

FoodSimplex - a public health tool to improve restaurants cleaning and sanitation status

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Abstract: Foodborne diseases have a negative impact on health, and little consideration has been given to such because the symptoms are often moderate and self-limiting. The microbiological contamination of meals by catering systems is one of the main issues, and it must be assessed to ensure safer meals. The aim of this study is to evaluate the hygienic quality in portuguese micro, small and medium restaurants through audit data and microbial sampling through the application of new food safety methodology – FoodSimplex. This four-year longitudinal study revealed maintenance or an improvement in the compliance with hygiene requirements according to the FoodSimplex checklist, and with statistical significance evolution in food handlers hands microbial analyses ($p=0,003$), which confirms that FoodSimplex contributed for a general food safety status uplift.

Keywords: public health, food safety, foodsimplex, restaurants, hygiene status.

Resumen: *FoodSimplex - una herramienta de salud pública para mejorar el estado de sanitario de los restaurantes*

Las enfermedades transmitidas por los alimentos tienen un impacto negativo en la salud y se les ha prestado poca atención porque los síntomas suelen ser moderados y autolimitados. La contaminación microbiológica de las comidas por los sistemas de restauración es uno de los principales problemas, y debe evaluarse para garantizar comidas más seguras. El objetivo de este estudio es evaluar la calidad higiénica en micro, pequeños y medianos restaurantes portugueses a través de datos de auditoría y muestreo microbiano mediante la aplicación de una nueva metodología de seguridad alimentaria: FoodSimplex. Este estudio longitudinal de cuatro años reveló un mantenimiento o una mejora en el cumplimiento de los requisitos de higiene de acuerdo con la lista de verificación de FoodSimplex, y con una evolución estadísticamente significativa en los análisis microbianos ($p = 0,003$), que confirma que FoodSimplex contribuyó para aumentar la seguridad general de los alimentos.

Palabras clave: salud pública, seguridad alimentaria, foodsimplex, restaurantes, higiene.

Introduction

The trend towards consuming meals outside of the home is found in many countries. The continued improvement of quality and productivity in restaurants can be a competitive advantage that leads the client to prefer one service over another, making quality a tool for proper sustainable management. The employees and owners food handling activities are directly related to managing hygienic-sanitary quality and for providing safe meals to the clients (Medeiros, Cavalli & Proença, 2012). Severe shortcomings have been noted in food safety knowledge of restaurant head chefs, catering managers, and other persons in charge of hygiene (Läikkö-Roto & Nevas, 2014).

Hygienic food preparation and the education of those involved in preparing, processing and service of meals are essential lines of defence in the prevention of most types of foodborne illness the infectious agent may be transferred to food directly or by cross-contamination (Veiros *et al.*, 2009).

A common outcome of poor knowledge is a recommendation for training. According to some authors, regular training programs for

the safe production of food and effective handwashing practices should be introduced. Recently, combined theoretical and practical training of food safety was shown to lead to a lower level of hand contamination (Soares *et al.*, 2013).

There are limitations relating to finances, technical, information and human resources existing in micro, small and medium enterprizes (SMEs) of the mass catering sector (Charalambous *et al.*, 2015). This fact takes to a severe hindrance to the implementation of the food safety systems, like Hazard Analyse Critical Control Point (HACCP), in this group of food businesses (FAO/WHO, 2006). There are many barriers hindering the implementation of the HACCP system in SMEs that involves a lack of understanding of the need for system documentation (Holt & Henson, 2000), a lack of qualified staff for the system implementation, insufficient skills for the assessment of the qualifications of an external consultant who is employed for the HACCP implementation (Karipidis *et al.*, 2009), limitations relating to qualified and experienced staff, as well as a low level of knowledge of food safety relating to the control of microbiological hazards (Walker, Pritchard & Forsythe, 2003).

The consumption of contaminated food by pathogenic microorganisms and their toxins are the main responsible for foodborne diseases (FBDs), in particular, gastrointestinal infections which have a severe negative impact in public health (Marzano & Balzaretto, 2011). In foodservice environments, various factors are related to FBDs, like unsafe sources of food, inadequate cooking, improper holding temperatures, contaminated equipment and poor personal hygiene. Hygienic food preparation and training of food handlers are essential lines of prevention of FBDs (Marzano & Balzaretto, 2011).

