (sensorial, microbiológica e química) (Azevedo, 2009).

As doenças de origem alimentar podem ser classificadas em: infeções, intoxicações e toxinfeções alimentares.

As infeções alimentares surgem quando se ingere um alimento contaminado com um microrganismo patogénico que é capaz de se multiplicar no trato gastrointestinal. Os sintomas aparecem após um período de incubação, que se inicia na ingestão do alimento e pode durar horas, dias ou mesmos até semanas, pois o microrganismo necessita de tempo para se multiplicar e exercer a sua ação patogénica (ASAE, 2014b; Soares, 2007).

As intoxicações alimentares ocorrem quando se ingerem alimentos que contêm substâncias tóxicas (toxinas), libertadas pelos microrganismos (bactérias e fungos) durante a proliferação no alimento (ASAE, 2014a; Baptista & Antunes, 2005; Soares, 2007). As substâncias podem ter várias origens, como, o próprio alimento, microbiana e química. A origem no próprio alimento está relacionada em que determinadas condições alguns produtos vegetais (por exemplo batatas, tomate, etc.), animais (sobretudo alguns peixes) ou outros organismos (cogumelos venenosos), produzem toxinas que são ingeridas quando estes alimentos são consumidos. No entanto a origem microbiana pode estar ligada ao consumo de alimentos onde previamente cresceu um microrganismo que produziu toxinas, que acabam por ser ingeridas juntamente com o alimento, o agente patogénico pode, inclusivamente, ter desaparecido antes da ingestão do alimento, mas não as suas toxinas. A origem química pode acontece através do consumo prolongado de alimentos/água de consumo contaminados com tóxicos de origem química (como metais pesados ou das dioxinas), pode resultar numa

acumulação destes tóxicos, o que a médio/longo prazo pode desencadear diversas doenças dos foros oncológico, neurológico, entre outros. Geralmente, estes tóxicos são veiculados pela água, o ar, os solos, ou por materiais em contacto com os alimentos (ASAE, 2014b; Portal HACCP, 2015a).

As toxinfeções alimentares ocorrem aquando do crescimento do microrganismo no trato gastrointestinal e estão associadas à produção de toxinas. No entanto, o termo toxinfeção deve ser interpretado com alguma precaução pois, muitas vezes é utilizado para, genericamente, designar o conjunto das infeções e das intoxicações alimentares (ASAE, 2014a).

As Doenças de Origem Alimentar são, vulgarmente, causadas por microrganismos patogénicos. No entanto, também podem ser provocados por toxinas de origem não bacteriana (por exemplo as micotoxinas) e agentes não biológicos (como, poluentes e metais pesados). Os microrganismos patogénicos mais frequentes são: as bactérias, os vírus e parasitas, porém os principais agentes biológicos causadores de DOA são as bactérias, não só em número como em frequência (ASAE, 2014a).

Nas últimas décadas a *Salmonella* spp. é o microrganismo que tem provocado a maior parte dos casos de infeções alimentares, com origem na ingestão de ovos, animais de capoeira e outras carnes, leite cru e chocolate. No entanto, a prevalência de infeções por *Campylobacter jejuni* (presente em leite cru, animais de capoeira crus ou mal cozinhados, e em água de consumo) tem aumentado de tal forma nos últimos anos, que em alguns países chega a superar a *Salmonella* spp. As infeções com origem em *Listeria monocytogenes* (proveniente de leite cru, leite pasteurizado posteriormente contaminado, queijos, gelados e saladas), embora sejam de baixa incidência, tem sido motivo de preocupação uma vez que esta bactéria pode provocar danos severos ou mesmo fatais em bebés, crianças, mulheres grávidas, idosos e indivíduos imunodeprimidos. Acresce ainda o facto de esta bactéria conseguir crescer a temperaturas tão baixas como as de refrigeração (ASAE, 2014a; Portal HACCP, 2015a), tendo uma temperatura mínima de crescimento de -0,4ºC (Baptista & Linhares, 2005). No que diz respeito às intoxicações alimentares, *Clostridium perfringens* é um dos agentes mais frequentes na manifestação desta doença de origem alimentar. As intoxicações alimentares estão normalmente associadas a

bactérias como *Staphylococcus aureus ,Clostridium botulinum, Bacillus cereus, Yersinia enterocolitica* e *Escherichia coli*. Contudo, nos últimos anos as intoxicações provocadas por estas duas últimas bactérias têm-se tornado prevalentes (ASAE, 2014a; Portal HACCP, 2015a).

Géneros alimentícios não seguros são responsáveis por mais de 200 doenças, que podem ir desde uma gastroenterite até uma doença cancerígena, podendo levar a morte dos consumidores na pior das hipóteses (Silva & Martins, 2015; WHO, 2014). A apresentação clinica mais comum das doenças de origem alimentar assume um conjunto de sintomas gastrointestinais (diarreia, dor abdominal, vómitos e náuseas), no entanto essas doenças podem também assumir sintomas neurológicos, ginecológicos, imunológico entre outros. Os sintomas mais graves que pode tomar é a falência de múltiplos órgãos, cancro, e a morte dos indivíduos infetados (Quali, 2015a; Soares, 2007; WHO, 2015). Estes sintomas são também de outras doenças não alimentares, que pode levar a diagnósticos errados e conduzir a tratamentos inadequados (Quali, 2015a). No entanto estima-se que cerca de 30% da população dos países industrializados sofram destas doenças que matam cerca de 2 milhões de pessoas por ano, com mais casos de crianças com idades inferiores a 15 anos, devido à ingestão de água ou géneros alimentícios contaminados, esta situação é pior nos países em desenvolvimento (Marzano & Balzaretti, 2013; Silva & Martins, 2015; WHO, 2014). Porém as crianças não são o único grupo de risco a serem infetados por doenças de origem alimentar, entram neste grupo também mulheres grávidas, idosos e imunodeprimidos porque são particularmente vulneráveis as este tipo de doenças (WHO, 2014).

As crianças estão em elevado risco de serem afetadas por doenças de origem alimentar pois o seu sistema imunológico estar ainda em desenvolvimento e assim dificulta a capacidade de combater as infeções, terem menor peso corporal e assim a dose para os microrganismos infeta-los é menor, um controlo limitado na dieta e riscos de segurança alimentar e pela redução de produção de suco gástrico, diminuindo a capacidade delas matarem os microrganismos nocivos (Marzano & Balzaretti, 2013).

A Organização Mundial de Saúde definiu cinco chaves para uma alimentação mais segura, como regras de prevenção que permitem melhorar a segurança

dos géneros alimentícios e também contribuir para a prevenção da ocorrência de doenças de origem alimentar. As cinco chaves são manter a limpeza, separar alimentos crus de alimentos cozinhados, cozinhar bem os alimentos, manter os alimentos a temperaturas seguras e usar água e matérias-primas seguras (Amorim et al., 2008).

Na Tabela 4 são apresentados exemplos de procedimentos a seguir as cinco chaves para uma alimentação mais segura.

Tabela 4. Exemplos de procedimentos a seguir as Cinco Chaves para uma alimentação mais segura (Amorim et al., 2008).

As Cinco Chaves	Exemplos de procedimentos a seguir cada chave de forma a realizar uma alimentação mais segura
Manter a limpeza	• Lavar as mãos antes de iniciar a preparação dos alimentos e, frequentemente, durante todo o processo; • Lavar as mãos depois de ir à casa de banho; • Higienizar todos os equipamentos, superfícies e utensílios utilizados na preparação dos alimentos; • Protejer as áreas de preparação e os alimentos de insectos, pragas e outros animais.
Separar os alimentos crus dos alimentos cozinhados	• Separar carne e peixe crus de outros alimentos; • Utilizar diferentes equipamentos e utensílios, como facas ou tábuas de corte, para alimentos crus e alimentos cozinhados; • Guardar os alimentos em embalagens ou recipientes fechados, para que não haja contacto entre alimentos crus e alimentos cozinhados.
Cozinhar bem os alimentos	• Cozinhar bem os alimentos, especialmente carne, ovos e peixe; • As sopas e guisados devem ser cozinhados a temperaturas acima dos 70 ºC, usar um termómetro para confirmação. No caso das carnes, assegurar que os seus exsudados são claros e não avermelhados; • Se reaquecer alimentos já cozinhados assegurar que o processo é o adequado;
Manter os alimentos a temperaturas seguras	• Não deixar alimentos cozinhados, mais de 2 horas, à temperatura ambiente; • Refrigerar rapidamente os alimentos cozinhados e/ou perecíveis (preferencialmente abaixo de 5 ºC); • Manter os alimentos cozinhados quentes (acima de 60ºC) até ao momento de serem servidos;

	• Não armazenar alimentos durante muito tempo, mesmo que seja no frigorífico; • Não descongelar os alimentos à temperatura ambiente;
Usar água e matérias-primas seguras	• Usar água potável ou trata-la para que se torne segura; • Seleccionar alimentos variados e frescos; • Escolher alimentos processados de forma segura, como o leite pasteurizado; • Lavar frutas e vegetais, especialmente se forem comidos crus; • Não usar alimentos com o prazo de validade expirado.

1.3.1 Fatores de risco para a origem das doenças de origem alimentar

Nos últimos tempos tem-se verificado um aumento das DOA e por consequente os problemas relacionados com a segurança alimentar ganharam uma importância global.

A vigilância epidemiológica tem evidenciado um aumento constante da prevalência das DOA (Baptista & Antunes, 2005). Os fatores de risco mais frequentes que originam a multiplicação microbiana e que contribuem para as doenças de origem alimentar na restauração são (EFSA, 2014; Osimani et al., 2013):

- Binómio tempo/temperatura inadequados;
- Higienização inadequada
- Manipulação inadequada;
- Arrefecimento incorreto;
- Temperatura inadequada durante a manutenção a quente;
- Refrigeração imprópria;
- Contaminação cruzada
- Manipulador infetado.

1.3.2 Indicadores de higiene

A expressão microrganismos indicadores pode ser aplicado a qualquer grupo taxonómico, fisiológico ou ecológico de microrganismos, caso estes estejam presente ou ausentes fornecem evidência indireta, referente a uma característica própria do passado da amostra (Forsyth, 2001; Jay, Loessner, & Golden, 2005). Os microrganismos indicadores de higiene são úteis na avaliação da segurança dos géneros alimentícios, porque tendem a estar presentes em maior número do que a maioria dos microrganismos patógenicos e são relativamente rápidos e fáceis de identificar (Bolton et al., 2009). Através das análises microbiológicas, os indicadores de higiene podem fornecer informação sobre a ocorrência de contaminações de origem fecal, sobre a provável presença de patogénicos ou sobre a deterioração e/ou rápida alteração/ deterioração da qualidade organolética dos géneros alimentícios, contaminação inicial das matérias-primas, mas são mais frequentemente usados para avaliar os níveis de higiene, segurança e qualidade em que os géneros alimentícios foram processados, armazenados e assim aumentam a confiança do consumidor (Montvill & Matthews, 2008). A presença de microrganismos indicadores de higiene em alimentos prontos para consumo, podem indicar que existiram uma qualidade deficitária das matérias-primas ou componentes dos géneros alimentícios, contaminação cruzada, limpeza e higienização inadequadas e binómino tempo/temperatura inadequado (Bolton et al., 2009). Os indicadores de higiene utilizados neste estudo foram microrganismos a 30º, Coliformes totais, *E.coli*, *Staphylococcus aureus* e *Enterobacteriaceae*.

Microrganismos Totais a 30ºC

A contagem de microrganismos totais a 30ºC surge como indicador do nível de higiene global dos géneros alimentícios do estabelecimento bem como as condições de higiene e cuidados durante produção até a distribuição, mas também pode ser um indicador do nível de contaminação da matéria-prima recebida (Biomerieux Industry, 2014).

Enterobacteriaceae

Enterobacteriaceae é uma família de bactérias gram-negativas não formadoras de esporos, muito abundante incluindo uma variedade de bactérias patogénicas, anaeróbias facultativas, geralmente catalase-positiva e usualmente tem a capacidade de reduzir o nitrato a nitrito (Baylis, Uyttendaele, Joosten, & Davies, 2011; Biomerieux Industry, 2014). Esta família inclui uma série de agentes patogénicos alimentares importantes, como a *Salmonella* spp., *Yersinia enterocolitica*, *Escherichia coli* patogénica (incluindo *E. coli* O157: H7), *Shigella* spp. e *Cronobacter* spp. (Baylis et al., 2011).

Enterobacteriaceae é um indicador de contaminação fecal de origem humana ou animal (fazem parte da flora intestinal do homem e animais), de contaminação ambiental (solo, poeira, água, insetos) e de equipamento contaminado. Assim a deteção destas bactérias permite avaliar a qualidade do género alimentício e as condições de higiene durante o processamento (Biomerieux Industry, 2014; Bolton et al., 2009).

Os membros da família da *Enterobacteriaceae* são responsáveis por causar doenças de origem alimentar e alguns também podem causar a deterioração dos géneros alimentícios contribuindo para perdas económicas substanciais e desperdício destes. O nível inicial de contaminação destas bactérias nas matérias-primas podem ser prevenidas pela existência de boas práticas agrícolas durante a produção primária e, posteriormente, durante o abate dos animais ao matadouro. Ao longo da cadeia de alimentar, contaminação por *Enterobacteriaceae*, incluindo patogénicos, deve ser prevenida ou controlada pela aplicação do HACCP e pelas boas práticas de fabrico (Baylis et al., 2011).

Coliformes *e E.coli*

Coliformes são bactérias anaeróbicas facultativas gram-negativas, que fermentam a lactose com formação de gás e estão presentes no intestino do homem, animais de sangue quente, solo e plantas. O grupo dos coliformes inclui espécies do género *Escherichia* spp., *Klebsiella* spp., *Enterobacter* spp. e *Citrobacter* spp. Os coliformes foram historicamente utilizadas como microrganismos indicadores de contaminação fecal. Os coliformes fecais

incluindo *E. coli*, são facilmente destruídos pelo calor e podem morrer durante a congelação e armazenamento de alimentos congelados (Forsyth, 2001; Montvill & Matthews, 2008).

As contagens de coliformes podem ser úteis para testar a contaminação pós-processamento, em que as fontes de contaminação podem ser: mãos dos manipuladores devido a higienização incorreta, matéria-prima contaminada com dejetos, contaminação cruzada, insetos, temperatura de processamento inadequada, utensílios e equipamentos contaminados. O microrganismo mais importante deste grupo é a *Escherichia coli*, que é considerado o melhor indicador de contaminação fecal de géneros alimentícios, uma contaminação com este microrganismo implica um risco de que outros agentes patogénicos entéricos podem também estar presentes. A presença de *E. coli* em alimentos processados termicamente significa que o processamento foi inadequado, mais comumente, a contaminação pós-processamento (Montvill & Matthews, 2008).

Os coliformes e a *E.coli* tem baixa especificidade visto se podem proliferar no meio ambiente e fixar-se à superfície dos equipamentos (Ramos, 2008).

Staphylococcus aureus

Staphylococcus aureus são cocos, gram-positivos, apresentando-se geralmente em cachos, imóveis, anaeróbios facultativos, mesófilos e facilmente destruídos pelo calor. Este microrganismo permite verificar as condições de higiene das instalações de géneros alimentícios e de bebidas a fim de garantir a segurança dos consumidores (Portal HACCP, 2015b; Merck Millipore, 2015).

O *S. aureus* encontra-se na pele e nas mucosas nasais dos seres humanos e dos animais, sendo uma causa frequente de intoxicação alimentar, assim é um indicador ideal para avaliar a qualidade de normas de higiene seguidas pelos manipuladores envolvidos na produção de géneros alimentícios ou bebidas.

Uma das razões para a patogenicidade facultativa de *S. aureus* é a sua capacidade para formar enterotoxinas (SET), que podem se acumular na comida contaminada e podem não ser totalmente inactivadas por tratamento térmico. Quase sempre as contaminações de produtos alimentares com *S. aureus* são causados por seres humanos (pelas mãos, espirros, tosse), portanto é

considerado como indicador de má higiene pessoal (Portal HACCP, 2015b; Merck Millipore, 2015; r-biopharm, 2015). No entanto a fonte de contaminação de genéros alimentícios por *S. aureus* pode também ser através de animais, equipamentos e superfícies ambientais (FDA, 2014).

1.3.3 Incidência na Europa e em Portugal

Na Tabela 5 são apresentados os dados de surtos alimentares ocorridos na Europa em cantinas de escolas e jardins-de-infância entre 2006 e 2013, disponibilizados pela EFSA.

Tabela 5. % de surtos ocorridos em escolas/jardins-de- infância entre 2006 e 2013 (EFSA, 2007, 2009, 2010, 2011, 2012, 2013, 2014, 2015).

Anos	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
% de surtos em escolas/ jardins e infância	6,2 %	8,0 %	5,3%	5,5 %	6,7 %	4,4 %	6,3 %	8,3 %

No ano de 2005, os surtos ainda não estavam discriminados por escolas e jardins-de-infância, mas neste ano 30% dos surtos ocorreram em escolas e lar de idosos. Pela Tabela 5 pode-se observar que o ano de 2011 foi o ano com menor % de surtos em escolas/jardins-de-infância e 2013 foi o que apresentou mais % de surtos.

A *Salmonella* e o Calicivírus foram responsáveis por surtos entre 2006 e 2010, no entanto a *Salmonella* também causou surtos em 2012. Dos 12,7% de surtos de *Clostridium perfringens*, 9,5% ocorreram em cantinas escolares e 3,2% em jardins-de-infância.

Em 2006 ocorreram 46 surtos de toxinas bacterianas em escolas/ jardins-de-infância, sendo em média 24 casos por surto (EFSA, 2007).

Tabela 6. % de surtos ocorridos em escolas/jardins-de- infância entre 2006 e 2012 de acordo com o microrganismo (EFSA, 2007, 2009, 2010, 2011, 2012, 2013, 2014).

Fonte	2006	2007	2008	2009	2010	2011	2012
Salmonella	Menos comuns	3,2 %	4,1 %	3,7 %	6,4 %		5,2 %
Clostridium perferingens	12,7 %						
Calicivirus	6,1 %	7,5 %	6,7 %	14 %	10,7 %		
Campylobacter		6,9 %	4,8 %	37,3 %			
Toxinas bacterianas	19,9 %	11,4 %					
E.coli		8,3					
Toxinas Staphylococcus						8,6 %	

Nos relatórios da European Food Safety Authority (EFSA) na União Europeia, estão descritos alguns surtos em escolas/jardins-de-infância. No ano de 2005 ocorreu um surto de *Clostridium perfringens* numa escola na Suíça, que atingiu 200 alunos. Sendo a principais causas a má manipulação dos alimentos e carne mista. Na Eslovénia ocorreu um surto de Calicivírus, que atingiu 95 pessoas (EFSA, 2007).

