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ORIGINAL RESEARCH ARTICLE

Evaluation of Hygienic Quality of Food Served in Universities Canteens of Northem Portugal

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Abstract Mass catering services have increased in the last years since people need to eat out mainly by work or study reasons. Microbiological quality of foodstuffs (n = 156) was evaluated in 20 food establishment (cafes and canteens) of two universities of northern Portugal. Overall, data revealed a high level of microbiological quality of foods served. No safety risks for consumers were detected since *Clostridium* spp., *Listeria monocytogenes* and *Salmonella* spp. were not detected. Among food types, hot meals displayed better microbiological results than cold foods ($p < 0.05$) as expected. Regarding hot meals, no differences were observed among different types ($p > 0.05$). Among cold meals, salads displayed the highest microbiological counts for hygiene indicators as well for food foodborne pathogens such as *Staphylococcus aureus*, *Escherichia coli* and *Bacillus cereus.* Although the risk of foodborne disease is scarce since counts were low. In cafes' meals, higher counts were observed than in canteens' meals which indicates that monitoring measures should be improved to avoid potential foodborne outbreaks related to the ready-to-eat products (salads, sandwiches and pastry). Results could be used as microbiological guidelines for canteens. Results indicated that proper food handling and adequate conservation of fresh foods along the food chain is essential in mass catering services to guarantee the food safety.

Keywords Canteens · Food safety · Foodborne pathogens · Cold foods · Hot foods

Introduction

Mass catering services have increased in the last years since people need to eat out mainly by work or study reasons. Regarding education establishments such as schools or colleges, they are characterized to serve a large amount of meals per day. Thus, food safety in canteens is a fundamental priority since meals, which special importance in primary schools, are destined to risk population [1]. In the European Union, all food operators (including catering services and industrial kitchens), must comply a set of food policies called the food package that laid down specific condition for food premises, food handlers, hygiene, traceability, microbial control, pest control, food storage, water supply or food equipment maintenance, among others. Also, all of them must put in place a food safety program based on HACCP methodology [2–5].

Currently, meals for school canteens are produced in a centralized kitchen and after meals are distributed throughout authorized transport to canteens. However, in Portugal most of schools from 5th to 12th degree as well as universities, have their own kitchens that supply meals for their canteens that are located in the same place.

Catering services have been related to several foodborne outbreaks associated to cross-contamination, deficient hand

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washing, improper cleaning and disinfection, inadequate food preparation practices or even airborne contamination [6–8]. Other factors such us the wide variety of dishes, limited human resources, insufficient knowledge, low motivation of employees, excessive work hours or outdated facilities may contribute to the failure of the compliance of the HACCP and further outbreaks [9]. Thus, the implementation of surveillance programs to guarantee the food safety is essential. Among them, measures such as *in-loco* training and *on-site* monitoring activities have been recommended [10]. Regarding microbiological analysis of finished products (e.g. meals), they are indicated for food process and product safety verification [11]. Thus, periodic microbiological analysis of foods served at school canteens can be implemented as a surveillance program to guarantee the safety of prepared foods [12]. However, the main problem regarding the evaluation of the microbiological quality of the food served in canteens is the absence of specific policy about microbiological criteria in contrast to other food commodities [5]. Since breakfast, lunch, snack and also dinner in academic canteens or cafes is part of the daily habit of students, the objective of the present was to assess the microbial quality of foods served in two universities in northern Portugal.

Materials and Methods

Food Establishments' Characterization

The microbiological quality of RTE foodstuffs was evaluated in 20 food establishment of two universities (L1 and L2) both located in northern Portugal. First university (L1) presented 4 canteens and 7 cafes, while the second university (L2) presented 4 canteens and 5 cafes. Both types of food establishments are traditional "cook-serve". Characteristics regarding food safety management, food processing and type of foods served in canteens and cafes under study are described elsewhere [10].