FoodSimplex is a food safety methodologic tool to SMEs restaurants that have the constraints mentioned above in the implementation of HACCP. It's a defined combination of stages that includes diagnostic audits, HACCP documentation preparation, training, food safety audits, microbial analyses and plan for non-compliance treatment. FoodSimplex was designed as a public health tool to be applied by Food safety technicians (Baltazar *et al.*, 2017). This study results from an investigation regarding FoodSimplex, in order to compare food safety status towards cleaning and sanitation, good manufacturing practices (GMP), HAPPCs documentation and microbial analyses before, during and after its implementation. The aim of this particular study was to assess the hygienic quality of the restaurants based on audit and microbial analyses results with the application of FoodSimplex.

Methodology

The sample group was SMEs – restaurants in Portugal, in total forty-two volunteer SME's were recruited to participate in the study. The sample selection criteria were: Economic Activity Code (EAC) for the restaurant sector (Portuguese financial code); Geographic area (Leiria district); belong to SMEs Portuguese category (undertakings employing fewer than 250 persons and the annual turnover of which shall not exceed EUR 50 million or whose annual balance sheet total does not exceed EUR 43 million) and availability of the restaurants to participate in the study. The exclusion criteria were, not complying with the duration of the study, bankruptcy and change in economic activity or geographic area.

During the study in each business was applied FoodSimplex

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methodology (Table 1.)

Table 1: *Foodsimplex*

Stage	Actions
1	Diagnosis audit (Assessment of technical/functional premises conditions and HACCP prerequisites)
	HACCP documentation (HACCP plan; Layout; Flowchart; Products; e.g.)
2	Diagnosis audit report
	HACCP Dossier
	Training Action "Hygiene & Food Safety – Restaurants"
3	Microbiological samples
	Food safety audit
4	Audit and microbiological analysis reports
	Training Action "Treatment of non-compliance – audit and microbiological report."
	Restaurant Improvement Plan

In stage 1 was performed a diagnosis audit and gathering of information about the food business premises, on identifying any areas of potential improvement, and to design the HACCP plan. Stage 2, participants received introductory training in food hygiene, and HACCP was presented the diagnostic audit results and assistance to implement the pre-requisite programmes. After stage 2, the sampling plan for microbial analyses began as the Food safety audits, for every assessment, by this two means, was developed training regarding the correction of the non-compliance items and to design an improvement plan (Charalambous *et al.*, 2015).

Audit

Hygiene was assessed using an audit tool, developed for the purpose, after consideration of standard hygiene criteria such as those listed in official control audits and scientific literature.

The contents of the audit checklist were evaluated by Food safety experts, consisted of 70 observations and three modules (Table 2.), each of which could be answered as 'compliance', 'non-compliance' or "Not applicable". In this study for the assessment of the

Table 2: *Audit Checklist structure*

Module	Main Item	N° subitems
Good Manufacture Practices (GMP)	A. Reception	3
	B. Room Temperature Storage	6
	C. Cold Storage	9
	D. Preparation	4
	E. Cooking	7
	F. Serving	5
Cleaning and Sanitation	G. Personal Hygiene	4
	H. General Sanitation	8
	I. Cleaning & Disinfection	6
Prerequisites HACCP and documentation	J. Records	2
	K. Documentation	11
	L. Facilities	5

restaurants' hygiene has analysed the results of module "Cleaning and sanitation" and the subitem "hygiene of the facilities and equipment" in the GMP module for each item (Reception, Room Temperature and Cold Storage, Preparation, Cooking and Serving) and the "Facilities" module during the timeline of the investigation (Table 4.).

Microbiologic Analyses

Swabs were taken from the hands of food handlers prior to food contact in the pre-preparation, preparation and cooking areas and were collected by the swab method (Santana *et al.*, 2009). Samples of the hands were collected during the work of randomly selected food handlers from the SMEs restaurants, after washed the hands, according to the established procedure, before the harvest.