Em 2006 os surtos de *Salmonella* nestas instituições foram menos comuns. Em Portugal ocorreu um surto de *E.coli*, que afetou 25 pessoas e a causa foram sandwiches com carne cozida, que foram servidas num piquenique escolar. Na Finlândia surgiu um surto de *Yersinia* no verão, em escolas e jardins-de-infância, que atingiu 502 pessoas, sendo a causa cenoura ralada que foi servida nestas instituições (EFSA, 2007). Em 2008 dos surtos em ambiente escolar um ocorreu na Finlândia, sendo a principal causa cenoura ralada e a fonte a *Yersinia* (EFSA, 2010).

No ano de 2007, na Letónia ocorreu um surto de *Shigella* spp.,numa escola/jardim-de-infância, que afetou 19 pessoas, em que 17 foram hospitalizados. Outro surto ocorreu na França em que a causa foi ervas e especiarias, com 146 casos e a fonte foi *Baccillus cereus (*EFSA, 2009*)*.

Um surto numa escola na Finlândia em 2009, afetou 550 pessoas na maioria jovens e crianças. A causa foram framboesas usadas em pequenos-almoços, sobremesas e produtos de confeitaria fina (ex: bolos de camadas) que não foram tratados termicamente e a fonte foi o Calicivírus (EFSA, 2011).

Dos surtos que ocorreram em ambiente escolar em 2010 um ocorreu em Poitiers, França, tendo como fonte a *Salmonella* entérica (serotipo 4,5,12:i:). As investigações realizadas identificaram como a causa a carne de hambúrguer congelada de uma única marca servida nas escolas. Foram identificados um total de 554 casos, sendo 544 adolescentes e 10 adultos (EFSA, 2012).

Em 2012 ocorreu um surto de vírus numa escola/jardim-de-infância na Alemanha, afetando 10950 pessoas mas apenas houve 38 hospitalizações, em que a causa foi associada com um lote de morangos congelados da China distribuídos por uma empresa de *catering.* Na Grécia, ocorreu um surto de Calicivírus (incluindo norovirus) numa escola primária, que afetou 79 pessoas (EFSA, 2014).

Em 2014 foi o ano em que mais pessoas afetadas por intoxicações alimentares foram investigadas no Instituto de Saúde Ricardo Jorge (INSA). Neste ano quase metade de intoxicações alimentares investigadas pelo INSA ocorreram em escolas pois dos 25 surtos investigados 11 ocorreram em escolas (Viegas et al., 2015).

Ao longo dos anos a origem e as causas das infeções, intoxicações e toxinfeções provocadas por microrganismos patogénicos, tem sido amplamente estudadas, visto que constituem um problema de saúde pública cuja magnitude é elevada, embora o conhecimento da situação seja inferior à realidade.

1.4. Objetivos

A implementação de um sistema de segurança alimentar é de suma importância para garantir um elevado nível de proteção do consumidor em matéria de segurança dos géneros alimentícios. As cantinas escolares, estabelecimentos de restauração coletiva que fornecem refeições a um dos grupos mais suscetíveis de serem alvo de doenças de origem alimentar, crianças e adolescentes, tem de ser permanentemente controladas as condições de higiene e segurança alimentar implementadas.

Esta Dissertação desenvolvida no âmbito do Mestrado em Gestão da Qualidade e Segurança Alimentar teve dois objectivos:

1. Dar seguimento a um trabalho já previamente efetuado pela Unidade de Microbiologia Aplicada da Escola Superior de Tecnologia e Gestão em 2007 de verificação do cumprimento dos requisitos legais e regulamentares em matéria de higiene e segurança alimentar, de 45 cantinas escolares do Município de Viana do Castelo. Neste trabalho devido a restrições temporais apenas 17 das cantinas inicialmente avaliadas foram novamente alvo de estudo ao nível da avaliação das condições higio-sanitárias.
2. Verificar a existência de uma correlação entre o nível de conhecimentos ao nível das questões de higiene e segurança alimentar (HSA), os hábitos dos manipuladores e os resultados microbiológicos dos operadores, superfícies e equipamentos em 26 cantinas escolares de vários níveis de ensino.

Referências bibliográficas

AESBUC. (2014). O Essencial do HACCP. Acedido a 27 de Dezembro, 2014, disponível em: http://max.uma.pt/~a2050202/Guias%20Normas/guiabolso_HACCP.pdf.

Afonso, A. (2006). Metodologia HACCP - Prevenir os acidentes alimentares. Segurança e Qualidade Alimentar 1, 12-15.

Afonso, A. (2008). Análises de perigos - Identificação dos perigos e avaliação dos riscos para a segurança alimentar. Segurança e Qualidade Alimentar, 5.

Amorim, J., & Novais, M. R. (2006). Guia para o Controlo da Segurança Alimentar em Restaurantes Europeus (pp. 13). Lisboa: INSA.

Amorim, J., Novais, M. R., Correia, M. J. F., & (2008). Cinco Chaves para uma Alimentação mais Segura (INSA Ed.).

ASAE. (2014a). Doenças de Origem Alimentar. Acedido a 30 de Março, 2015, disponível em: http://www.asae.pt/.

ASAE. (2014b). HACCP - O que é. Acedido a 6 de Maio, 2015, disponível em: http://www.asae.pt/pagina.aspx?f=1&back=1&codigoms=0&codigono=57995855AAAAAAAAAAAAAAAA&back=1&chave=Haccp&tema=&advance=.

ASAE. (2015). Perigos de Origem Alimentar. Acedido a 12 de Maio, 2015, disponível em: http://www.asae.pt/?cn=59605963AAAAAAAAAAAAAAAA.

Azevedo, R. T. (2009). Higiene e Segurança Alimentar: o que significa? Qual a sua aplicação? Acedido a 2 de Abril 2015, disponível em: http://naturlink.sapo.pt/Natureza-e-Ambiente/Interessante/content/Higiene-e-Seguranca-Alimentar-o-que-significa-Qual-a-sua-aplicacao/section/4?bl=1.

Baptista, P., & Antunes, C. (2005). Higiene e Segurança Alimentar na Restauração (Vol. 2, pp. 10, 11, 13, 14, 28, 29, 40, 41, 42, 43, 44). Forvisão, Guimarães.

Baptista, P., & Linhares, M. (2005). Higiene e Segurança Alimentar na Restauração (1ª ed., Vol. 1, pp. 11, 12, 21, 22, 26). Forvisão, Guimarães.

Baptista, P., Pinheiro, G., & Alves, P. (2003). Sistemas de Gestão de Segurança Alimentar (1ª ed., pp. 35, 36). Forvisão, Guimarães.

Baptista, P., & Saraiva, J. (2003). Higiene Pessoal na Indústria Alimentar (1ª ed., pp. 5). Forvisão, Guimarães.

Baptista, P., & Venâncio, A. (2003). Os Perigos para a Segurança Alimentar no Processamento de Alimentos (1º ed.). Forvisão, Guimarães.

Baylis, C., Uyttendaele, M., Joosten, H., & Davies, A. (2011). Introduction, Changes in Taxonomy and *Enterobacteriaceae* and their role an Indicator and Index Organism Foods The *Enterobacteriaceace* and their Significance to the Food Industry (pp. 5-10), ILSI Europe.

Biomerieux Industry. (2014). Hygiene Indicators in Food Microbiology Acedido a 22 Maio, 2015, disponível em: file:///C:/Users/Utilizador/Downloads/Focus_Hygiene_indicators_Food_Microbiology_June2014%20(3).pdf.

Bolton, D., & Maunsell, B. (2004). Guidelines for food safety control in European restaurants. Ashtown Dublin, Republic of Ireland: The Food Safety Departmant, Teagasc, The National Food Centre.

Bolton, E., Little, C., Aird, H., Greenwood, M., McLauchlin, J., Meldrum, R., . . . Grant, K. (2009). Hygiene Indicator Organisms. In H. P. Agency (Ed.), Guidelines for Assessing the Microbiological Safety of Ready-to-Eat Foods Placed on the Market (pp. 12).

Codex Alimentarius (2003). Recommended International Code of Practice General Principles of Food Hygiene. Codex Alimentarius Commission (CAC). CAC/RCP 1-1969, Rev. 4-2003.

Decreto-lei 306 de 2007. Qualidade de água destinada ao consumo humano.

EFSA (2007). The Community Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents, Antimicrobial Resistance and Foodborne Outbreaks in the European Union in 2006: EFSA Journal 2007, (pp. 251, 254, 259, 261, 264.)

EFSA (2009). The community summary report - Food-borne outbreaks in the European Union in 2007: EFSA Journal 2007, (pp. 24,37,40,48,50,56,64,66,75,79,88,91).

EFSA (2010). The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2008: EFSA Journal 2010, (pp. 243, 251, 254, 256, 259, 269).

EFSA (2011). The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2009: EFSA Journal 2011, (pp. 270, 281, 282, 297).

EFSA (2012). The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2010: EFSA Journal 2012, (pp. 325, 330, 338, 352, 355, 356, 361).

EFSA (2013). The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2011: EFSA Journal 2013, (pp. 202, 204, 228).

EFSA (2014). The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2012: EFSA Journal 2014, (pp. 263, 264, 273, 282, 288, 293, 298).

EFSA (2015). The European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in 2013: EFSA Journal 2015, (pp. 125, 131, 133).

FAO (1997). Hazard Analysis and Critical Control Point (HACCP) system and guidelines for its application. Acedido a 13 de Abril, 2015.

FDA (2014). *Staphylococcus aureus*. Acedido a a 5 de Maio 2015, disponível em: http://www.fda.gov/Food/FoodborneIllnessContaminants/CausesOfIllnessBadBugBook/ucm070015.htm

Forsyth, S. J. (2001). Food Poisoning Microorganisms. In Blackwell (Ed.), The Microbiology of Safe food (1ª ed.). Nova Iorque, EUA.

FQA, & DCTA/ESAC. (2002). HACCP - Manual de Formação.

INSA (2008). Cinco chaves para uma alimentação mais segura (pp. 4,11). Disponível em: http://www.insa.pt/sites/INSA/Portugues/Publicacoes/Outros/Paginas/CincoChavesparaumaAlimentacaomaisSegura-ManualdeFormacao.aspx.

Jay, J. M., Loessner, M. J., & Golden, D. A. (2005). Indicators of Food Microbial Quality and Safety. In Springer (Ed.), Modern Food Microbiology (7ª ed.). Nova Iorque, EUA.

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. (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.

Merck Millipore. (2015). Cultivation of *Staphylococcus aureus*. Acedido a 22 de Maio, 2015, disponível em: http://www.merckmillipore.com/PT/en/products/industrial-microbiology/indicator-organisms-for-food-and-beverage-industry/staphylococcus-aureus/_Vub.qB..NoAAAFDQ8dUTxI8,nav.

Montvill, T. J., & Matthews, K. R. (2008). Indicator Microorganisms and Microbiological Criteria. In A. Press (Ed.), Food Microbiology: An Introduction (pp. 77 - 83). Washington, USA.

Novais, M. R. (2006). Noções gerais de Higiene e Segurança Aliemntar - boas práticas e pré-requisitos HACCP. Segurança e Qualidade Alimentar, 1 (pp. 10,11).

NP EN ISO 19011. (2012). Linhas de orientação para auditorias a sistemas de gestão.

Oliveira, B. (2007). Qualidade e Segurança Alimentar na Restauração Coletiva - Vantagens do Sistema HACCP. Segurança E Qualidade Alimentar 2.

Osimani, A., Aquilanti, L., Tavoletti, S., & Clementi, F. (2013). Evaluation of the HACCP System in a University Canteen: Microbiological Monitoring and Internal

Auditing as Verification Tools. International Journal of Environmental Research and Public Health, 10 (4), 1572-1585.

Portal HACCP (2015a). Doenças de Origem Alimentar. Acedido a 22 de Maio, 2015, disponível em: http://www.segurancalimentar.com/conteudos.php?id=30.

Portal HACCP (2015b). *Staphylococcus aureus*. Acedido a 22 de Maio, 2015, disponível em: http://www.segurancalimentar.com/conteudos.php?id=228.

Quali (2015a). Doenças de origem alimentar. Acedido a 13 de Abril, 2015, disponível em: http://www.quali.pt/seguranca-alimentar/204-doencas-origem-alimentar.

Quali (2015b). Perigos Alimentares. Acedido a 19 de Maio, 2015, disponível em: http://www.quali.pt/seguranca-alimentar/206-perigos-alimentares.

Quali (2015c). Pincípios Gerais do HACCP. Acedido a 23 de Março, 2015, disponível em: http://www.quali.pt/haccp/221-principios-gerais.

Quali (2015d). Segurança Alimentar. Acedido a 12 de Março, 2015, disponível em: http://www.quali.pt/seguranca-alimentar/212-seguranca-alimentar.

Quali (2015e). Segurança Alimentar em Portugal e na Europa. Acedido a 10 de Maio, 2015, disponível em: http://www.quali.pt/haccp/225-seguranca-alimentar-portugal-europa.

r-biopharm (2015). Compact Dry X-SA. Acedido a 22 de Maio, 2015, disponível em:http://www.r-biopharm.com/products/food-feed-analysis/microbiology-hygiene/staphylococcus-aureus/item/compact-dry-x-sa.

Ramos, A. (2008). Análise da Qualidade Microbiológica de Alimentos Prontos a Comer. Acedido a 21 de Maio, 2015, disponível em: http://pt.slideshare.net/tonyeu/apresentao-estagio-2008-2956370.

Santos, M. J., Nogueira, J. R., Patarata, L., & Mayan, O. (2008). Knowledge levels of food handlers in Portuguese school canteens and their self-reported behaviour towards food safety. International Journal of Environmental Health Research, 18(6), 387-401.

Silva, R., & Martins, C. (2015). Segurança Alimentar - Revista da Indústria Alimentar - Tecnoalimentar, 2.

Soares, E. (2007). Doenças de Origem Alimentar: infeções e intoxicações. Segurança e Qualidade Alimentar 2.

Soares, K., Garcia-Diez, J., Esteves, A., Oliveira, I., & Saraiva, C. (2013). Evaluation of food safety training on hygienic conditions in food establishments. Food Control, 34(2), 613-618.

Vaz, A., Moreira, R., & Hogg, T. (2000). Introdução ao HACCP (pp. 6, 8-22).

Viegas, S., Cunha, I. C., Correia, C. B., Sousa, R., Bonito, C. C., A., C., . . . Calhau, M. A. (2015). Investigação laboratorial de surtos de toxinfeções alimentares, 2014 (Vol. 5, pp. 4, 5, 6): Instituto Nacional de Saúde Doutor Ricardo Jorge, IP.

WHO (2014). Food safety. Acedido a 25 de Março, 2015, disponível em: http://www.who.int/mediacentre/factsheets/fs399/en/.

WHO (2015). Foodborne diseases. Acedido a 10 de Março, 2015, disponível em: http://www.who.int/topics/foodborne_diseases/en/.

2. Desenvolvimento Experimental

2.1. Hygiene Sanitary Assessment in Viana do Castelo`s school canteens

Abstract

School canteens are intended for a population and age group in which nutritional balance is critical and must follow strict hygiene and food safety criteria in order to prevent the potential occurrence of foodborne diseases.

The objective of this study was to assess the hygiene/sanitation and food safety conditions in canteens of primary schools and kindergartens in the municipality of Viana do Castelo, Portugal, in two distinct periods.

This cross-sectional descriptive study was carried out in 17 school canteens. The sampling instrument used throughout the audits was a checklist, based on Portuguese and European legislation. Following the application of the checklist, the results were transformed into “conformities”, “non-conformities” and “not applicable”.

The application of the checklist in canteens achieved a compliance rate ranging from 47% to 67% in 2007, a rate that increased in 2014, when the compliance percentage recorded ranged from 62% to 80%. While in 2007 the hygiene and food safety conditions were described as being “acceptable” and “not acceptable”, in 2014 they were considered to be “acceptable” and “good”. It can be concluded that over this 7-year period there was a positive evolution in school canteens regarding hygiene and food safety. However, there are still major non-conformities to be corrected. The increase of hygiene and food safety standards and the elimination of the existing non-conformities can only be achieved with the help and commitment of schools and fund managers.

Keywords: Hygiene and food safety, school canteens, HACCP, foodborne outbreaks

1. Introduction

In recent years, food safety has become one of the most worrying and impacting issues on public opinion, as consumers expect to have assurances that the food they consume is safe (Osimani, Aquilanti, Tavoletti, & Clementi, 2013). According to *Codex Alimentarius*, food safety should guarantee that food will not cause harm to the consumer (provided it is prepared or eaten according to its intended use) and is intrinsically linked to food hygiene (*Codex Alimentarius*, 2003).

Thus, due to the enormous amount of meals served in schools, hospitals, companies and nursing homes canteens, food safety is essential in collective catering establishments, (Osimani et al., 2013; Veiros, Proenca, Santos, Kent-Smith, & Rocha, 2009).

Because children are considered to be one of the main risk groups, it is important to control the safety conditions of production and distribution processes of the food being catered to them. If there is structural failure, lack of knowledge or bad hygiene practices by food handlers, there is a high probability that serious foodborne outbreaks might occur (M. J. Santos, Nogueira, Patarata, & Mayan, 2008; Veiros et al., 2009).

Between 1998 and 2008, the Center for Disease Control (CDC) in the United States received reports of 13,405 foodborne outbreaks, which resulted in 273,120 reported cases, 9,109 hospitalizations and 200 deaths. Of these 13,405 outbreaks, 286 occurred within the school environment, resulting in 17,266 cases (Hannah Gould,L. 2013).

In 2005, according to the European Food Safety Authority (EFSA), 30% of foodborne diseases in the European Union occurred in schools and nursing homes (EFSA, 2007b). From 2006 it was possible to differentiate those that had occurred only in schools and kindergartens. Between 2006 and 2013 the percentage of outbreaks occurring in schools and kindergartens varied between a minimum of 4.4% (2011) and a maximum of 8.3% (2013) (EFSA, 2007a, 2009, 2010, 2011, 2012, 2013, 2014, 2015). Regarding the microorganisms associated with the outbreaks reported, it was found that the *Salmonella* spp. and Calicivirus were responsible for outbreaks in 2006, 2007, 2008, 2009 and 2010 (EFSA, 2007a, 2009, 2010, 2011). In 2012 *Salmonella* spp., Virus and Calicivirus were

the microorganisms responsible for outbreaks in schools and kindergartens (EFSA, 2014). *Campylobacter* spp. is linked to foodborne outbreaks in 2007, 2008 and 2009 (EFSA, 2009, 2010, 2011). Bacterial toxins produced by certain microorganisms have also been responsible for outbreaks in schools, namely *Clostridium perfringens* in 2006, *Staphylococcu*s spp. in 2006, 2007, 2011 and 2013 and *Bacillus spp.* in 2007 and 2013 (EFSA 2007a, 2009, 2013, 2015).