Microbial Analysis

The microbiological control of foods under study focused on meals served at canteens and cafes in two universities. A total of 156 RTE food samples as follows: 94 from canteens (4 canteens L1 × 13 samples = 52 (plus 2 samples in one canteen) + (4 canteen L2 × 10 samples = 40) and 62 from cafes (7 cafes L1 × 6 samples = 42 + 5 cafes L2 × 4 samples = 20) were collected monthly in a 4-year period (2012–2016). For logistics reasons, all food samples were collected in the morning, between 9:00 a.m. and 11:00 a.m. on each sampling day. Food samples analyzed included salads, pasta, Portuguese cooked meat dishes (includes pork, beef, chicken, minced meat, meatballs, hamburguer or poultry), fish dishes (cod, hake, squid), vegetables, fast food (pizza, sandwich), pastry (meat patties and similar), soup, fruit and sweet bakery/desserts. Approximately 250 g of each food sample was aseptically collected and placed in a sterilized plastic bag. Food temperature was recorded with a portable thermometer at the time of sampling. All samples were transported within 1.5 h to the laboratory, using portable coolers. Samples were stored at 3 °C, for 2 h, until analysis. For microbiological analysis, 10 g of sample was aseptically weighed and then, 90 ml of sterile peptone salt solution [13] was added and homogenized in a stomacher (Lab Blender, U.K.) for 60 s. The serial decimal dilutions in the peptone salt solution were prepared and 1 or 0.1 ml samples of the appropriate dilutions were poured or spread on non-selective and selective agar plates. *Salmonella* spp. counts were obtained after incubation on xylose lysine deoxycholate agar (XLD, Biolab, Hungary) at 37 °C for 24–48 h; *Listeria monocytogenes* was incubated on oxford agar (OA, Biokar diagnostics, France) at 30 °C for 48 h; *Staphylococcus aureus* on Baird-Parker agar (BP, Biolab, Hungary), supplemented with egg yolk tellurite (Difco) and sulfamethazine and incubated at 37 °C for 48 h; total plate count (TPC) were enumerated in plate count agar media (PCA, Liofilchem) incubated at 30 °C for 72 h; yeast (YST) and mould (MLD) on supplemented Rose-Bengal Chloramphenicol agar (Oxoid) at 25 °C for 3–5 days; Enterobacteriaceae (ENT) were incubated in violet red bile glucose agar (VRBG; Liofilchem) at 35 °C for 24 h; *Escherichia coli* counts were obtained after incubation on tryptone-bile-glucuronic medium (TBX) (BiHimedia Lab pvt.) at 41.5 °C for 24 h; *Bacillus cereus* (BC) was performed on manitol egg polymyxin agar (MYP; Liofilchem) at 30 °C for 24 h. The enumeration of characteristic cell forming units for *Salmonella* spp. [14]; *L. monocytogenes* [15], total plate count [16], mould and yeast [17], total coliforms [18], and *E. coli* [19] was based on the identification procedures. The enumeration of Enterobacteriaceae [20], *B. cereus* [21] and coagulase-positive *S. aureus* [22, 23] was performed by biochemical tests and a coagulase test respectively. In case of microorganisms counts were below the detection limit, the result was considered to be zero for statistical purposes.

Data Analysis

To assess the microbiological quality of meals, all of them were classified according the standards as described in Table 1. In order to study the differences regarding the microbiological counts among of foodstuffs, location and type of establishment, a one-way ANOVA test was performed. Comparisons of means were obtained by the

Table 1 Microbiological quality classification of meals served at universities food establishment. Adapted from Santos et al. [24] and Gilbert et al. [25]