Sampling was performed using swabs, test and cap tubes, sterile disposable gloves, Styrofoam box, adhesive label and pen. The test tubes contained 10 mL of diluent (sterile buffered water) each, which were stored in styropor and the transportation was carried out under refrigeration (between 0 and 4° C) to the laboratory. The procedure was according to ISO 18593: 2004 – "Horizontal methods for sampling techniques from surfaces using contact plates and swabs" (point 8 and 9) and the microbial analysis of the hands of the workers, total aerobic microorganisms were counted at 30°C, was according to ISO 4833:2003 – "Horizontal method for the enumeration of microorganisms -- Colony-count technique at 30 degrees C".

The establishment of microbiological criteria is a risk management measure, which will allow an increase in consumer protection and competitiveness among food business operators through the definition of fair and precise rules in the European Union (Gomes, 2007). When establishing microbiological limits, the risks related to microorganisms and the conditions for food handling and consumption should be considered, as well as the likelihood of the microorganisms being distributed unequally in the food and the variability inherent in the analysis procedure (*Codex Alimentarius*, 2003). However, the criteria stipulated by Regulation (EC) N° 2073/2005 relate only to microorganisms in food, and no limits are established for the hands of manipulators. Due to the lack of microbiological criteria for the hands of handlers with food during meal confectionery, microbiological limits should be set on the basis of guides and standards of legislation, literature, practical experience, prior data and internal rules of each. Thus, each company must define the criteria that best fit its operating system. For this investigation, was considered the microbial criteria of laboratory responsible for the analyses.

The samples examined are divided into three categories: *satisfactory*, *acceptable* and *unsatisfactory*. A three-class sampling plan is used if it is acceptable that some samples exceed the lower limit (m), as long as a risk contamination level (M) is not exceeded. (Table 3.).

Table 3: *Laboratory Microbial Criteria (CFU/cm²)*

Microorganisms	Microbial Criteria (CFU/cm ²)		
	Unsatisfactory	Acceptable	Satisfactory
Microorganisms 30°C	> 10 ²	≥ 4 ≤ 10 ²	<4

Results

Hygiene Audit Data

The results in table 4. represent the percentages of conformities in the items and in the global hygiene assessment domain observed in the four audit moments. The Percentages of higher conformities are found in items "Facilities - Drinking Water", "Facilities - Gas and electricity", "Reception - Hygiene of the facilities and equipment", "Personal Hygiene – Visible diseases", "Cleaning & Disinfection - Operational dishwasher equipment", "General Sanitation –

Table 4: Hygiene Audit Data

Items	Subitens	Conformity (%)				p-value
		Aud. 1	Aud. 2	Aud. 3	Aud. 4	
Reception		91,3%	100,0%	87,0%	100,0%	0,475
Room Temperature Storage		52,2%	62,5%	58,3%	83,3%	0,085
Cold Storage	Hygiene of the facilities and equipment	20,8%	25,0%	8,3%	4,2%	0,112
Preparation		60,9%	58,3%	50,0%	82,6%	0,088
Cooking		45,8%	39,1%	54,2%	65,2%	0,157
Serving		81,0%	95,7%	78,3%	83,3%	0,249
Personal Hygiene	Uniforms	73,9%	47,6%	65,2%	75,0%	0,028
	Gloves	80,0%	83,3%	90,0%	100,0%	a)
	Evidence of adornments and/or lack of personal hygiene	81,0%	95,5%	90,9%	95,0%	0,417
	Visible diseases	100,0%	100,0%	100,0%	100,0%	0,468
General Sanitation	Dressing rooms	33,3%	47,8%	56,5%	77,3%	0,013
	Soap and disinfectant dispensers and towel rails	52,2%	58,3%	54,2%	78,3%	0,210
	No manual washbasin with hot and cold water	38,5%	26,1%	27,3%	28,6%	0,981
	First aid kit	55,0%	38,9%	57,9%	47,4%	0,585
	Cloths	60,9%	78,3%	70,8%	75,0%	0,487
	Obsolete material and equipment	70,8%	73,9%	63,6%	79,2%	0,474
	Use/conditions of non-food products	95,8%	95,7%	77,3%	94,7%	0,042
	Sanitary plan compliance	80,0%	83,3%	83,3%	100,0%	a)
Cleaning & Disinfection	Dishwashing conditions	41,7%	20,8%	25,0%	54,5%	0,046
	Operational dishwasher equipment	95,8%	95,7%	95,8%	95,8%	0,801
	Waste containers	17,4%	25,0%	25,0%	36,4%	0,420
	Pest Control	59,1%	57,1%	42,9%	57,1%	0,392
	Waste Treatment	83,3%	90,5%	85,0%	95,2%	0,595
	Chemical Products Storage	54,2%	69,6%	45,5%	73,9%	0,093
Facilities	General conditions	45,8%	62,5%	58,3%	58,3%	0,440
	Suitability	100,0%	83,3%	79,2%	91,7%	0,069
	Drinking Water	100,0%	100,0%	100,0%	100,0%	0,392
	Gas and electricity	100,0%	100,0%	100,0%	100,0%	1,000
	March in Front	75,0%	83,3%	66,7%	100,0%	0,004
Global assessment		66,0%	66,9%	63,8%	76,1%	0,004