The application of HACCP system prerequisites is a practice available and optimized since 2004 through the application of regulation 852/2004 of the EU. One of the most commonly used methods for checking the conformity of legal and regulatory requirements on hygiene and food safety is the use of checklists based on current legislation and the requirements set out in the *Codex Alimentarius* (Osimani et al., 2013). This method was already used in several studies where focus was put on the evaluation of hygiene/sanitation conditions of facilities, equipment and handling procedures in school canteens (Barros, Lameiras, & Rocha, 2008; Rodriguez-Caturla et al., 2012; M. J. d. O. Santos, Nogueira, & Mayan, 2007; Toth & Bittsanszky, 2014) and colleges (Osimani et al., 2013; Veiros et al., 2009).

The aim of this study was to evaluate the evolution of hygiene and food safety conditions in elementary schools and kindergartens' canteens in the municipality of Viana do Castelo, Portugal, in two distinct time periods, separated by 7 years.

2. Material and Methods

A cross-sectional descriptive study was conducted in 17 primary school and kindergarten canteens in the municipality of Viana do Castelo, Portugal. The data was collected in two phases (both during the preparation of meals): the first phase took place between June and November 2007 and the second phase between September and November 2014.

2.1. Data collection instrument:

Based on *Codex Alimentarius*, in Regulation (CE) nº 852/2004, we used a checklist for assessing the hygiene and food safety conditions in school canteens.

This checklist has been widely applied in the context of the IQA Project (IQA, 2009) (Annex1).

On average, the visits to the canteens went on for about 90 minutes. The checklist was filled in based on visual observation and interviews that were conducted with food handlers.

The checklist inclued 102 items, that were grouped into personal hygiene, toilets/changing rooms for food handlers, the reception of raw materials, storage of raw materials and finished products, work areas, pest control, sanitation, waste, personnel and records.

2.2. Data analysis:

The results of the application of the checklist have been converted into “compliance” (when the requirements -items- were fulfilled) and “non-conformities” (when the requirements -items- were not fulfilled). If the item was not applicable to the situation in question, it was considered to be “not applicable”. Based on the data, the percentage of non-conformities was calculated for each item, theme and school by using the ratio of the number of schools in non-compliance and the total number of schools (excluding all not applicable records).

3. Results and Discussion

By using the checklist in canteens, in 2007 we achieved a compliance percentage that ranged from 47% to 67%. In 2014, there was an increase in the number of compliances, ranging from 62% to 80%. In this study, we used the scaling suggested by Veiros et al. (2009) as reference, i.e., the relation to compliance percentage of a school was considered to be very good if it was ≥ 90%, good if it ranged from ≥75% to <90%, acceptable from ≥50 % to <75% and not acceptable if it was <50%. In 2007, three school canteens were considered not acceptable in terms of hygiene and food safety and 14 were considered acceptable. In 2014, there were positive developments, as 10 schools were classified as acceptable and 7 were considered good. In similar studies, Veiros et al. (2009) obtained a 62% compliance percentage when evaluating a university canteen; Santos et al.

(2007) obtained an average of 62.8% when assessing the hygiene/sanitary conditions of 32 school canteens; and Barros et al. (2008) obtained a 68.4% compliance percentage when they studied the hygiene/sanitary conditions of 40 canteens. Osimani et al. (2013) obtained a variation between 92% and 96% when they evaluated a university canteen over a period of five years and Toth et al. (2014) recorded an average of 68% when they assessed 68 school kitchens. Based on the data, it can infered that in relation to the scale used in this study and suggested by Vieiros et al. (2009), almost all audited canteens in these studies have an acceptable compliance percentage (≥ 50% and 75%), while the canteen studied by Osimani et al. (2013) was considered to be very good (with a compliance rate ≥ 90%). These results will help frame the subsequent data obtained from the 17 school canteens in the municipality of Viana do Castelo in 2014.

The results obtained through the application of the checklist in the schools audited within this study are presented in Figure 1. It can be observed that from 2007 to 2014 there has been a decrease in the percentage of non-conformities recorded in the 17 schools. In 2007, school no. 8 was one of the schools with the highest percentage of non-conformities, whereas in 2014 that number was cut down to half. Schools no. 1 and 14 were the ones in which a lower decrease in the number of non-compliance was registered, only about 5% from 2007 to 2014.

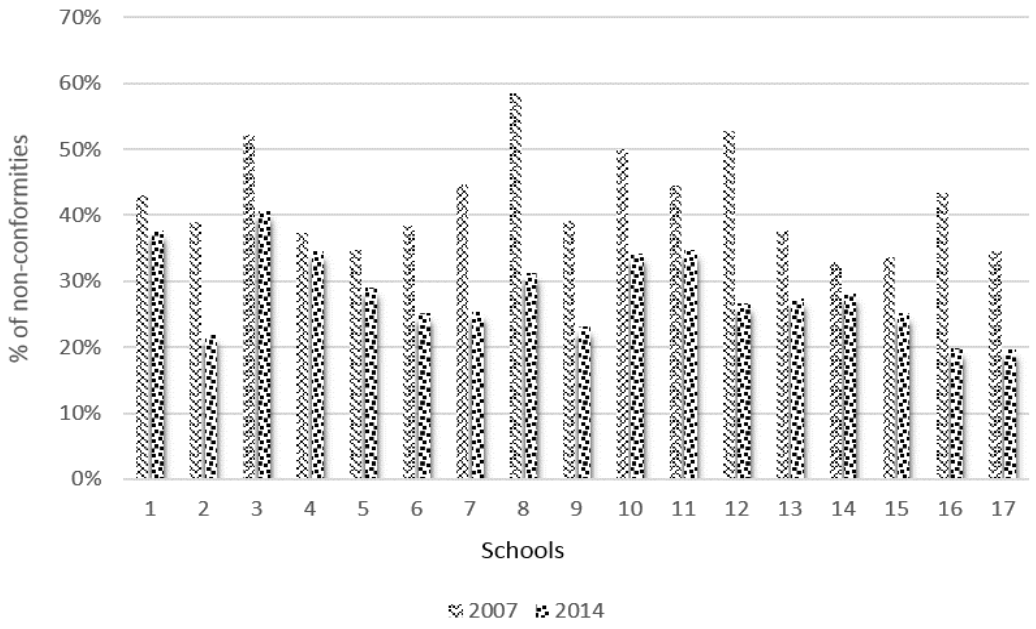

Figure 1. Percentage of non-conformities found in schools.

3.1. Personal hygiene and health, toilets/changing rooms for food handlers

Food safety is largely dependent on personal hygiene and the health of food handlers, as this is one of the main factors to be taken into account when preventing the occurrence of food poisoning. The main sources of contamination of foodstuffs usually lie in the following factors: the health of food handlers, their personal hygiene, the use of inadequate clothing and unprofessional practices and negligent conduct. The toilets and changing rooms for food handlers should be separated by gender and handlers must be provided with the appropriate equipment to reduce cross-contamination.

In Figure 2 we present the results for each of the criteria analyzed concerning the personal hygiene and health of food handlers (Figure 2a), as well as the available sanitary facilities/staff locker rooms (Figure 2b).

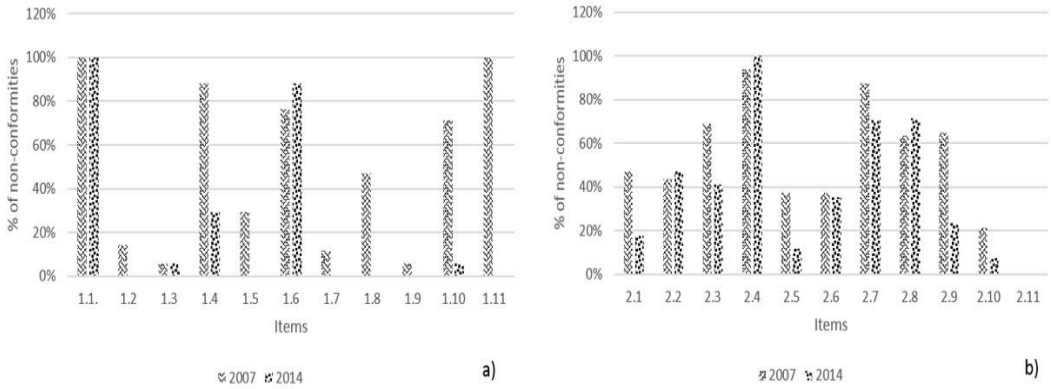

Figure 2. Percentage of non-conformities (a) personal hygiene and health of food handlers and (b) sanitary facilities/staff locker room.

Both in 2007 and in 2014 there were canteens in Viana do Castelo that did not have medical fitness certificates for handlers (item 1.1). The use of accessories (1.4), which can be associated with the risk of having handlers releasing and contaminating food products, has significantly decreased from 88% to 29%. This situation was also observed by Osimani et al. (2013), who also found that, over the years, the use of accessories and ornaments decreased to the point that, in recent years, the handlers no longer use them. All visitors must wear protective

clothing before entering the reception, storage and preparation areas (1.10), and follow the rules applicable to food handlers. It should be noted that in 2014, only one school allowed visitors without enforcing these rules. This situation could have easily been avoided, as all canteens have special kits for all of those visiting the facilities and who are not food handlers. In 47% of the audited canteens, the overall state of cleanliness and tidiness of toilets/locker rooms (2.1) was considered to be inappropriate, a number that decreased to 18% in 2014. Other problems that persist in canteens have to do with the lack of disinfectant liquid soap (2.3) and the absence of appropriate devices for drying hands (2.5) and waste disposal (2.6). In addition, there are also no nailbrushes (2.7), and individual lockers are not properly identified and closed (2.9) with personal objects often being placed outside the lockers (2.10). Despite the fact that the percentage of non-conformities in these cases has decreased, in some canteens one can still find similar situations, meaning that, there is still work to be done regarding these items. Situations involving objects placed outside lockers were also observed by Veiros et al. (2009). In this study, the authors found that in canteens where there were no lockers available for staff, personal objects were kept on hangers or even on top of chairs, or any other places that would serve this purpose. In 2007, 69% of the canteens did not have disinfectant liquid dispensers (2.3). However, in 2014, that percentage was lower, with 41% of canteens having been reported as having this problem. A similar situation was also identified in other studies (Santos et al., 2007; Barros et al., 2008; and by Veiros et al., 2009). The lack of adequate devices for hand drying and washing was also found in canteens of schools in the Vila Real district (M. J. Santos et al., 2008) and in a university canteen (Veiros et al., 2009). In 2014, there was an increase in the percentage of non-compliance of some of items on the checklist, i.e., in some canteens there was a shift regarding the implementation of best practices in specific procedures, leading to this increase. Food handlers must not wear work clothing and footwear outside the processing zone, because they can become sources of microorganisms that can contaminate raw materials and result in cross-contamination. It should be noted that about 76% of food handlers in 2007 did not wear appropriate clothing (1.6), a figure that slightly rose in 2014, when 88% of handlers didn’t wear appropriate clothing. This increase is due to the presence of outside staff, hired helpers, (operational assistants) who are only

required to wear an overall, cap, shoes and apron (which are not considered to be appropriate clothing). Item 2.2 (existence of clean hot and cold water in the sinks) had a slight increase from 44% to 47%, as in most cases only cold water was available, something that had already been observed by Santos et al. (2007) when analyzing the canteens of the Vila Real district, where no hot water was available in sanitary facilities, thus hindering what is considered to be the correct hand washing procedure. Regarding items 2.4 and 2.8 there was a small increase. In 2014, taps with manual override were available in all the canteens (2.4) (an increase from 94% to 100%) for washing hands. The problem of having not manually commanded taps was also observed by Barros et al. (2008) and Santos et al. (2007). The lack of cold and/or hot water and the fact that the taps are operated manually, can be troublesome, as it hinders the correct hand washing procedures and can become a source of contamination, as micro-organisms will continue to be found on the handlers' hands. The existence of gender separation in sanitary facilities (2.8) is another mandatory requirement that was not taken into account by some school canteens (the percentage non-conformity increased from 64% to 71%). In some cases, food handlers used the teachers' sanitary facilities.

3.2. Reception and storing raw materials and finished products

Foodstuffs should be received, stored and conserved in safety conditions. Reception is a very important stage of this process, because any problems that occurs at the reception stages, will compromise the following stages. Therefore, foodstuffs should be closely monitored, as to ensure that no products unfit for consumption are accepted and in that way prevent possible food related diseases. After being received, the products should be stored in adequate places, which have suitable conditions that keep them from deteriorating and/or avoid cross contamination between the different raw materials.

In Figure 3 we have the results for the items concerning the criteria for raw materials reception (Figure 3a), and also the conservation of raw materials and consumables (Figure 3b).

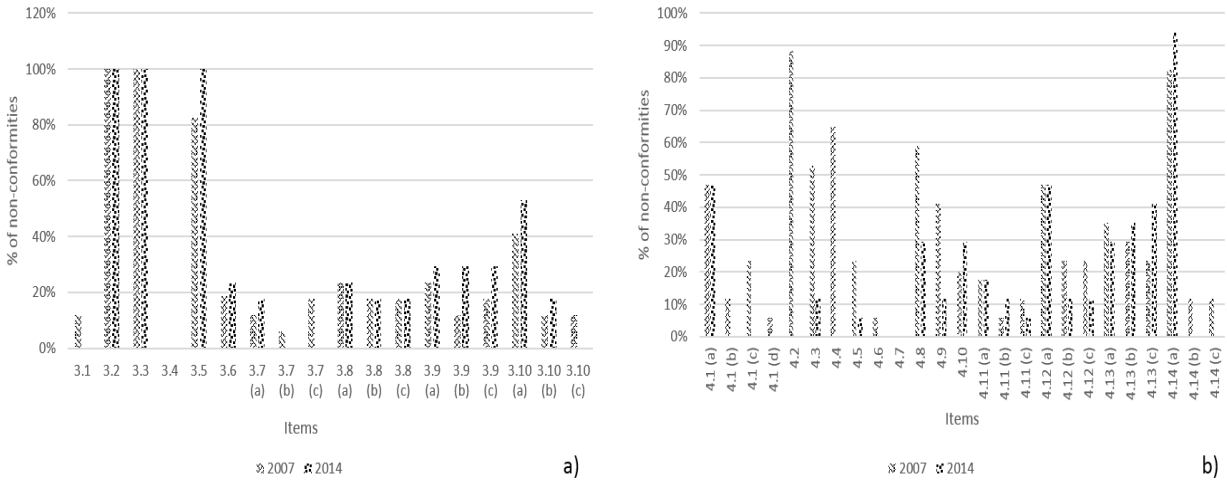

Figure 3. % of non-conformities (a) the reception of raw materials and (b) for the storage of raw materials, finished products.

As it is possible to see in Figure 3a in some items, as, for example, item 3.2 (the lack of raw material fact sheets) and item 3.4 (lack of raw material compliance certificates), the percentage of non-conformities is the same for 2007 and 2014. Keeping up with these requirements is very important, especially in cases of foodborne outbreaks, when you need to document and verify the food sources, and check if the foodstuffs were in compliance with regulations at the time they were accepted and stored. Therefore, canteens should ask suppliers to keep these sheets and certificates, as they are like an “ID” for raw materials, and help handlers understand the products’ origin, their ingredients, as well as other important features.

In items referring to walls, overall hygiene, organization, maintenance and odour control in units where dry products are stored, the non-compliance percentage was also the same. So, from 2007 to 2014 there was no change regarding these items. However, those responsible for storage could have done a better job and repaired the walls, as well as invested in handler training, as to improve the storage facilities’ overall hygiene, organization and maintenance and avoid potential product contamination. The frequently cleaning and sanitization of

storage facilities is key in order to ensure that the products are stored and conserved adequately and prevent the occurrence of dust and other kinds of dirt and hinder microbial development. In some canteens, where best practices have been correctly implemented, there has been a decrease in the percentage of non-compliance in some of these items. As for items concerning the storage of raw materials and consumables, in 2007, 24% of stored products were not properly organized into types/families/categories (4.5), a percentage that decreased to 6% in 2014. This is a similar situation to that that had been observed by Santos et al. (2007) and Barros et al. (2008). Products should be grouped into families or categories, as to, not only make them easier to access, but also avoid the possibility of cross-contamination.

In 53% of the canteens, products weren't placed at an adequate distance from the walls, the ceiling or themselves (4.3). In 2014 only one canteen continued to be non-compliant on this item. This also occurred in the university canteen analysed by Osimani et al. (2013). Even though control samples are collected in every canteen, in 29% of the situations the containers used were inadequate (4.8). In 2007, in 41% of the canteens, products were stored in inadequate containers, a number that dropped to 12% in 2014. Even so, some materials were stored in cardboard boxes. A similar situation was also found in Penafiel (Barros et al., 2008). In 2014, as they stopped promoting and enforcing best practices regarding some items, there was an increase in the non-compliance percentages.

In 2007, 82% of the canteens in the study had no records concerning the reception of raw materials (3.5). In 2014, all canteens were non compliant with this criteria. A similar situation was recorded by Veiros et al. (2009). Raw material reception is a very important stage, as handlers should check the products and record the quantity, expiration date, the product's condition, as well as the packaging and temperature at the time of reception, among other important criteria. If a product is non-compliant, it can be immediately discarded, thus eliminating any contamination risk.

There was a slight increase (from 20% to 29%) in the identification of non-compliant products being received in school canteens. This kind of occurrence also took place in the canteens of the Penafiel municipality (Barros et al., 2008), as well as in the canteen analysed by Osimani et al. (2013). It is important to keep

accurate records and have a plan to deal with non-compliant products, so that they cannot contaminate other products. They should be stored separately and clearly labelled as being non-compliant.

As for floors, in 2007 12% of the canteens had floors made of materials considered to be inadequate (3.7 a), but in 2014, this non-compliance rose to 18%. As for maintenance and the good state of repair (3.9 b) and hygiene (3.9 c) of ceilings, there was an increase, respectively from 12% to 29% and from 18% to 29%, as some of the canteens had damp stains, something that was also observed in the study of Santos et al. (2007). The percentage of non-compliance in item 3.9 (ceilings made of suitable material), increased slightly, from 24% to 29%.

3.3. Work areas

Work areas are the places where there should be higher levels of hygiene and food safety, as it is where food is prepared and cooked. However, in order to ensure this work is done in optimal sanitary and safety conditions, facilities, equipment and utensils should follow some requisites: they should be in good condition and ensure cleanliness. Facilities must be built as to ensure that foodstuffs, handlers and utensils/equipment can be easily and orderly moved (or move) from one area to another, minimizing the risk of overlapping stages and cross contamination.

Figure 4 shows the evolution of the items regarding the criteria set for the work area. In the years ranging from 2007 to 2014, following the implementation of good practices focusing on different items, it was possible to overcome all previously recorded non-compliances.

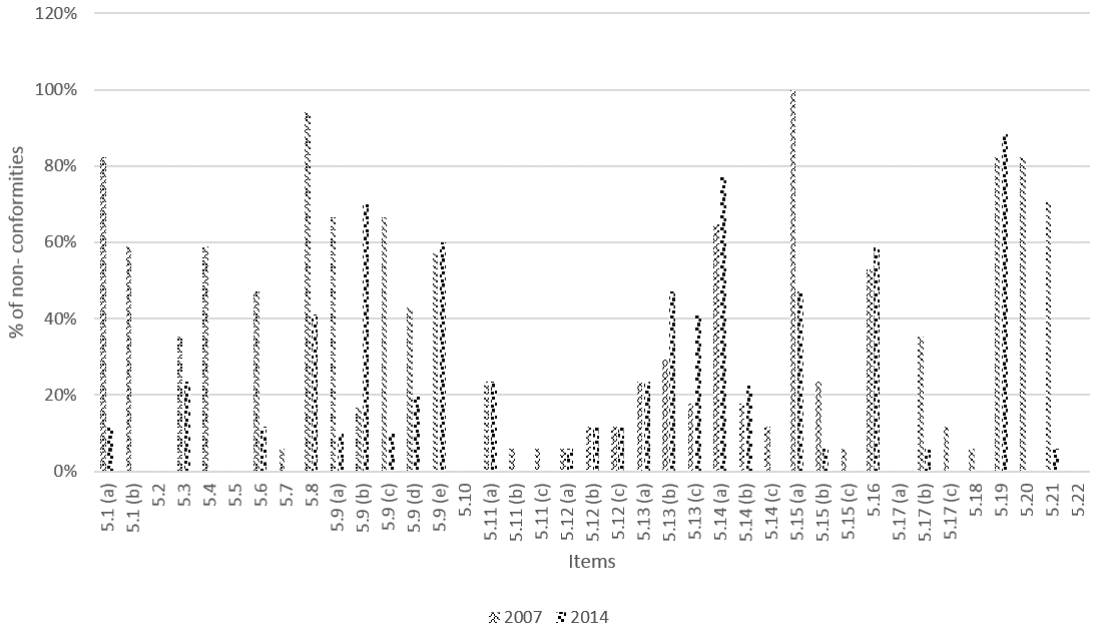

Figure 4. Percentage of non-conformities found in the work area.

In Figure 4 you can see that the percentage of non-compliance has stayed the same in items related to the walls (5.12), the fact that they are in good state of repair, overall hygiene and the fact the ceilings were built from suitable material (5.13a). In some canteens, best practices were implemented, having resulted in the decrease of the percentage of non-compliance in some items. The percentage of non-compliance for light bulbs in the work areas (5.3) that are not adequately protected went down from 35% to 24%. Nevertheless, unprotected bulbs are an actual physical danger in those areas, as when a bulb breaks, it has no protection and the glass can fall over the food and eventually be consumed, causing serious problems. This lack of bulbs' protective guards was also noted by Barros et al. (2008) when he studied the canteens from the Penafiel municipality. As for item 5.6. (the existence of a suitable ventilating system) it decreased from 47% to 12%. In canteens lacking ventilating systems, people would often open windows, even if they weren't fitted with insects nets, a problem that was also reported by Barros et al. (2008). Opening windows that are not fitted with insects nets is dangerous as pests carrying all sorts of disease can come into the work areas and contaminate the foodstuffs. For that reason, it is important to have operating ventilating systems, and if it is necessary to open windows,

they must always be fitted with insects nets. In 2014, 41% of the canteens were not equipped with sinks used exclusively for hand washing (5.8) vs. 94% in 2007. However, in canteens where you could find this kind of sink, only 10% used sensor taps (5.9a), 70% did not simultaneously have hot and cold running water in these sinks (5.9b), 10% did not have disinfectant liquid soap (5.9c), 20% did not have suitable hand drying devices (5.8d), and 60% did not have appropriate waste disposal units next to the sinks (5.9e). The non-compliance percentage of items 5.9a and 5.9b increased from 2007 to 2014. As described in EC Regulation nº 852/2004, there should be an adequate number of available hand wash sinks (which must operate with both hot and cold running water) as well as cleaning supplies and suitable drying devices. The absence of exclusive hand wash sinks and sensor taps was also observed by Santos et al. (2007) and Barros et al. (2008). The lack of suitable, fully equipped and exclusive hand wash sinks is a serious problem, as it can foster contamination and prevents handlers from properly eliminating the microorganisms that can be found in their hands. In 2007 the utensils being used in 100% of the analysed school canteens were made from materials deemed inadequate (5.15 a), i.e., porous material (like wood), having dropped to 47% in 2014. Santos et al. (2007) also confirmed that in more than half of the canteens observed, handlers used utensils made of wood or wood like materials, having considered that this material can foster cross contamination and should be banned from all canteens. The condition and state of repair of utensils (5.15 b) was considered to be non-compliant in 24% of the canteens in 2007 and in 6% in 2014. Even though the equipment available in canteens was considered to be adequate, in 35% of the canteens they weren't well preserved, a number that decreased to 6% in 2014. The state of repair of equipment was linked to signs of corrosion. In the canteens audited by Santos et al. (2007) and Barros el al. (2008) there were also pieces of equipment that displayed a poor maintenance status. In 2014 there was an increase in the non-compliance percentage of some items, i.e., in canteens where best practices stopped being implemented, this percentage escalated. The way utensils were stored (5.16) was also deemed inadequate in 53% of the canteens in 2007 and 59% in 2014, this slight increase was due to the fact that many utensils were found in open shelves and exposed to open air. The prepping facilities should be thought out in a way that they allow a "forward motion" circuit, in which there is no backtracking

throughout the production and manipulation process. This will stop cross-contamination between clean and unclean foodstuffs/stages. Cooked food should be sent out through a different passage from where dirty dishes are returned to the kitchen. As for item 5.19, in 2007 cross contamination was found in 82% of the audited canteens, a number that increased to 88% in 2014. This kind on non-compliance was also found by Santos et al. (2007) and Barros et al. (2008). In the remaining items, regarding floor (5.11), walls (5.12), ceilings (5.13) and doors (5.14), the non-compliance rates range from 0% to 65% in 2007 and 0% to 77% in 2014, when the highest value refers to the fact that doors are made from unsuitable materials (porous material or wood).

3.4. Pest control, sanitation and waste

Pest control (insects, rodents, birds, vermin and other animals) is very important for school canteens, as a way of avoiding microbial and physical contamination, economic loss due to the damaging of food, but mostly for the risk it represents for human health, as it can lead to poisoning and foodborne diseases caused by contaminated foodstuffs. Because pests are sources of contamination by microorganisms, special attention should be paid to preventing their entrance into facilities (through doors, windows, orifices and raw materials). It is therefore necessary to sanitize utensils and work equipment, so that foodstuffs stay clean and are protected from all sorts of food waste and material degradation. All utensils and pieces of equipment should be thoroughly and frequently cleaned and disinfected with specific products that help keep microorganism from transmitting to foodstuffs. All waste (organic or not) should be separated and placed in appropriate containers, as not to contaminate foodstuffs.

In Figure 5 we have the results regarding the items that were analysed within the criteria defined for pest control (Figure 5a), sanitizing (Figure 5b) and waste (Figure 5c).

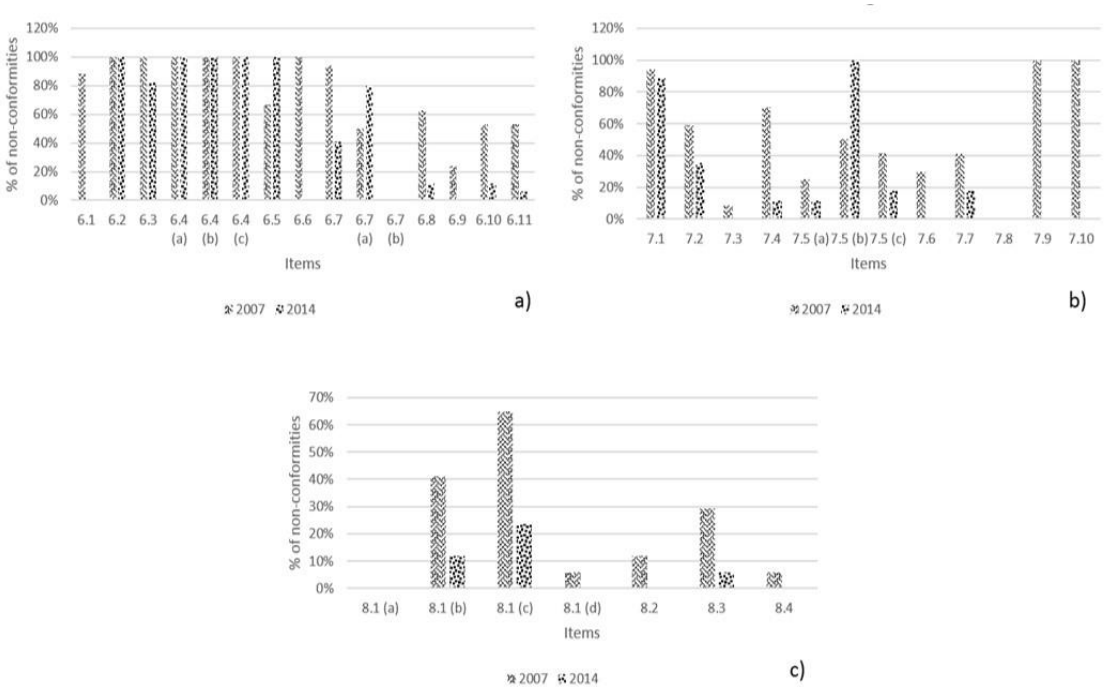

Figure 5. % of non-conformities (a) pest control, (b) Sanitizing and (c) waste.

Regarding the items concerning the existence of visit plans (6.2), the non-compliance percentage was 100%. Both in 2007 and 2014, no visit plans (6.2) were found at any of the 17 schools being audited, as well as no data sheets (6.4 a), sales permits (6.4 b) and safety data files for the products being used in pest control (6.4 c). In the canteens audited by Santos et al. (2007) and Barros et al. (2008) there were also no documented pest control plans. It is important for canteens to have these documents, not only because they are effective preventive pest control measures, but also in case of poisoning, as the products and baits being used will determine the course of action to take in these situations. In 2007 no school had maps with the location of baits. However, in 2014, only 82% of school canteens were considered to be non-compliant regarding this item. Having these documents is also of utmost importance in cases in which there are different people responsible for checking the baits and if there are any pests, so that they know exactly where to find them. In 94% (2007) and 41% (2014) of the canteens, windows that could be opened to the outside were not fitted with mosquito nets (6.7). This non-compliance was also present in the school canteens of Penafiel and Vila Real (Barros et al., 2008; M. J. d. O.

Santos et al., 2007; Veiros et al., 2009). The electric insect killer devices were place in inadequate places (6.8) – 63% in 2007 and 12% in 2014. Santos et al. (2007) and Barros et al. (2008) in their studies, also checked this item, having found that the devices were either non existent, turned off or placed in inadequate places. The percentage of non-compliances regarding the existence of orifices, drains and other places through which pests could enter (6.10) decreases from 53% to 12%. In 2007 pests were found in 94% of canteens, whereas as in 2014 only one school was non-compliant in this item. All places through which pests can enter must be closed and any public places or entrances should be equipped with devices that kill or ward off pests before they come into the work areas. This sort of pest control measures should minimize the risk of contamination.

The sanitization and disinfection of equipment is a very important stage, therefore canteens should have access to all the material required to preserve and prepare food in adequate sanitary conditions. However, not all the audited canteens met these requirements. In some canteens the products used for sanitizing were not designed specifically for the food area, thus resulting in improper cleaning which could lead to microbial contamination and increase the risk of poisoning. These products mustn't be stored close to the foodstuffs, as there is the danger of chemical contamination. This contamination could be prevented through the application of correct storage and handling methods. Item 7.1 (lack of data sheets for sanitizing products) went down from 94% to 88%. As for items regarding sanitizing products, most of them are also lower. While in 2007 25% of the places where sanitizing products were stored were not ventilated (7.5 a), in 2014 that number decreased to 12%. In 2007 50% of places where sanitizing and cleaning material was stored were not clearly identified (7.5 b), however, in 2014 no canteen was compliant with this item (100%). The item concerning the correct separation of waste (8.3) decreased from 29% to 6%, having been observed that in canteens where waste was separated, they would also recycle and separate organic waste and cooking oils. A similar non-compliance was also found in the study of Barros et al. (2008). As you can see in Figure 5c, waste disposal devices aren't always closed (8.1 c) 65% in 2007 and 24% in 2014.

3.5. Staff and records

Food handlers should be aware of the tasks and responsibilities inherent to their workplace, but they should also receive specific training in hygiene and food safety, so they can follow the correct procedures when working in school canteens, thus preventing foodborne diseases and contamination. School canteens should also keep accurate records and closely monitor processes, from the moment raw goods are received up until the time they are ready to be consumed. In Figure 6 we have the results regarding the items concerning staff (Figure 6a) and records (Figure 6b).

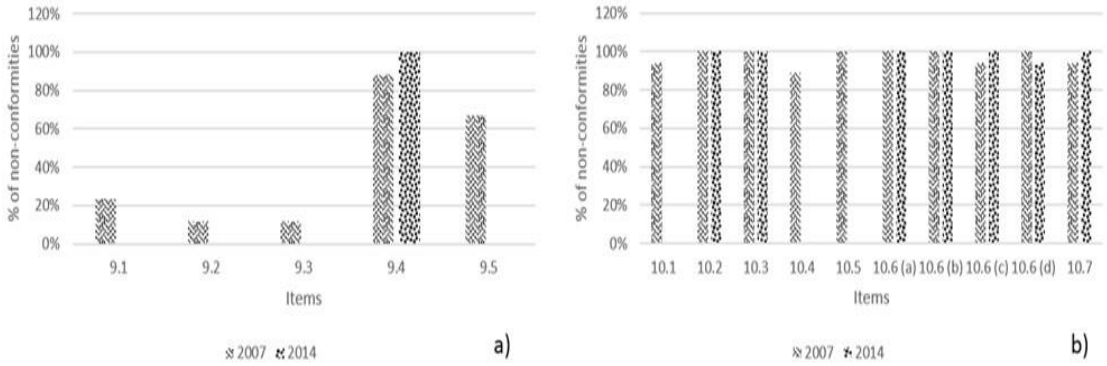

Figure 6. % of non-conformities (a) personal and (b) records.

In Figure 6a) it should be noted that in 2014, 100% of the canteens had no specific training programs for staff (9.4), as it was the supervising body's responsibility to inform workers and handlers whenever such programs were available. This is a similar situation to that that has been observed by Santos et al. (2007), Veiros et al. (2009) and Toth et al. (2014). Ongoing staff training is considered to be very important, as it is a key issue in food safety. As described in EC regulation no. 852/2004, food handlers must be supervised and be able to attend adequate instruction/training in food safety and hygiene matters that help them perform their jobs.

As you can see in Figure 6 b), the non-compliance rate regarding records is very high, with some items reaching 100%. That is the case of maintenance and calibration records (or lack thereof) (10.2 and 10.3), as well as the lack of certificates of analysis performed to foodstuffs (10.6 a), water (10.6 b), surfaces

(10.6 c), handlers (10.6 d) and records regarding cooking oils (10.7). Only one school has records of food handlers' analysis (10.6 d). Because there were no other schools with certificates, the percentage of non-compliance for this item in 2014 was 94%. Nevertheless, food handlers state that their hands are regularly analysed and that the results are sent the supervising body. If there is a problem and/or results are non-compliant, handlers and schools will be notified. The fact that there are no maintenance and calibration plans means that this sort of procedure isn't being carried out. As a result there is no way of predicting if there will be a malfunction or a system failure that may result in contamination. The fact that there is no percentage of non-compliances regarding items 10.4 and 10.5 in 2014, does not, however, mean that this is no longer an issue. As there are no maintenance records (10.4) or equipment calibration records (10.5), these items do no apply and were not, therefore, considered in this audit. However, it should be noted that three schools kept updated equipment maintenance records.

In this particular area it is necessary to develop and enforce best practices policies, in order to get lower non-compliancy levels.

4. Conclusion

We can conclude that even though the percentage of non-compliances has decreased from 2007 to 2014, there are still very important non-compliances that must be addressed. In most cases this will not difficult to eliminate these issues.

These audits played a very important role in checking the practical implementation of best practices regarding hygiene and food safety in school canteens.

In most of the items, there was a reduction in the percentage of non-compliances for most areas, however, some stayed the same and others were eliminated in 2014. In other items, the percentage of non-compliances rose. This was particularly perceivable in areas such as infrastructures (walls, ceilings and doors) and the lack of records concerning the reception of raw goods, pest control and other data sheets regarding hygiene and food safety control. Many schools continue to not use cleaning products that are specifically design for the food

area, which is something to be considered in the future (as it would help improve the overall level of cleanliness and hygiene in their facilities).

The audits also confirmed that there are no annual training programs for handlers, something that should be safeguarded, as handlers are entitled to training on food safety and hygiene. This would ensure that meals would be adequately prepared and served, and prevent foodborne diseases.

These non-compliances can easily be eliminated if school and city institutions commit and work together towards raising the bar on the standards of hygiene and food safety in school canteens.

We also come to the conclusion that from 2007 to 2014, best practices policies were implemented in all school canteens for 45 of the 102 checked items. For these items, the non-compliance levels in 2014 were 0%.

References

Regulation nº 852/2004 of the European Parliament and of the Council on the hygiene of foodstuffs. Official Journal of the European Union L 139.

Barros, M. O., Lameiras, J., & Rocha, A. (2008). Espaços de refeição e estabelecimentos de educação do município de Penafiel - caracterização higio-sanitária. Revista SPCNA (Sociedade Portuguesa de Ciências da Nutrição e Alimentação), 14 (nº2), 66-73.