a) not a reliable number of observations in audit

Use/conditions of non-food products” and “Facilities – Suitability”.

The items in which lower percentages of conformities were observed were “Cleaning & Disinfection - Waste containers”, “Cold Storage - Hygiene of the facilities and equipment”, “General Sanitation - No manual washbasin with hot and cold water”, “Cleaning & Disinfection - Dishwashing conditions”, “Facilities - General conditions”, “Cooking - Hygiene of the facilities, equipment and utensils” and “General Sanitation - Dressing rooms”.

The Cochran's Q test revealed the existence of statistically significant differences (p-value < 0,05) in the items “Personal Hygiene – Uniforms”, “General Sanitation - Dressing rooms”, “General Sanitation – Use/conditions of non-food products”, “Cleaning & Disinfection - Dishwashing conditions” and “Facilities - March in Front”.

The Friedman test, used to compare the overall percentages of conformities in the four audit moments, revealed the existence of

Table 5: Food handlers Microbial Analyses (Unsatisfactory (US), Acceptable (A), Satisfactory (S))

Analyses object	N° sample	Parameters	First evaluation			Final evaluation			p-value
			US	A	S	US	A	S	
Food handlers	23	Microorganims at 30°	23,5%	32,4%	44,1%	0,0%	10,0%	90,0%	0,003

significant differences (p -value = 0.004), and it was found that the hygiene conditions improved at the fourth audit time.

Microbiologic Analyses – Food Handlers

The results in Table 5 verify that the percentage of microbiological analyzes done to food handlers with the satisfactory result was much higher in the last evaluation compared to the result observed in the first evaluation. The Wilcoxon signed ranks test revealed that the differences were statistically significant (p -value = 0.003).

Discussion

Audit

All sections of the audit score show the sample group made improvements in hygiene during the study by comparison with their score at the beginning. These results are similar to the study of Charalambous *et al.*, 2015.

Regarding the items concerning the meal production stages (reception, storage, preparation, cooking and distribution) the subitem “Hygiene of the facilities and equipment” presented a general improvement towards compliance, except in the cold storage. For this matter, the results might be due to the few numbers of equipment in the kitchens, that lead to ice accumulation, which compromises the hygiene status.

In the module “Personal Hygiene”, there was a statistical significant improvement in the use of uniforms (p = 0,028), regarding the “gloves” subitem there was not enough data to provide statistical analyse, because not always the food handlers tasks require their utilization as so it was not a reliable number of observations in audit moment. For the subitem “Evidence of adornments and/or lack of personal hygiene” there was a definite change unlike the investigation of Rodríguez *et al.*, 2011 which verified noncompliant behaviours of handlers, as the and change of gloves, use of aprons for cleaning hands, and wearing jewellery. Rodríguez *et al.*, 2011, Campos *et al.*, 2009 and Veiros *et al.*, 2009 detected the proper use of hair nets in only 23%, 33%, 24% respectively, in this investigation, 75% comply. Also, in Osimani *et al.*, 2018 food handlers of a canteen were found to wear earrings and necklaces during food preparation, and the required cap was not always correctly worn. Through the study, this kind of behaviour has received considerable attention through FoodSimplex training and procedures because it represents a concern as jewellery could inadvertently fall in the preparations, thus constituting a risk for the consumer.

In the audit assessment for “General Sanitation”, subitems like “Soap and disinfectant dispensers and towel rails”, “First aid kit”, “Cloths”, “Obsolete material and equipment” had improve towards compliance, with statistical significance in subitems “Dressing rooms” (p =0,013) and “Use/conditions of non-food products” (p =0,042).