Codex Alimentarius. (2003). Recommended International Code of Practice General Principles of Food Hygiene. Codex Alimentarius Commission (CAC). CAC/RCP 1-1969, Rev. 4-2003.

EFSA (2007a). The Community Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents, Antimicrobial Resistance and Foodborne Outbreaks in the European Union in 2006: EFSA Journal 2007; (pp. 251, 254, 259, 261, 264.).

EFSA (2007b). The Community Summary Report onTrends and Sources of Zoonoses, Zoonotic Agents, Antimicrobial Resistance and Foodborne Outbreaks in 2005: EFSA Journal 2007; (pp. 221, 222, 223.).

EFSA (2009). The community summary report - Food-borne outbreaks in the European Union in 2007: EFSA Journal 2007 (pp. 24,37,40,48,50,56,64,66,75,79,88,91).

EFSA (2010). The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2008: EFSA Journal 2010; (pp. 243, 251, 254, 256, 259, 269).

EFSA (2011). The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2009: EFSA Journal 2011; (pp. 270, 281, 282, 297).

EFSA (2012). The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2010: EFSA Journal 2012; (pp. 325, 330, 338, 352, 355, 356, 361).

EFSA (2013). The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2011: EFSA Journal 2013; (pp. 202, 204, 228).

EFSA (2014). The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2012: EFSA Journal 2014; (pp. 263, 264, 273, 282, 288, 293, 298).

EFSA (2015). The European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in 2013: EFSA Journal 2015; (pp. 125, 131, 133).

IQA (2009). Projecto “Inovar para a Qualidade Alimentar” 2004/EQUAL/A1/AD/274 financiado pelo programa EQUAL do Ministério do Trabalho e da Segurança Social, dirigidos a empregadores/dirigentes e chefias e operadores de empresas do ramo alimentar, (2005-2009).

L. Hannah Gould, K. A. W., Antonio R. Vieira, Karen Herman, Ian T. Williams, Aron J. Hall, Dana Cole, . (2013). Surveillance for Foodborne Disease Outbreaks - United States , 1998-2008. MMWR Centers for Disease Control and Prevention (CDCP) srveillance summaries: Morbidity and Mortality Weekly Report.2013. 62 (No.2), 5,8,30.

NP EN ISO 19011. (2012). Linhas de orientação para auditorias a sistemas de gestão.

Osimani, A., Aquilanti, L., Tavoletti, S., & Clementi, F. (2013). Evaluation of the HACCP System in a University Canteen: Microbiological Monitoring and Internal Auditing as Verification Tools. International Journal of Environmental Research and Public Health, 10(4), 1572-1585.

Rodriguez-Caturla, M. Y., Valero, A., Carrasco, E., Posada, G. D., Garcia-Gimeno, R. M., & Zurera, G. (2012). Evaluation of hygiene practices and microbiological status of ready-to-eat vegetable salads in Spanish school canteens. Journal of the Science of Food and Agriculture, 92(11), 2332-2340.

Santos, M. J., Nogueira, J. R., Patarata, L., & Mayan, O. (2008). Knowledge levels of food handlers in Portuguese school canteens and their self-reported behaviour towards food safety. International Journal of Environmental Health Research, 18(6), 387-401.

Santos, M. J. d. O., Nogueira, J. M. R., & Mayan, O. (2007, Julho/Dezembro de 2007). Condições higio-sanitárias das cantinas escolares do distrito de Vila Real.

Revista Portuguesa de saúde pública, 22 (nº2), 59-66.

Toth, A. J., & Bittsanszky, A. (2014). A comparison of hygiene standards of serving and cooking kitchens in schools in Hungary. Food Control, 46, 520-524.

Veiros, M. B., Proenca, R. P. C., Santos, M. C. T., Kent-Smith, L., & Rocha, A. (2009). Food safety practices in a Portuguese canteen. Food Control, 20(10), 936-941.

Annex 1: Audit Checklist used in audits

Date of Audit		
Audited entity		
Address		
References	***Codex Alimentarius; Regulation EC No. (852/2004)***	
Auditor		
Contact person/ company representative	**Name**	***Position***

1. Food Handlers' Personal Hygiene and Health	**YES**	**NO**	**N.A.**	**Observations/comments**
1.1 Presence of workers' medical certificates (Directive of 16 March).				
Appearance				
1.2 Wounds, cuts and other visible skin lesions are duly protected.				
1.3 Fingernails are short, clean and free of polish.				
1.4 Food handlers are not wearing accessories/jewellery.				
1.5 Work clothes are used exclusively in the workplace.				
1.6 Clean and appropriate clothing and footwear.				
1.7 Worker's hair is completely protected.				
Attitudes				
1.8 Hands are properly washed throughout the work period/shift.				
1.9 There are no inadequate behaviours in places where food is handled (including smoking, spitting, eating, chewing, sneezing or coughing over unprotected foodstuffs).				
Visitors				
1.10 Visitors follow the same rules that apply to food handlers.				
1.11 There are visitor kits.				

2. Sanitary facilities / Food handlers' locker rooms	**YES**	**NO**	**N.A.**	**Observations/comments**
2.1 The general state of hygiene, organization and cleaning is adequate.				
2.2 There is cold and warm drinking water in the sinks.				
2.3 There is liquid antibacterial soap available in the sinks.				
2.4. There are automatic taps in the sinks.				
2.5 There are suitable hand drying devices.				
2.6 There are suitable waste disposal devices.				
2.7 There are nailbrushes.				
2.8 There is gender separation.				
2.9 There are clearly identified and closed individual lockers.				
2.10 Personal objects are placed inside the lockers.				
2.11 Facilities are not in direct contact with the places where food is handled.				

3. Receiving raw goods	**YES**	**NO**	**N.A.**	**Observations/comments**
Reception Procedures				
3.1 The general state of hygiene, cleaning and maintenance is adequate.				
3.2 There are technical files for the raw goods.				
3.3 There are conformity certificates for the raw goods.				
3.4 There are no breaks in the cold chain.				
3.5 There are records regarding raw goods reception.				
3.6 There are procedures for dealing with nonconforming products.				
Infra-structure				
3.7 Floors				
a) made of adequate material				
b) in good state of conservation.				
c) are kept clean.				
3.8 Walls				
a) made from adequate material.				
b) in good state of conservation.				
c) are kept clean				
3.9 Ceilings				
a) made from adequate material.				
b) in good state of conservation.				
c) are kept clean				
3.10 Doors				
a) made from adequate material.				
b) in good state of conservation.				
c) are kept clean				

4. Keeping and storing Raw and Subsidiary Materials and Consumables	**YES**	**NO**	**N.A.**	**Observations/comments**
Conservation and storing procedures				
4.1 Adequate sanitization, organization, maintenance and odour control in storage units for:				
a) dry products.				
b) conservation of frozen products.				
c) refrigeration.				
d) subsidiary goods.				
4.2 There are temperature monitoring devices.				
4.3 Products are stored at an appropriate distance from the walls, floor, ceiling and themselves.				
4.4 Products are properly labelled and identified.				
4.5 The different products are stored by type/ family/ category.				
4.6 The FEFO/ FIFO methods are followed.				
4.7 Cooling equipment's temperatures are kept within the specs.				
4.8 Samples (from finished products) are taken in adequate recipients.				
4.9 Products are packaged in adequate containers.				
4.10 Nonconforming products are clearly labelled.				
Infrastructures				
4.11 Floors				
a) made of adequate material				
b) in good state of conservation.				
c) are kept clean.				
4.12 Walls				
a) made from adequate material.				

b) in good state of conservation. c) are kept clean				
4.13 Ceilings				
a) made from adequate material.				
b) in good state of conservation.				
c) are kept clean				
4.14 Doors				
a) made from adequate material.				
b) in good state of conservation.				
c) are kept clean				

5. Work areas	**YES**	**NO**	**N.A.**	**Observations/comments**
Infra-structures				
5.1 The *lay*out blocks cross contamination.				
a) there are separate prepping areas for different kinds of food.				
b) the cooking area is separate from the prepping area.				
5.2 Adequate lighting (natural and / or artificial).				
5.3 The light bulbs are adequately protected.				
5.4 The drains are removable and able to stop residual water reflux and contain pests.				
5.5 The sewers are equipped with siphons.				
5.6 There is adequate ventilation.				
5.7 There is an effective smoke extracting system.				
5.8 There are exclusive hand washing sink(s) (with running drinking water).				
5.9 Hand washing sinks have:				
a) automatic taps.				
b) both cold and warm water.				

c) antibacterial liquid soap.				
d) adequate hand drying devices/solutions.				
e) an adequate waste disposal device.				
5.10 Drinking water is available.				
5.11 Floors				
a) made of adequate material				
b) in good state of conservation.				
c) is kept clean.				
5.12 Walls				
a) made from adequate material.				
b) in good state of conservation.				
c) are kept clean				
5.13 Ceilings				
a) made from adequate material.				
b) in good state of conservation.				
c) are kept clean				
5.14 Doors				
a) made from adequate material.				
b) in good state of conservation.				
c) are kept clean				
Utensils				
5.15 Utensils:				
a) made from adequate material.				
b) in good state of conservation.				
c) are kept clean				
5.16 Utensils are properly stored.				
Equipment				
5.17 Equipment				
a) made from adequate material.				
b) in good state of conservation.				

c) is kept clean				
Others				
5.18 This area is overall sanitized, clean and neat.				
5.19 There is no cross contamination.				
Best practices				
5.20 Prepping and cooking				
5.21 Food conservation				
5.22 Consumption exposure				

6. Pest Control	**YES**	**NO**	**N.A.**	**Observations/comments**
6.1 There is a contract with a company that specializes in pest control.				
6.2 There is a visit plan.				
6.3 There is a map of facilities with the location of baits.				
6.4 As for the products used, there are:				
a) technical files				
b) sales permits				
c) safety records				
6.5 There are visit reports.				
6.6 The bait stations are clearly identified.				
6.7 Windows that open outside are fitted with mosquito nets that are:				
a) removable.				
b) in a good state of cleaning and maintenance				
6.8 Electric insect traps are on at all times and place in adequate locations.				

6.9 Facilities are well kept and there is no vegetation inside or outside.				
6.10 Holes, drains and other places through which pest can enter are kept closed.				
6.11 There are no animals in the facilities.				

7. Sanitization	**YES**	**NO**	**N.A.**	**Observations/comments**
Cleaning products				
7.1 There are technical files for the cleaning products.				
7.2 All products are designed and suitable for the food industry.				
7.3 Cleaning products are used according to manufacturers' instructions.				
7.4 Cleaning products and equipment are kept in adequate places.				
7.5 Products and equipment are stored in places that are:				
a) ventilated.				
b) adequately identified.				
c) kept closed.				
7.6 All cleaning products are clearly labelled and identified.				
7.7 There is specific cleaning equipment for each area.				
7.8 Cleaning equipment is regularly sanitized and disinfected.				
Sanitization plan				
7.9 There is a sanitization plan.				
7.10 There are sanitization records.				

8. Waste	YES	NO	N.A.	Observations/comments
8.1 Waste disposal devices are: a) made from appropriate material. b) kept closed. c) have non-manual opening mechanisms. d) fitted with adequate, waterproof bags that prevent leaks.				
8.2 Waste disposal bags are placed outside and there is no build-up of waste/rubbish in work areas.				
8.3 Waste separation (including cooking oil) is done correctly.				
8.4 Waste disposal devices are adequately sanitized.				

9. Staff	YES	NO	N.A.	Observations/comments
Tasks and responsibilities				
9.1 Members of the staff are aware of their tasks and responsibilities regarding food safety and the protection of foodstuffs.				
9.2 Members of the staff have the necessary knowledge and skills to perform their tasks in a sanitary way.				
9.3 Workers handling cleaning products and other potentially hazardous substances are instructed about the correct procedure and techniques to handle them.				
Training programs				
9.4 There is a thought-out training program.				
9.5 The training program is regularly revised and assessed.				

10. Records	**YES**	**NO**	**N.A.**	**Observations/comments**
10.1 There are records regarding equipment temperature monitoring.				
10.2 There is a maintenance plan.				
10.3 There is an equipment calibration plan.				
10.4 There are maintenance records.				
10.5 There are equipment calibration records.				
10.6 There are analysis reports for analyses done to: a) food.				
b) water.				
c) surfaces.				
d) handlers.				
10.7 There are records regarding cooking oils records.				

The Auditor

2.2 Food Handlers in school canteens – Levels of knowledge on hygiene and food safety

Abstract:

Food handlers play a very important role in preventing potential foodborne diseases in school canteens. Their relevance and responsibility in this setting is indisputable, as any incident may affect a great number of students. Because handlers are potential carriers and sources of microorganisms, which can lead to cross contamination and contaminate foodstuffs and surfaces/utensils (among others), they should have adequate training on hygiene and food safety. This training will help them not only to be more accurate and meticulous in their tasks, but will also contribute towards preventing future problems and outbreaks.

This work aims at establishing a correlation between the level of knowledge regarding Hygiene and Food Safety (HFS) issues and objective criteria involving best practices, such as the microbiological evaluation of surfaces/utensils and the hands of food handlers working in school canteens.

The study was carried out in 26 school canteens of the Viana do Castelo district (Portugal) and involved 86 food handlers. A questionnaire was developed as to assess the food handler's knowledge of hygiene and food safety. Following the face-to face application of the questionnaire, samples were taken from the handlers' hands and from work surfaces/utensils. These samples were then subjected to microbiological analysis as to determine their hygiene indicators and levels. The results were subsequently converted into a scale of 1 to 5, making it possible to correlate the knowledge of hygiene and food safety, hygiene practices and the microbiological results to the hygiene indicators.

To analyse the data we use Partial least squares (PLS) is an approach to structural equation modelling (SEM) that is extensively used in the social sciences to analyse quantitative data. However, as far as we know, this statistic methodology isn't used in food safety studies.

Partial least squares (PLS) was used to assess the reliability/validity of the measures and make a causal-predictive analysis. By combining the

questionnaire and the microbiological data resulting from the analysis. It is generally assumed that lack of knowledge may be responsible for inadequate and inefficient hygiene practices, thus leading to potential contamination and foodborne outbreaks. The outcomes of this study are unexpected since the show that habits are influenced by the knowledge of hygiene and food safety in only 18%, whereas microbiological results are influenced in only 5%.

As for the levels of hygiene, 97,6% surfaces/utensils and 75,6% of handlers (their hands) analysed were acceptable regarding microbiologic criteria.

These results show how important it is to closely and systematically monitor the application of HFS practices that make it possible to collect objective data and implement corrective measures. These measures will have to include staff training and the close monitoring of their work.

Keywords: school canteen, food handlers, hygiene and food safety, HACCP, foodborne outbreaks, knowledge, hygiene indicators

1. Introduction

A foodborne disease is an infectious or toxic disease caused by agents that enter the body through the ingestion of water and/or food (ASAE, 2014; WHO, 2015). Every year, it is estimated that 30% of people living in industrialized countries suffer from foodborne diseases (ASAE, 2014) and diseases caused by the ingestion of food that is contaminated with pathogenic microorganisms or their toxins, making it a public health issue, both in developed and developing countries (where it is even a more troublesome issue) (Martins, Hogg, & Gestal Otero, 2012; Santos, Nogueira, Patarata, & Mayan, 2008; Soares, Garcia-Diez, Esteves, Oliveira, & Saraiva, 2013).

The microorganisms can come from different sources. There are studies that suggest that the sources of contamination can be the food handlers' hands, contaminated foodstuffs, storing temperatures and unsuitable preparation, inadequate prepping conditions, equipment, utensils and facilities in poor conditions, contaminated water hygiene practices, but also raw goods bought

from unsafe sources (Bas, Ersun, & Kivanc, 2006; de Oliveira et al., 2014; McIntyre, Vallaster, Wilcott, Henderson, & Kosatsky, 2013; Osaili et al., 2013; Soares et al., 2013).

One of the goals of schools is to serve balanced meals to their students. However, it is important that school canteens also follow adequate food safety practices. This is particularly important on account of the number of meals served everyday and the vulnerability of the potential victims (Santos et al., 2008).

From 2005 to 2012 several foodborne outbreaks took place in schools and kindergartens and were reported to the European Food Safety Authority (EFSA). In 2005 an outbreak of *Clostridium perfringens* affected 200 students. This outbreak was mainly caused by the bad handling of foodstuffs, more specifically meat (EFSA, 2007b). In 2006, there was an E.coli outbreak in Portugal, which was caused by cooked meat in sandwiches served at a school picnic, affecting 25 people (EFSA, 2007a). In 2006 and 2008 two outbreaks of *Yersinia* were reported in Finland. The source is thought to have been grated carrot (EFSA, 2007a, 2010). In the year 2007, in Latvia there was an outbreak of *Shigella* spp. occurred in a school/kindergarten, which affected 19 people, in which 17 were hospitalized. In Australia an outbreak of *Staphylococus aureus* enterotoxin, with 116 cases and but only 2 people were hospitalized, and that the cause was the milk served in the school/kindergarten. Another outbreak occurred in France in which the cause was herbs and spices, with 146 cases and the source was *Baccillus cereus* at a school/kindergarten. (EFSA, 2009).

Also in Finland, in 2009, 550 students were infected with *Calicivirus*, an infection caused by berries (EFSA, 2011). Another great outbreak, linked to the ingestion of frozen burger meat, happened in France, in 2010. This outbreak and the ensuing contamination was caused by *Salmonella* enteric (serotype 4,5,12:i:), and involved 544 teenagers and 10 adults (EFSA, 2012). In September 2012, there was a norovirus outbreak in Germany that affected 10950 students, with 38 having to be hospitalized. This outbreak was linked to the ingestion of frozen Chinese strawberries (EFSA, 2014).

Food handlers working in school canteens are key in assuring food safety. They can bearers of microorganisms throughout the course of a gastrointestinal

disease, or if they are going through the final stage of a disease (even when they no longer display any symptoms), or even without any kind of clinical problem, and, therefore, may become vehicles for food, surfaces, equipment or utensils contamination. Food handlers' hands are the main channel through which the diseases can spread out, either due to cross contamination or because of poor personal hygiene (e.g. inadequate hand washing after using the bathroom or throughout food preparation processes - (Bas et al., 2006; Soares et al., 2013). Therefore, handlers should have theoretical and practical training in hygiene and food safety (HFS), as training is considered to be an effective strategy in preventing poor hygiene that can lead to outbreaks. Training should also inspire handlers to constantly and systematically follow hygiene practices, thus ensuring food safety (Egan et al., 2007; Soares et al., 2013).

Dealing with these issues, several studies have been carried out in school canteens, as well as restaurants, catering services and food companies. While some of these studies aim at assessing food handlers' knowledge and perceptions of issues regarding hygiene and food safety (Bas et al., 2006; da Cunha et al., 2013; Faour-Klingbeil, Kuri, & Todd, 2015; Ko, 2013; Martins et al., 2012; McIntyre et al., 2013; Osaili et al., 2013; Sani & Siow, 2014; Santos et al., 2008), others focus on the microbiological assessment of equipment, surfaces, utensils, foodstuffs and the hands of handlers (de Oliveira et al., 2014; Garayoa, Diez-Leturia, Bes-Rastrollo, Garcia-Jalon, & Vitas, 2014; Marzano & Balzaretti, 2013; Rodriguez-Caturla et al., 2012; Soares et al., 2013).

The aim of this study was to correlate the food handlers' knowledge of hygiene and food safety to the microbiological evaluation of surfaces/utensils and the hands of handlers who work in school canteens using Partial least squares (PLS) to assess the reliability/validity of the measures and make a causal-predictive analysis.

2. Methods

This is a quantitative study that relied on a questionnaire and on microbiological analyses to establish correlations between the knowledge of hygiene and food safety and the hygiene of food handlers and the results of those analyses.

2.1. Study population

The study took place in 26 canteens in 17 schools and kindergartens, 1 prep school, 2 secondary schools and 7 colleges within the Viana do Castelo (Portugal) district. Considering the handlers that took part in the study, most participants (45.3%) were between 46-55 years old, followed by 22.1% who were 36-41 and 19.8% who were in the 56-63 age group. The application of the questionnaires and the hand sampling stage took place between the 29th September 2014 and the 10th February 2015 and involved 86 handlers who worked in the canteens and 81 surfaces/utensils.

2.2. Data collection

2.2.1. Questionnaire

The questionnaire was developed based on a literature review on the topic of food handlers' perceptions on Hygiene and Food Safety and hygiene practices in school canteens. It was applied to food handlers and carried out face-to-face (with an average duration of 20 minutes). This questionnaire was divided into two sections; (I) socio-demographic features; and (II) knowledge of Hygiene and Food Safety and hygiene practices (Annex 2).

The first section describes the socio-demographic features of the participant food handlers (age, gender, qualifications, professional status, number of years on the current job, previous occupation, reasons for having applied for this particular job, the amount of training received in Hygiene and Food Safety (HFS) – date of the last training session attended and the total number of hours of training on HFS).

The second section is divided into seven sub-topics: vehicles for the transmission of pathogens in food (VT, 12 questions); cross contamination (CC, 7 questions); heat treatments (HT, 5 questions); refrigeration techniques (RT, 4 questions); cold storage (CS, 6 questions); concerns about food safety (CFS, 3 questions); HACCP (HACCP, 3 questions); personal hygiene (PH, 25 questions); and cleaning and disinfection (CL, 9 questions). The survey of the topics regarding personal hygiene and cleaning and disinfection was based on frequency. We used a 5-point Likert scale (1= never; 2= rarely; 3= sometimes; 4= often; 5=

always). As for the remanding topics, as the answers were based on the level of agreement towards given statements, another 5-point Likert scale was used (1= disagree; 2= partially disagree; 3= agree; 4= partially agree; and 5 =totally agree).

2.2.2. Microbiological analysis

We collected a total of 86 samples from handlers' hands and 81 from surfaces/ utensils. In every school, we collected samples from 3 different surfaces/ utensils (plate, glass, spoon or knife). While collecting the samples from the handlers' hands and surfaces, we followed norms NP 1828:1982, ISO 18593:2004 e ISO 7218:2007 (point eight).

After collecting the samples they were analysed in the Applied Microbiology Unit of the Polytechnic Institute of Viana do Castelo, a testing facility that is accredited according to NP EN ISO/IEC 17025, with certificate no. L0359 from IPAC (Portuguese Institute for Accreditation).

The following analyses were carried out in surfaces/utensils microorganism enumeration at 30ºC (ISO 4833 – 1: 2013) and *Enterobacteriaceae* enumeration (ISO 21528 – 2: 2004). As for the handler's hands, we looked for *Escherichia coli* (NP-2308: 1986 – general protocol for detecting *Escherichia coli*), detection coliform bacteria at 30ºC (NP-2164: 1983 – General protocol for detecting coliform bacteria) and *Staphylococcus aureus* (NP-2260: 1986 – general protocol for detecting *Staphylococcus aureus*) analysis was proposed.

The result of the microbiological analyses made to the handlers' hands and the work surfaces were converted into a quantitative classification, according to the criteria listed in Table1.

Table 1. Scale used for presenting microbiological results.

Scale	Results from the handlers' hands	Results from the surfaces
1	All analyses came back positive	All analyses were ≥ 1 ufc/cm^2
2	*Staphylococcus* aureus and Positive total coliforms	Microorganisms at 30°C ≥ 1200 ufc/cm^2 and *Enterobacteriaceae* < 1 ufc/cm^2
3	Positive *Staphylococcus* aureus	*Enterobacteriaceae* ≥ 1 ufc/cm^2
4	Positive total coliforms or Positive total coliforms and *E.coli*	Microorganisms at 30°C ≥ 1 ufc/cm^2
5	All analyses came back negative	All analyses were < 1 ufc/cm^2

The microbiological results regarding the surfaces/utensils were interpreted based on the guidelines listed in Table 2 (Little & Sagoo, 2009). The results of the analyses conducted on the handlers' hands were considered to be satisfactory when they were absent (negative) and unsatisfactory when the presence of microorganisms had been detected (positive).

Table 2. Guidelines for the interpretation of microbiological results obtained from cleaning cloth and swab samples (Little & Sagoo, 2009).

Sample	Microorganisms	Microbiological Status	
		Acceptable	**Unsatisfactory**
Template area swab in contact with surfaces used when preparing food and that had recently been cleaned	Aerobic Colony Count	<10^3 cfu/cm^2	≥10^3 cfu/cm^2
	Enterobacteriaceae	<10^2 cfu/cm^2	≥10^2 cfu/cm^2

2.3. Measurements

In this section we present the measurements carried out in this study and their dimensionality and epistemic relations[1] (representing the relation between indicators and construct). We have used a formative measurement model, adapted from previously published questionnaires (Bas et al., 2006; da Cunha et al., 2013; McIntyre et al., 2013; Sani & Siow, 2014; Santos et al., 2008) and applied a scale to measure the knowledge of hygiene habits. We also adapted the same scale to measure the contribution towards microbiological results indicators (hygiene). To represent and measure the levels of knowledge (Know) we used a one-dimensional construct model based on a reflective 15-item-variable. As for the Habits construct, 6 reflective items were used in order to measure it. The Microbiological (Micro) construct was based on 1 reflective item. All items were measured using a 5-point Likert scale (ranging from 1 – strongly disagree – unsatisfactory – to 5 – strongly agree – acceptable). All the measurements used throughout the study are listed in (Table 4).

2.4. Data analysis

To test the research model, we applied the Partial Least Square (PLs) technique using SmartPLS2 software (Ringle, Wende, & Will, 2005). Partial Least Square (PLs) is a variance-based structural equation modeling technique (Henseler, Ringle, & Sinkovics, 2009). We chose this technique because the model supports the complexity in terms of relationships and level of dimensionality; the study focuses on predicting the dependent variable, also adding new measurements and relations to previous literature (Roldán & Sánchez-Franco, 2012). The model to be analysed is presented in Figure 1. Through this model we intend to determine if there is any influence/relationship between the knowledge of hygiene food safety (Habits) and microbiological results (Micro).

[1] There are two types of epistemic relations. First, a reflective measurement model establishes that changes in the construct lead to variations in its indicators. Secondly, the formative measurement model posits that the indicators altogether influence the construct (Roldán & Sánchez-Franco, 2012).

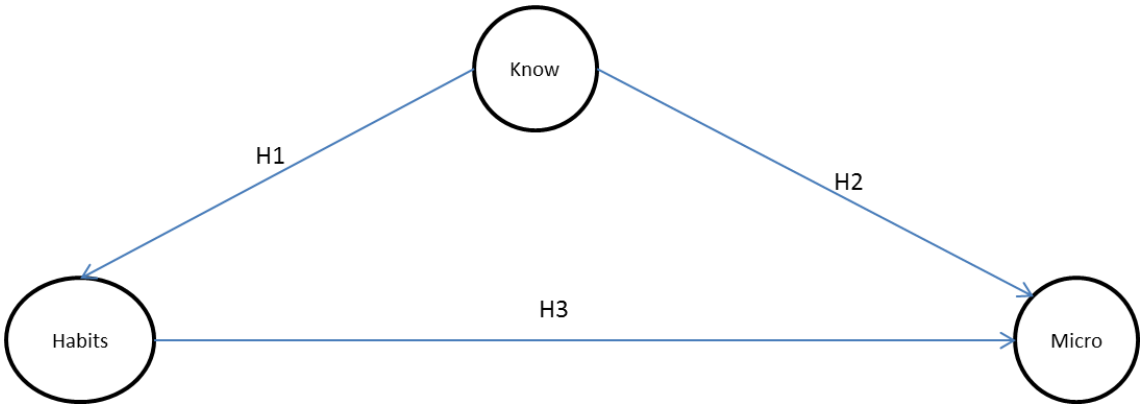

Figure 1. Proposed model.

3. Findings:

3.1. Socio-demographic features

In Figure 2, Figure 3 and Figura 4 we present the findings regarding the socio-demographic features and training of the food handlers who answered the questionnaires.

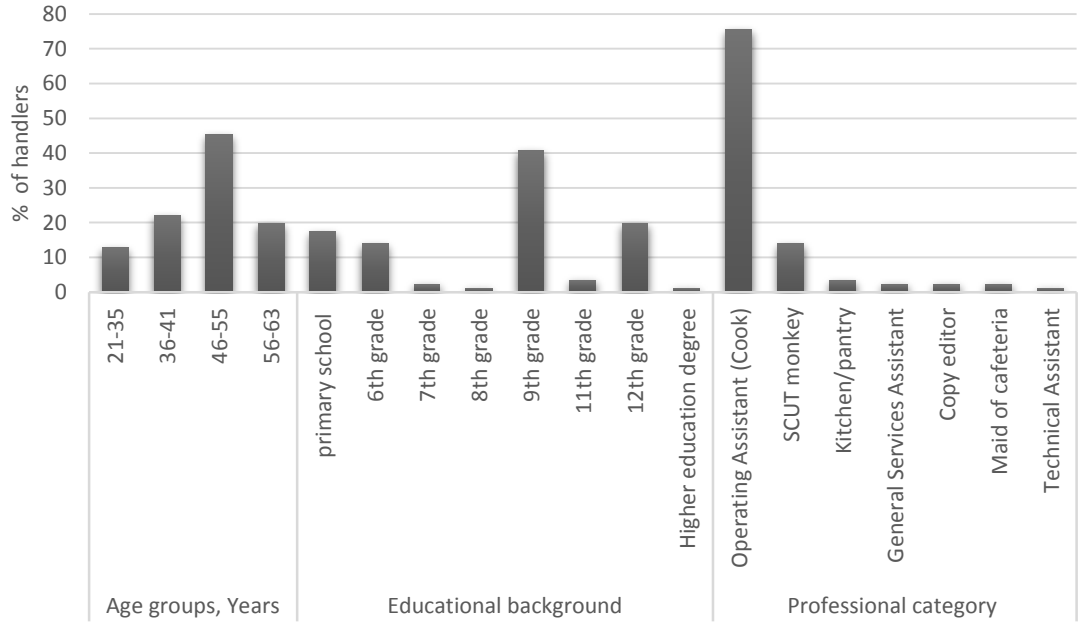

Figure 2. Socio-demographic features of food handlers (age, educational background and professional category.

The 86 handlers interviewed had an average age of 54 (ranging from 21 to 63 years old), and were all female. Their education level was diverse, ranging from

people who had only completed primary school to those with college degrees. However, 40.7% had completed the 9th grade. As for their professional category, 76.6% of handlers were operational assistants.

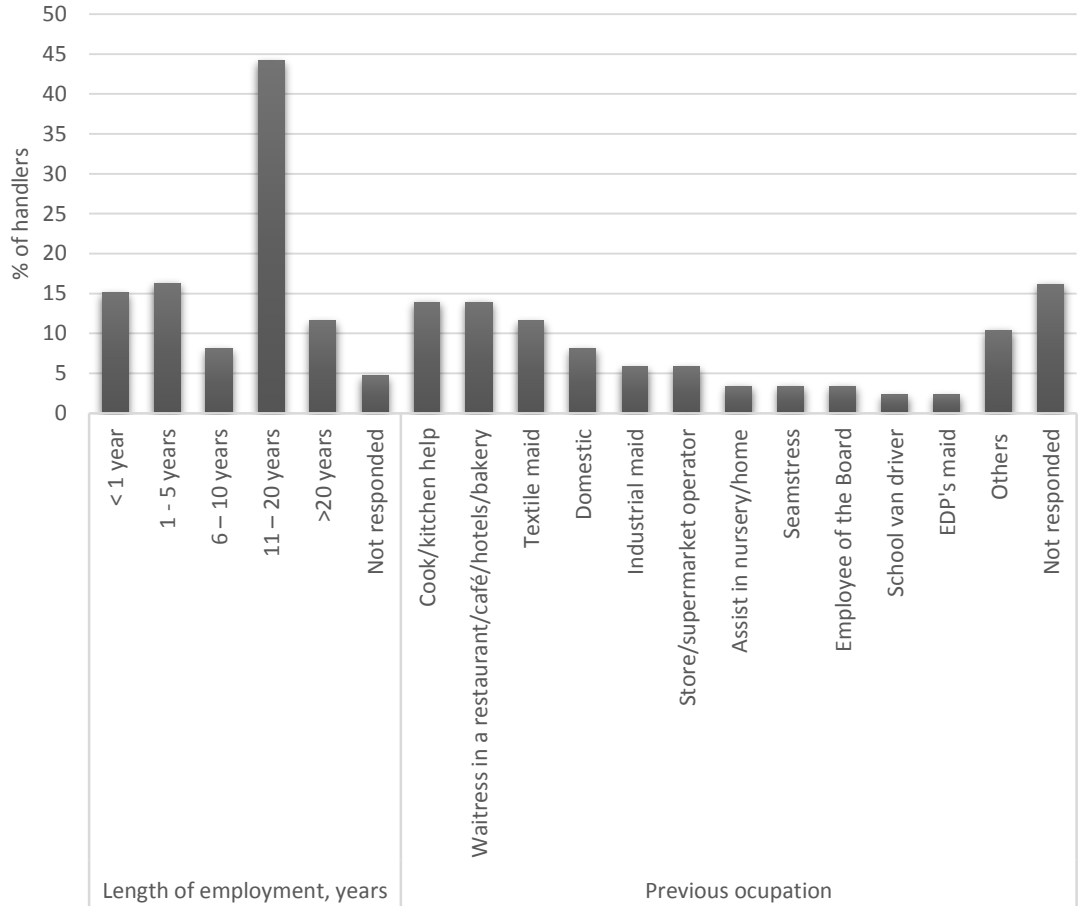

Figure 3. Socio-demographic features of food handlers (duration of employment and previous occupation)**.**

As for the duration of employment, as you can see in Figure 3, 44.2% of handlers had been doing this job for between eleven to twenty years. Most food handlers had previously worked as cooks or kitchen assistants, waitresses, factory workers (particularly in the textile industry), housewives or shop assistants/cashiers.

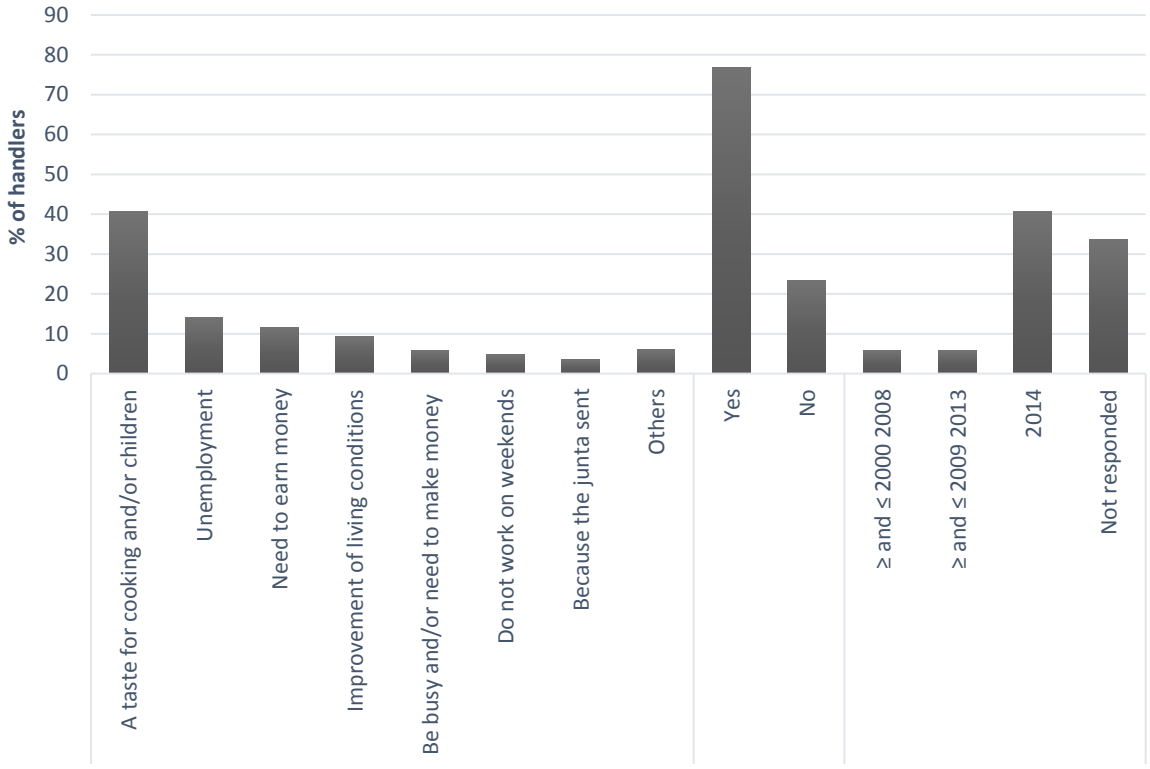

Figure 4. Socio-demographic features of food handlers (motivation, previous training in hygiene and food safety, date of last training program attended).

Based on the motivation factors Figure 4, 40.7% of food handlers worked in canteens because they liked working in the kitchen and/or with children; 14% were previously unemployed; 11.7% needed the money; and 9.3% wanted to improve their living conditions. 66 (76.7%) out of the 86 food handlers interviewed had received specific training in hygiene and food safety, whereas the remaining 20 (23.3%) had no training. The latter (food handlers with no training) had worked as handlers in canteens for an average of 2 years and 5 months. 50% of the handlers who had training received their last training in 2014 and 33.6% couldn't remember when they had last attended training courses/programs.