The use of cloths, which can favour the bacterial spread, also had an improvement (Bergen *et al.*, 2009).

For the item “Cleaning and Disinfection”, Osimani *et al.*, 2018 found negative compliance in general conditions of cleanliness, concerning food preparation areas, low level of inadequacy for the cleanliness of tools and tableware. In this study, dishwashing conditions have improved some restaurants initially didn’t have dishwashing machines or with no pre-washing procedures (p -value = 0.046), restaurants with dishwashing machines presented some times

problems in drying procedure. Waste containers were recommended to be in washable material with plastic bags in the interior and with waste separation for reclining.

Pest control fulfilled the designation, but there was some inadequate management in the file sheets archive, map of baits and identification of the placement of the same in the kitchen.

Regarding the item “Facilities” there was a generally positive change to compliance in all subitems. Initially like Haukijärvi & Lundén, 2017 mainly noncompliance was concerning infrastructure with cleaning facilities missing, adverse conditions of ceilings, walls and floors and with small spaces for their intended purpose. The terms of potable water, gas and electricity supply were adequate and remained in that condition through the study (p -value=1). Facilities “general conditions” improved with hygiene practices but the suitability of the facilities and a small decline in compliance, due to adulteration of the use of some areas in service time (e.g. preparation zone with unclean crockery). The “march in front” practice, had an improvement through the design of flow diagrams in each kitchen layout, no improvement with statistical significance (p -value=0.004).

The correction of noncompliance related to infrastructure can be difficult due to economic reasons and especially difficult when operations have started. Proper facilities enabling GMPs are essential at all types of food premises, especially in restaurants, which are the most common sites of foodborne outbreaks (Haukijärvi & Lundén, 2017; Zoonosis Center, 2015). The FoodSimplex methodology allowed an evolution towards compliance in this item in SMEs restaurants.

At the end of the investigation and according to cleaning and sanitation assessment in audit data, there was a statistical significant improvement towards compliance (p -value=0.004).

Microbiologic Analyses – Food Handlers

Rodríguez *et al.*, 2011 verified regarding the use of gloves, that the general trend observed was that food handlers did not use gloves regularly, and hand washing was not always done correctly. These inappropriate behaviours can lead to the presence of pathogens, that can survive for a relatively long time and could also be transmitted through the food chain. In this investigation, there was an improvement with statistical significance in food handlers hands microbial analyses (p =0,003), which confirms that the FoodSimplex methodology contributed for the uplift.

Unhygienic handling of food causes a critical risk for food safety. Poor hygiene has been shown to lead to the detection of pathogens like *Salmonella Enteritidis* on hand towel samples and *Staphylococcus aureus* and *Escherichia coli* O157:H7 in the working equipment (Sheth, Gupta, & Ambegaonkar, 2011). Among food handlers, a lack of knowledge has been reported regarding food allergens, temperatures in food handling, hand hygiene, and other microbiological risks for food contamination.

The primer identification of deficient practices leads to the implementation of effective training methods for food handlers in food service systems. The results of several studies by Bergen *et al.*, Santana *et al.* and Veiros *et al.*, have confirmed that training of food handlers can be useful. However, training should be repeated over time to overcome the reluctance of food handlers to apply the acquired knowledge, which it looked on with FoodSimplex.

FoodSimplex had in account other factors that influence the hygiene of food handlers like the number of meals served, the socioeconomic

status of the geographical area, and the number and qualifications of the staff members (Bering, 2008; Griffith, 2002) and relies in recommended periodic microbiological assessment of highrisk food service operations, in addition to visual inspection, for minimizing the risk of foodborne disease outbreaks.

Conclusion

Studies have associated foodborne disease outbreaks with poor personal hygiene than with unsafe food sources. This investigation performed a 4-year intervention in SMEs restaurants with the application of FoodSimplex methodology regarding hygiene status. Based on the results, the improvement towards compliance were statistical significant not only in audit data but also in food handlers hands microbial analyses. The scores on attributes evaluated in the checklist were correlated with microbial counts in food handlers hands, initially with a relation between audit and microbial data to improper hygienic measures, but along the study the improvement was notorious. As so, FoodSimplex is shown to be an essential public health tool, with effective contribute to the safety uplift of the meals served.

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