3.2. Measurement model

To evaluate reflexive measurement models, we must first ascertain their reliability and validity.

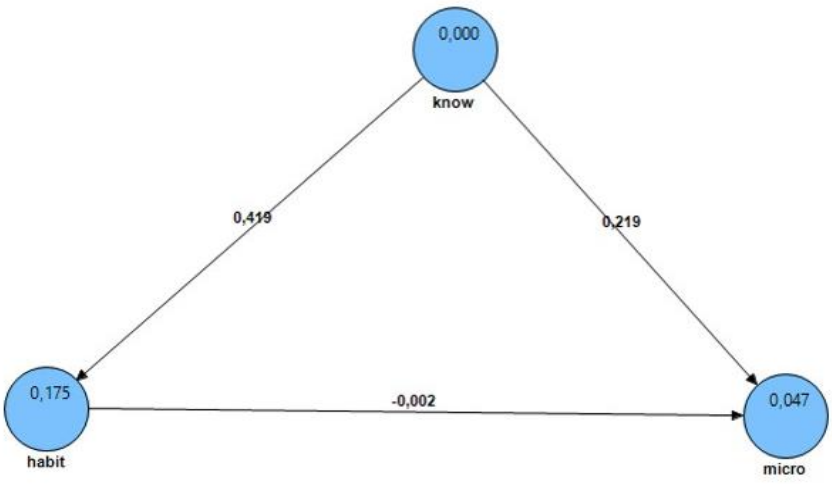

Figure 5. Measurement Model.

In our study, we began by analyzing the questionnaire's reliability. As can see in Table 3, we have established that, from the from 74 questions/remarks included in the questionnaire, only 22 have a reliability factor greater 0.7, and can, therefore, fulfill the reliability premise.

Table 3. Outer Loading the Habit, Knowing and Micro.

	Habit	**Know**	**Micro**
CS3	0	0,7165	0
CC1	0	0,7487	0
CC2	0	0,8364	0
CC3	0	0,9055	0
CC4	0	0,8482	0
CC5	0	0,8507	0
CC6	0	0,8753	0
PH11	0,7895	0	0

PH12	0,9134	0	0
PH18	0,7652	0	0
PH19	0,8449	0	0
PH20	0,8769	0	0
CD5	0,7578	0	0
Micro	0	0	1
CFS1	0	0,8046	0
CFS2	0	0,7948	0
HT1	0	0,7302	0
HT4	0	0,745	0
HT5	0	0,8469	0
RT3	0	0,7651	0
VT11	0	0,7696	0
VT7	0	0,7408	0

To analyze the construct's reliability, we analyzed the composite's reliability and the Cronbach's alpha, where both should be greater than 0.7. This condition is satisfied in all reflective constructs and dimensions (Table 3 and Table 4).

To analyze the convergent validity, the Average Variance Extracted (AVE) was analyzed. As AVE surpassed 0.5 (Roldán & Sánchez-Franco, 2012), we concluded that all reflective dimensions and constructs attained convergent validity (Table 4).

Table 4. Measurement model.

	Construct/Dimension/indicator	*Cronbachs Alpha*	*Loading*	*Composite Reliability (CR)*	*Average Variance Extracted (AVE)*
Habit	0,9087		0,928	0,6834	
PH11	Do you wash your hands every time you change tasks?		0,7895		
PH12	Do you wash your hands before and after you handle any foodstuff?		0,9134		
PH18	Do you wash your hands after you handle chemical products or cleaning equipment?		0,7652		
PH19	Do you wash your hands after touching dirty surfaces?		0,8449		
PH20	Do you wash your hands after touching leftovers, rubbish and/or rubbish bags/cans?		0,8769		
CD5	Do you clean the objects and surfaces you are going to use before and after handling food?		0,7578		
Know	0,9596		0,9638	0,6409	
CS3	Microorganisms that are responsible for foodborne diseases can develop at room temperature.		0,7165		

CS1	The use of gloves reduces the risk of transmitting infections to consumers.		0,7487		
CS2	Foodborne diseases can be caused by ready-to-eat food that has been in contact with raw meat.		0,8364		
CS3	Taking multiple steps when preparing foodstuffs increases the amount of handling and can therefore increase the risk of contamination.		0,9055		
CS4	Raw food should be kept separate from cooked food.		0,8482		
CS5	Microorganisms can contaminate food through contact with other contaminated goods.		0,8507		
CS6	Preparation surfaces can also be responsible for food contamination.		0,8753		
CFS1	Food handlers are responsible for preventing food poisoning.		0,8046		
CFS2	Keeping a clean environment in the kitchen area is a way of controlling food safety.		0,7948		
HT1	Time and temperature are important factors when constraining bacterial growth.		0,7302		
HT4	Leftovers should be reheated at 75ºC.		0,745		

HT5	Keeping food at room temperature for a long period of time may cause microorganisms to grow/expand.		0,8469		
RT3	Cooked food may be safely refrigerated at temperatures below 5ºC.		0,7651		
VT11	Foodborne diseases are usually infectious or toxic diseases caused by agents that enter the body through the ingestion of water or food.		0,7696		
VT7	Lettuce and other vegetables may contain dangerous microorganisms.		0,7408		
Micro	1		1	1	
MICRO			0		

***** p<0,01 (basead on t (4999, two-tailed test)**

To analyze the discriminant validity (which indicates if the construct is different from other constructs), we have demonstrated that the correlations between the constructs are smaller than the square root of AVE, as can see in Table 5 (in bold).

Table 5. Discriminant Validity.

	(1)	*(2)*	*(3)*
(1) Habit	**0,863**	0	0
(2) Know	0,4276	**0,810**	0
(3) Micro	0,8099	0,444	**0,829**

So, with this analysis we have confirmed the discriminant validity of the constructs and validated the measurement model (Figure 5).

3.3. Structural model

To evaluate the statistical significance of path coefficients, we used bootstrapping analysis (with 5000 resamples) to generate standard errors, t-statistics, and confidence intervals of standardized regression coefficients. With this analysis we established that all direct effects are significant for the proposed model (Figure 5 and Figure 6).

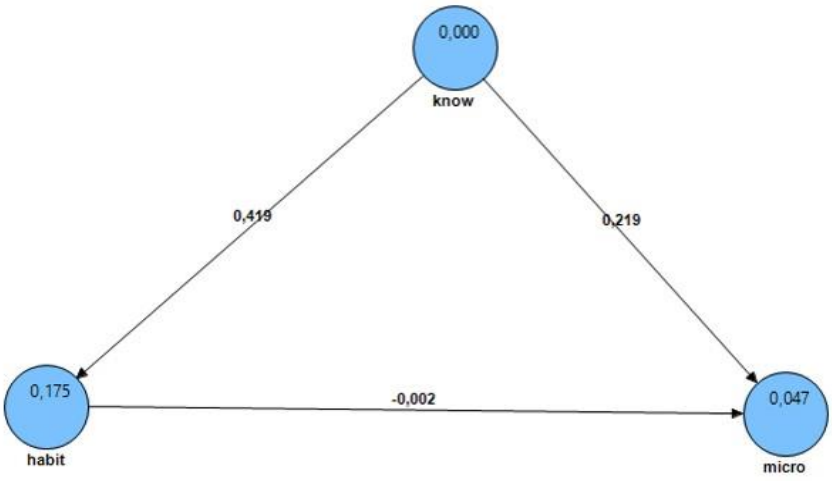

Figure 6. Structural Model (bootstrap analysis).

Analyzing the percentile bootstrap at 95% confidence interval also validates the statistical significance of path coefficients. This result supports H2 and H3 (Table 6). It does not validate the H1 hypothesis.

Table 6. Effects on the endogenous variable.

Hypothesis		***Direct effect***	***t-value (bootstrap)***	***Percentile 95% confidence interval***	***Support***	***Explained variance***
H1	**Habit -> Micro**	0,0027	0.086	[-0,0515; 0,0263] Sig.	NO	NA
H2	**Know -> Habit**	0,43	5.388	[;0,291875; 0,59525] Sig.	Yes	18%
H3	**Know -> Micro**	0,2166	4.280	[0,117775; 0,30535] Sig	Yes	5%

NA: Not applicable

With this analysis, we established that the entire supported hypothesis explains part of the variance, namely, “Know” explains 18% of the Hygiene Habits, and 5% of the Micro variance.

In this model we can determine that knowledge regarding hygiene and food safety (Know) has a positive influence on hygiene practices (Habits) and is also linked to microbiological outcomes (Micro). In our study, hygiene habits had no effect on microbiological outcomes.

Ko (2013) e Sani et al. (2014) in their study, in which they established that food handlers’ level of knowledge regarding food safety has an impact on their hygienic practices and the fact they handle food according to safety norms and standards. However, this knowledge can be influenced by other factors. *Santos* et al. (2008), Osaili et al. (2013), and Faour-Klingbeil et al. (2015) have concluded that food handlers’ knowledge of food safety can be shaped by training, i.e., handlers who have had training have a better understanding and more knowledge of HFS than those who haven’t had any training. Also according to Santos et al. (2008), food handlers who have had recent training are better informed that those who received training 6 or more years ago. McIntyre et al. (2013) found that the handlers’ knowledge regarding food safety wanes over time. He determined a significant loss of knowledge over a 15-year period, i.e., those who had received

training recently had a higher level of knowledge that those that had it 15 or more years before. Taking into account the fact that training improves knowledge and considering that the handlers' knowledge levels decrease over time, handlers should get regular training (McIntyre et al., 2013). However, this is a relative factor, as the number of courses and the duration of training do not directly translate into being "more knowledgeable" (Santos et al., 2008), meaning that handlers who have attended more courses or have more hours of training do not necessarily have a better understanding and knowledge of food safety. Cakiroglu et al. (2008), Martins et al. (2012), McIntyre et al. (2013) determined that handlers who have worked in canteens longer and have a higher level of experience, have more knowledge of food safety than those who have worked for less time. Faour-Klingbeil et al. (2015) established that handlers who had a 10 or more years of experience in the field had a greater level of knowledge. Santos et al. (2008), on the other hand, have found the opposite, i.e., fewer time on the field meant a better level of knowledge. In their study, Osaili et al. (2013) found that experience and time spent working in the field had no impact on food handlers' knowledge. According to McIntyre et al. (2013), Cakiroglu et al. (2008) and Martins et al. (2012) handler's academic background influences their knowledge, i.e., a higher level of schooling translates into a better knowledge of issues surrounding hygiene and food safety. In their study, the authors also found that handlers' motivations for working in school canteens was key and had a great influence on their knowledge regarding hygiene and food safety. McIntyre et al. (2013) also noted that age was only determinant in the group of handlers with no training. In this group, the older they were, the more knowledge they had. Faour-Klingbeil et al. (2015) found that food handlers in highest posts also had a higher level of knowledge.

As for hygiene practices, in this study we have come to the conclusion that only 18% can be credited to previous knowledge on food safety. Cakiroglu et al. (2008) and Santos et al. (2008) found that another important factor that impacts on hygiene, is the handler's academic background, i.e., the higher level of schooling, the better the hygiene practices and habits. Another important element is the employment duration (work experience). Santos et al. (2008) have found that food handlers who have less experience working in canteens, tend to follow

correct procedures, whereas Cakiroglu et al. (2008) have come to the opposite conclusion: having more experience reflects positively in handlers' hygiene practices. The more intense their work pace is, that is, the more meals they have to prepare, the harder it will be for food handlers to follow the correct hygienic procedures, which can lead to foodborne diseases. Food handlers' training continues to be a key element in determining their hygiene habits. If training isn't done properly and they are not shown all they can do in order to correctly sanitize their hands, work surfaces and utensils, it will be harder to inhibit the appearance and growth of microorganisms that can cause foodborne diseases (McIntyre et al., 2013).

The microbiological results of the analyses carried out are only influenced by previous knowledge of issues regarding hygiene and food safety by 5%. There have been many studies about the microbiological results before and after food handlers' training, i.e., analysing whether staff training can influence microbiological results. Soares et al. (2013) found that after food handlers have attended training, the count of hygiene indicators decreased about 60% in canteens and nearly 45% in coffee shops, i.e., training in hygiene and food safety was statistically relevant in reducing microbiological results in equipment, surfaces and the hands of food handlers. Garayoa et al. (2014) determined that after having received training, food handlers acquired a better understanding of cleaning and disinfection procedures, which had a positive impact on the results of microbiological analysis, i.e., staff training had a positive influence on microbiological results.

But are there other factors that influence microbiological results elements such the sanitization of the workplace, the use of cleaning products that are appropriate for the food industry, the correct hand washing and workplace cleaning procedures, as well has the state of facilities and the work pace should also be considered.

Training food handlers is a key element that can influence their knowledge and practices, and, therefore, have an impact on microbiological results. If this training is thought out in a way that it motivates handlers, i.e., is based mostly on practical everyday situations, it can translate into a deeper knowledge and higher level of

hygiene and food safety, thus preventing potential foodborne diseases and outbreaks.

3.4. Microbiological analysis

Surfaces that come into contact with foodstuffs and the hands of food handlers are the main source of food contamination. Therefore, they are key to preventing microorganism contamination. Microbiological analysis of the surfaces that have come in contact with food and food handlers' hands are an effective tool in assessing whether the hygiene and disinfection practices are being put in place correctly. Hence, it is necessary to monitor the surfaces and handlers' hands very closely through microbiological analysis.

Around 98% of the analysed surfaces were considered to be "acceptable" according to the previously defined criteria (Table 2). Therefore, 2.4% of surfaces were deemed "unacceptable". These results show that in the surfaces considered acceptable, the cleaning and sanitization procedures followed by food handlers were effective. 35.8% of the analysed surfaces achieved a value of 4 (Microorganisms at 30°C ≥ 1 ufc/cm2), 1.2% a value of 2 (Microorganisms at 30°C ≥ 1200 ufc/cm2 and *Enterobacteriaceae* < 1 ufc/cm2), and 1.2% a value of 1 (Microorganisms at 30°C and *Enterobacteriaceae* ≥ 1 ufc/cm2). According to Table 2, in all surfaces that achieved a value of 5 or 4 the results can be considered acceptable. As for the utensils that achieved a value of 1 or 2, they were considered to have been inappropriately sanitized. This might have happened for several reasons, as, for example, the ineffectiveness of the dishwasher or bad handling practices during storing. In some canteens the surfaces/utensils were kept in outdoor shelves. Other reasons for these hygiene problems may also include inadequate cleaning and disinfection procedures and the use of cleaning products that are not suited for the food industry. If the right procedures aren't put into practice in these canteens and if no adequate places are set out for storing utensils, there might be potential future foodborne outbreaks and food contamination. In our study 2.4% of the analysed surfaces exceeded the reference limits set in Table 2. Marzano et al. (2013), on the other hand, after analysing Italian school and kindergarten canteens observed that only

1.4% of surfaces were “unacceptable”. Another study carried out in Spanish schools, found that taps and chopping boards were the surfaces in which there was a higher count of microorganisms (that exceeded the limits) and determined this was due to inadequate cleaning and disinfection procedures (Rodriguez-Caturla et al., 2012). In another study, Garayoa et al. (2014) found that, after a second period of testing, 15.9% of surfaces had levels of contamination that were above the set limits. Soares et al. (2013), in a study that took place in coffee shops and canteens, noted that before food handlers received training, all canteens and 3 out of the 6 coffee shops analysed had acceptable microorganisms counts at 30º in surfaces/utensils. After having had training all establishments had acceptable levels. Another study about hygiene practices and foodstuffs in great scale events catering services (the 2012 Olympic Games in London), found that 52% of the samples taken from work surfaces and chopping boards had unsatisfactory results, specially compared with food and serving containers and utensils, with only 27% of unacceptable results (Willis, 2012).

Around 76% of the analyses performed on food handler’s had a satisfactory result regarding the microbiological hygiene indicators (Table 1). The results show that the presence of the coliform bacteria *E.coli* and *Staphylococcus* spp. in these handlers was negative. This can signal that these handlers have followed the correct hand washing procedure, hence avoiding potential contamination. However, some food handlers are unable to follow procedure due to the lack of knowledge regarding the series of steps that should be taken or the unavailability of adequate hand washing and drying material (e.g., exclusive hand washing sinks, antibacterial soap and industrial paper). In this case, 8.1% of handlers reached a value of 4, 15.1% a value of 3 and 1.2% a value of 2. Handlers with contaminated hands, i.e., whose hands had been incorrectly sanitized, should be informed of that fact, so that all those involved can understand what happened and control potential contamination sources, thus hindering prospective foodborne outbreaks.In a study carried out in Italian schools and kindergartens, the microbiological analyses done to food handlers’ hands showed that the total count of the coliform bacteria and *Staphylococcus aureus* exceeded the reference limits, in respectively 18.1% and 10.4% of cases (Marzano & Balzaretti,

2013). It was also determined that 21 handlers weren't adequately sanitizing their hands, as the presence of certain microorganisms (total coliform, *E.coli* and *S.aureus)* was detected. Soares *et al.* (2013) did not make out the presence (or lack thereof) of *E.coli* and *S. aureus*. However, much like in our study, a high percentage of total coliform was detected. The number of total coliforms found in canteens and coffee shops was considered unacceptable before handlers completed the sanitation procedures. However, the decrease found after the sanitation procedure was not deemed statistically relevant as it can't be separated from the fact that handler received training (Soares et al., 2013).

4. Conclusions

It is generally assumed that lack of knowledge may be responsible for inadequate and inefficient hygiene practices, thus leading to potential contamination and foodborne outbreaks. The outcomes of this study are unexpected since the show that habits are influenced by the knowledge of hygiene and food safety in only 18%, whereas microbiological results are influenced in only 5%.

As for microbiological results regarding the hygiene indicators in surfaces/utensils and the food handlers' hands, they are, for the most part, acceptable. Although there are situations in which the adequate sanitation and desinfection procedures aren't being followed. As a result, handlers or other specialized staff/monitor should review the procedures and the sanitization and disinfection products in order to determine where the problem is and take action to solve it.

One of the premises of future work would be the creation of a questionnaire specifically adapted to the canteen setting and to tasks perform by each operator. This would make it possible to get more specific results.

References

ASAE (2014). Doenças de Origem Alimentar. Retrieved a 30 de March, 2015, from http://www.asae.pt/.

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.

da Cunha, D. T., Fiorotti, R. M., Baldasso, J. G., de Sousa, M., Fontanezi, N. M., Caivano, S., Rubim Camargo, M. C. (2013). Improvement of food safety in school meal service during a long-term intervention period: a strategy based on the knowledge, attitude and practice triad. *Food Control, 34*(2), 662-667.

de Oliveira, A. B. A., da Cunha, D. T., Stedefeldt, E., Capalonga, R., Tondo, E. C., & Cardoso, M. R. I. (2014). Hygiene and good practices in school meal services: Organic matter on surfaces, microorganisms and health risks. *Food Control, 40*, 120-126.

EFSA (2007a). The Community Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents, Antimicrobial Resistance and Foodborne Outbreaks in the European Union in 2006: EFSA Journal 2007; (pp. 251, 254, 259, 261, 264.).

EFSA (2007b). The Community Summary Report onTrends and Sources of Zoonoses, Zoonotic Agents, Antimicrobial Resistance and Foodborne Outbreaks in 2005: EFSA Journal 2007; (pp. 221, 222, 223.).

EFSA (2009). The community summary report - Food-borne outbreaks in the European Union in 2007: EFSA Journal 2007 (pp. 24,37,40,48,50,56,64,66,75,79,88,91).

EFSA (2010). The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2008: EFSA Journal 2010; (pp. 243, 251, 254, 256, 259, 269).

EFSA (2011). The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2009: EFSA Journal 2011; (pp. 270, 281, 282, 297).

EFSA (2012). The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2010: EFSA Journal 2012; (pp. 325, 330, 338, 352, 355, 356, 361).

EFSA (2014). The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2012: EFSA Journal 2014; (pp. 263, 264, 273, 282, 288, 293, 298).

Egan, M. B., Raats, M. M., Grubb, S. M., Eves, A., Lumbers, M. L., Dean, M. S., & Adams, M. R. (2007). A review of food safety and food hygiene training studies in the commercial sector. *Food Control, 18*(10), 1180-1190.

Faour-Klingbeil, D., Kuri, V., & Todd, E. (2015). Investigating a link of two different types of food business management to the food safety knowledge, attitudes and practices of food handlers in Beirut, Lebanon. *Food Control, 55*, 166-175.

Garayoa, R., Diez-Leturia, M., Bes-Rastrollo, M., Garcia-Jalon, I., & Vitas, A. I. (2014). Catering services and HACCP: Temperature assessment and surface hygiene control before and after audits and a specific training session. *Food Control, 43*, 193-198.

Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. *Advances in International Marketing, 20*, 277-320.

ISO 4833 (2013). Microbiology of the food chain - Horizontal method for the enumeration of microorganisms - Colony count at 30 °C by the pour plate technique.

ISO 7218 (2007). Microbiology of food and animal feeding stuffs - General requirements and guidance for microbiological examinations (ponto 8).

ISO 18593 (2004). Microbiology of food and animal feeding stuffs - Horizontal methods for sampling techniques from surfaces using contact plates and swabs.

ISO 21528 - 2 (2004). Microbiology of food and animal feeding stuffs - Horizontal methods for the detection and enumeration of Enterobacteriaceae - Part 1: Detection and enumeration by MPN technique with pre-enrichment.

Ko, W. H. (2013). The relationship among food safety knowledge, attitudes and self-reported HACCP practices in restaurant employees. *Food Control, 29*(1),

192-197.

Little, C., & Sagoo, S. (2009). Evaluation of the hygiene of ready-to-eat food preparation areas and practices in mobile food vendors in the UK 431-443. . *International Journal of Environmental Health Research, 19*, 431-443.

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. (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.

McIntyre, L., Vallaster, L., Wilcott, L., Henderson, S. B., & Kosatsky, T. (2013). Evaluation of food safety knowledge, attitudes and self-reported hand washing practices in FOODSAFE trained and untrained food handlers in British Columbia, Canada. *Food Control, 30*(1), 150-156.

NP 1828 (1982). Microbiologia Alimentar. Colheita de amostra para análise microbiológica.

NP 2164 (1983). Microbiologia Alimentar. Regras gerais para a pesquisa de bactérias coliformes.

NP 2260 (1986). Microbiologia Alimentar. Regras gerias para a pesquisa de *Staphylococcus aureus*.

NP 2308 (1986). Microbiologia Alimnetar. Regras gerais para a pesquisa de *Escherichia coli*.

NP EN ISO/IEC 17025 (2005). General requeriments for the comperence of testing and calibration laboratories.

Osaili, T. M., Abu Jamous, D. O., Obeidat, B. A., Bawadi, H. A., Tayyem, R. F., & Subih, H. S. (2013). Food safety knowledge among food workers in restaurants in Jordan. *Food Control, 31*(1), 145-150.

Ringle, C. M., Wende, S., & Will, A. (2005). SmartPLS 2.0 (beta).

Rodriguez-Caturla, M. Y., Valero, A., Carrasco, E., Posada, G. D., Garcia-

Gimeno, R. M., & Zurera, G. (2012). Evaluation of hygiene practices and microbiological status of ready-to-eat vegetable salads in Spanish school canteens. *Journal of the Science of Food and Agriculture, 92*(11), 2332-2340.

Roldán, J. L., & Sánchez-Franco, M. J. (2012). Variance-based structural equation modeling: Guidelines for using partial least squares in information systems research. In O. M. Mora, A. Gelman, Steenkamp & M. Raisinghani (Eds.), *Research methodologies in engineering of software systems and information systems: Philosophies, methods and innovations* (pp. 193-221). Hershey, PA: Information Science Reference.

Sani, N. A., & Siow, O. N. (2014). Knowledge, attitudes and practices of food handlers on food safety in food service operations at the Universiti Kebangsaan Malaysia. *Food Control, 37*, 210-217.

Santos, M. J., Nogueira, J. R., Patarata, L., & Mayan, O. (2008). Knowledge levels of food handlers in Portuguese school canteens and their self-reported behaviour towards food safety. *International Journal of Environmental Health Research, 18*(6), 387-401.

Soares, K., Garcia-Diez, J., Esteves, A., Oliveira, I., & Saraiva, C. (2013). Evaluation of food safety training on hygienic conditions in food establishments. *Food Control, 34*(2), 613-618.

WHO (2015). Foodborne diseases. Retrieved 10 de March, 2015, from http://www.who.int/topics/foodborne_diseases/en/.

Willis, C., Elviss, N., Aird, H. , Fenelon, D., & McLauchlin, J. (2012). An Evaluation of Hygiene Practices in Catering Premises at Large Scale Events in the United Kingdom with a Focus on Identifying Risks for the Olympics 2012 Health Protection Agency Food Water and Environmental Microbiology Network

Annex 2: questionnaire used in the interview face to face to the handlers

The aim of this questionnaire is to study the level of knowledge of school canteens' workers regarding Hygiene and Food Safety

Socio-demographic features

Age	
Gender	
Academic qualifications	
Professional status/category	
Years on the job	
Previous occupation	
Reasons for applying for this job	
Training in Hygiene and Food Safety	
Date of the last training programme/course attended	
Number of hours of training in Hygiene and Food Safety	

Please indicate the degree to which you agree with the following statements:

VT	Vehicles of pathogen transmission in food	Disagree	Partially disagree	Agree	Partially agree	Totally agree
VT1	Fresh eggs may contain *Salmonella*.	☐	☐	☐	☐	☐
VT2	Microorganisms can always be found on the surface of meat.	☐	☐	☐	☐	☐
VT3	Canned food may contain microorganisms.	☐	☐	☐	☐	☐
VT4	Microorganisms that can contaminate food can be found on the skin, nose and mouth of healthy individuals.	☐	☐	☐	☐	☐

VT5	It is common to find *Salmonella* in chicken.	☐	☐	☐	☐	☐
VT6	Chicken can be more dangerous than beef and pork, due to the high probability of having *Salmonella.*	☐	☐	☐	☐	☐
VT7	Lettuce and other vegetables may contain dangerous microorganisms.	☐	☐	☐	☐	☐
VT8	Food served cold (salads) must not be disinfected.	☐	☐	☐	☐	☐
VT9	Cooked food does not contain microorganisms.	☐	☐	☐	☐	☐
VT10	Food prepared well in advance may allow microorganisms to develop and grow.	☐	☐	☐	☐	☐
VT11	Foodborne diseases are infectious or toxic diseases caused by agents that enter the body through the ingestion of water or food.	☐	☐	☐	☐	☐
VT12	*Staphylococus aureus* is linked to foodborne diseases.	☐	☐	☐	☐	☐
CC	**Cross Contamination**	**Disagree**	**Partially disagree**	**Agree**	**Partially agree**	**Totally agree**
CC1	The use of gloves reduces the risk of transmitting infections to consumers.	☐	☐	☐	☐	☐
CC2	Foodborne diseases can be caused by ready-to-eat food that has been in contact with raw meat.	☐	☐	☐	☐	☐
CC3	Taking multiple steps when preparing foodstuffs increases the amount of handling and can, therefore, increase the risk of contamination.	☐	☐	☐	☐	☐
CC4	Raw food should be kept separate from cooked food.	☐	☐	☐	☐	☐

CC5	Microorganisms can contaminate food through “superior” contact with other contaminated goods.	☐	☐	☐	☐	☐
CC6	Preparation surfaces can also be responsible for food contamination.	☐	☐	☐	☐	☐
CC7	Following the correct procedure for cleaning equipment and surfaces increases the risk of contamination.	☐	☐	☐	☐	☐
HT	**Heat treatment**	**Disagree**	**Partially disagree**	**Agree**	**Partially agree**	**Totally agree**
HT1	Time and temperature are essential to control bacterial growth.	☐	☐	☐	☐	☐
HT2	Cooked food can be kept in temperatures above 65ºC for some (2) hours.	☐	☐	☐	☐	☐
HT3	Food prepared in advance should be reheated at 75 ° C.	☐	☐	☐	☐	☐
HT4	Leftovers should be reheated at 75 ° C.	☐	☐	☐	☐	☐
HT5	Keeping food at room temperature for a long period of time may cause microorganisms to grow.	☐	☐	☐	☐	☐
RT	**Refrigeration techniques**	**Disagree**	**Partially disagree**	**Agree**	**Partially agree**	**Totally agree**
RT1	Leftovers should be stored in the containers in which they were prepared.	☐	☐	☐	☐	☐
RT2	Leftovers should be stored in shallow containers that are 5-10 cm deep, so that they can be adequately refrigerated.	☐	☐	☐	☐	☐
RT3	Cooked food can be safely refrigerated at temperatures below 5ºC.	☐	☐	☐	☐	☐

RT4	Food should be slowly cooled at room temperature before being stored in the refrigerator.	☐	☐	☐	☐	☐
CS	**Cold storage**	**Disagree**	**Partially disagree**	**Agree**	**Partially agree**	**Totally agree**
CS1	The temperature registered on thermometers should be checked once a day.	☐	☐	☐	☐	☐
CS2	Freezing kills all the bacteria responsible for foodborne diseases.	☐	☐	☐	☐	☐
CS3	Microorganisms that are responsible for foodborne diseases can grow at room temperature.	☐	☐	☐	☐	☐
CS4	Frozen food should be thawed at room temperature.	☐	☐	☐	☐	☐
CS5	After thawing, meat can be kept at room temperature up to 5 hours.	☐	☐	☐	☐	☐
CS6	Thawed food can be refrozen.	☐	☐	☐	☐	☐
CFS	**Concerns about food safety**	**Disagree**	**Partially disagree**	**Agree**	**Partially agree**	**Totally agree**
CFS1	Food handlers are responsible for preventing food poisoning.	☐	☐	☐	☐	☐
CFS2	Keeping a clean environment in the kitchen area is a way of controlling food safety.	☐	☐	☐	☐	☐
CFS3	Food safety is more important than taste.	☐	☐	☐	☐	☐
HACCP	**HACCP**	**Disagree**	**Partially disagree**	**Agree**	**Partially agree**	**Totally agree**
HACCP1	"HACCP" is short for “Dangers and Critical Control Points Analysis”. It is the best method of controlling food safety throughout the world.	☐	☐	☐	☐	☐
HACCP2	HACCP’s goal is to safeguard public health by preventing accidents (food poisoning, food poisoning by toxins or infections).	☐	☐	☐	☐	☐

HACCP3	HACCP addresses product's final quality and not preparation procedures.	☐	☐	☐	☐	☐

PH	Personal hygiene	Never	Rarely	Sometimes	Often	Always
PH1	Do you keep your fingernails short, thoroughly clean and without nail polish?	☐	☐	☐	☐	☐
PH2	When you wash your hands, do use warm water on your forearms and up to the elbows?	☐	☐	☐	☐	☐
PH3	Do you wash your hands and forearms with antibacterial liquid soap?	☐	☐	☐	☐	☐
PH4	When you wash your hands do you vigorously brush the area between your fingers, your thumb and the back of your hands for 20 seconds?	☐	☐	☐	☐	☐
PH5	When you wash your hands, do you brush your fingernails with an adequate brush (that is dried and cleaned in-between usage)?	☐	☐	☐	☐	☐
PH6	When you wash your hands, do you rinse them and your forearms with warm water until you remove the antibacterial soap completely?	☐	☐	☐	☐	☐
PH7	When you wash your hands do you thoroughly dry them with disposable towels?	☐	☐	☐	☐	☐
PH8	Do you wash your hands after putting on your uniform?	☐	☐	☐	☐	☐
PH9	Do you wash your hands before you start working?	☐	☐	☐	☐	☐
PH10	Do you wash your hands after you put on or change your gloves?	☐	☐	☐	☐	☐
PH11	Do you wash your hands every time you change tasks?	☐	☐	☐	☐	☐
PH12	Do you wash your hands before and after you handle any kind of foodstuff?	☐	☐	☐	☐	☐

PH13	Do you wash your hands after using the bathroom?	☐	☐	☐	☐	☐
PH14	Do you wash your hands after you touch your hair, eyes, mouth, ears or any other part of your body?	☐	☐	☐	☐	☐
PH15	Do you wash your hands after you blow your nose, sneeze or cough?	☐	☐	☐	☐	☐
PH16	Do you wash your hands after you eat, drink or smoke?	☐	☐	☐	☐	☐
PH17	Do you wash your hands after performing cleaning tasks?	☐	☐	☐	☐	☐
PH18	Do you wash your hands after you handle chemical products or cleaning equipment?	☐	☐	☐	☐	☐
PH19	Do you wash your hands after touching dirty surfaces?	☐	☐	☐	☐	☐
PH20	Do you wash your hands after touching leftovers, rubbish and/or rubbish bags/cans?	☐	☐	☐	☐	☐
PH21	Is your uniform clean, light and complete (with cap, apron, shoes, overall and trousers) and do you remove all sorts of accessories (earrings, rings, necklaces)?	☐	☐	☐	☐	☐
PH22	Do you take off your uniform when you are not preparing food?	☐	☐	☐	☐	☐
PH23	Do you take off your uniform during your breaks?	☐	☐	☐	☐	☐
PH24	Do you wear the same uniform when you are performing cleaning tasks and when you are preparing food?	☐	☐	☐	☐	☐
PH25	If you have diarrhoea, fever, a sore throat, or are vomiting will you still come to work?	☐	☐	☐	☐	☐
CD	**Cleaning and disinfection**	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**
CD1	Do you use cleaning products specifically designed for the food industry when sanitizing utensils and surfaces?	☐	☐	☐	☐	☐
CD2	Do you sanitize and disinfect the material/equipment used for cleaning at the end of each day or after using it?	☐	☐	☐	☐	☐

CD3	Do you wash the knives and chopping boards immediately after using them?	☐	☐	☐	☐	☐
CD4	Do you disinfect and clean the prepping surfaces when you change foods?	☐	☐	☐	☐	☐
CD5	Do you clean the objects and surfaces you use before and after handling food?	☐	☐	☐	☐	☐
CD6	Do you remove the rubbish from the surfaces?	☐	☐	☐	☐	☐
CD7	Do you use any sort of detergent solution to remove the dirt coverage and bacteria, keeping or suspending them in the solution?	☐	☐	☐	☐	☐
CD8	Do you rinse the suspended dirt and any residual soap?	☐	☐	☐	☐	☐
CD9	Do you dry clean or use other appropriate methods for removing dirt and residual detergent?	☐	☐	☐	☐	☐

Thank you for taking part in our study.

3. Conclusão

As auditorias relativamente às condições de higiene e segurança alimentar surgem associadas ao 6º princípio do HACCP que consiste em estabelecer procedimentos de verificação para avaliar se o funcionamento do sistema é eficaz. Assim, as auditorias às condições das cantinas escolares foram ferramentas importantes para verificar na prática o nível de implementação das boas práticas de higiene e segurança alimentar por parte dos manipuladores. Relativamente às condições de higiene e segurança alimentar das cantinas escolares pode-se concluir que apesar de ter havido um decréscimo da % das não conformidades de 2007 para 2014, sendo positivo, ainda existem não conformidades bastantes importantes para serem eliminadas e de fácil aplicação. Em todos os temas praticamente houve uma diminuição das % de não conformidades, no entanto muitas mantiveram-se e outras desapareceram em 2014. Em alguns itens houve um aumento da % de não conformidades, estes estão ligados principalmente ao estado das infraestruturas (paredes, tetos e portas) e à inexistência de registos referentes à receção das matérias-primas, ao controlo de pragas e outros registos importantes para controlar a higiene e segurança alimentar. Ainda existe uma grande parte de escolas que não usam produtos de higienização próprios para a área alimentar, devendo apostar nestes produtos para aumentar a higiene nas suas instalações. Outra conclusão que se pode retirar é a inexistência de um plano anual de formação, porém este deveria existir pois todos os manipuladores de alimentos devem ter formação em higiene e segurança alimentar. No entanto também foi possível observar que de 2007 para 2014 as boas práticas relacionadas com 45 itens dos 102 itens analisados foram devidamente implementadas em todas as cantinas escolares, não existindo não conformidades, ou seja a % de não conformidade em 2014 era 0%.

No estudo realizado ao conhecimento sobre questões de higiene e segurança alimentar e análises de indicadores de higiene é possível concluir que os hábitos são influenciados em 18% pelo conhecimento sobre questões de Higiene e Segurança Alimentar, e que o conhecimento influencia em 5% os resultados microbiológicos. Estes resultados ficam aquém do que era esperado pois de forma corrente associamos a falta de conhecimentos à existência de hábitos de

higiene incorretos e ineficientes que podem levar a contaminações e possíveis surtos alimentares. Quanto aos resultados microbiológicos quanto aos indicadores de higiene em superfícies / utensílios e manipuladores na sua maior parte, eram aceitáveis ou satisfatórios. Ou seja existe, na sua maioria, uma adequada implementação de boas práticas.