	Satisfactory	Acceptable	Unsatisfactory	Unacceptable
Indicators microorganisms				
Total plate count	< 5 log CFU/g	$\geq 5 < 6$ log CFU/g	≥ 6 log CFU/g	n/a
Enterobacteriaceae	< 2 Log CFU/g	$\geq 2 < 4$ log CFU/g	≥ 4 log CFU/g	n/a
Escherichia coli	≤ 1 log CFU/g	$> 1 < 2$ log CFU/g	≥ 2 log CFU/g	n/a
Mould	< 2 log CFU/g	$\geq 2 < 3$ log CFU/g	≥ 3 log CFU/g	n/a
Yeast	< 2 log CFU/g	$\geq 2 < 5$ log CFU/g	≥ 5 log CFU/g	n/a
Pathogenic microorganisms				
Staphylococcus aureus	< 1 log CFU/g	$\geq 1 \leq 3$ log CFU/g	$> 3 < 4$ log CFU/g	≥ 4 log CFU/g
Listeria monocytogenes	Absent in 25 g	≤ 2 log CFU/g	–	≥ 2 log CFU/g
Bacillus cereus	< 2 log CFU/g	$\geq 2 \leq 3$ log CFU/g	$> 3 < 5$ log CFU/g	≥ 5 log CFU/g
Clostridium spp.	< 1 log CFU/g	$\geq 1 \leq 3$ log CFU/g	$> 3 < 4$ log CFU/g	≥ 4 log CFU/g
Salmonella spp.	Absent in 25 g	–	–	Present in 25 g

Tukey HSD test, for a significance level of $p < 0.05$. According to the type of serving, foodstuffs were mainly classified in two groups: hot meals and cold meals. First includes salads, cakes and sandwiches while hot meals include cooked dishes mainly composed by rice, chicken, fish, meat, pasta or soup.

All meals had been classified into 4 levels: satisfactory, acceptable, unsatisfactory or unacceptable. These levels were established using the standard guide for evaluation of the microbiological quality of foods prepared in catering establishments [24] as reference for the total plate count, *E. coli*, *S. aureus*, *L. monocytogenes*, *Clostridium* spp., *Salmonella* spp., *B. cereus*, mould and yeast. Enterobacteriaceae parameter was considered using guidelines for the microbiological quality of some RTE foods sampled at the point of sale [25]. Microbiological classification described above, was made based on the worst result obtained in one of the indicators/pathogens tested for each sample (Table 1).

The qualitative classification of foods and the influence of the type of foods, food establishment, location and hot/cold foods was assessed by Chi squared test for a significance level of $p < 0.05$. All statistical analyses were completed using SPSS Statistics Software (version 21).

Results and Discussion

Overall the data (Table 2) revealed a high level of microbiological quality of foods served, although microbiological counts for TPC and Enterobacteriaceae displayed better results than reported elsewhere [26]. In addition, data revealed that hot meals displayed lower microbiological counts than cold meals. Proper implementation of good hygiene practice are essential to guarantee low microbiological counts as reported by other authors [27] in which a reduction up to 4 log CFU/g of TPC in canteens' meals were achieved after its implementation. According our results, no safety risks for the consumers were considered, since *Clostridium* spp., *L. monocytogenes* and *Salmonella* spp. were not detected [8]. Presence of foodborne pathogens in catering units has been associated to improper cooking [28].

Regarding cold meals, salads presented the highest microbiological counts for hygiene indicators as well food foodborne pathogens (*S. aureus* and *E. coli*) [26]. Results are compatible with factors such as poor disinfection procedures, cross-contamination and absence of thermal processing [29, 30] reported similar results in salads for TPC. However those authors founded lower counts (< 1 log CFU/g) for Enterobacteriaceae after monitoring the cutting and after using active chlorine in washing lettuces. This suggests that sanitizing procedures of vegetables in canteens and cafes under study should be improved to reduce the contamination levels. Although sandwiches displayed lower microbiological counts, no statistical differences were observed with exception of Enterobacteriaceae. Presence of *B. cereus* in salads served at canteens has been recently in the literature [8]. Its presence has been associated to improper washing and sanitizing since spores may survive. Although salads studied presented the highest counts for *B. cereus*, the risk of foodborne intoxication is scarce since counts about 5 log CFU/g have been referred as the limit which foodborne disease can occur [31]. The microbiological results of salads make us reflect since new trends in healthy foods recommend the consumption of

Table 2 Microbiological counts (expressed as log CFU/g ± SD) of foodstuffs under study

	Cold meals				Hot meals						p (CM × HT)
	Cakes	Salads	Sandwich	p	Rice	Chicken	Fish	Meat	Pasta	Soup	p
n	28	17	43		8	3	12	24	5	16	
ENT	0.52 ± 1.17^{b}	2.05 ± 2.08^{a}	1.06 ± 1.24^{b}	< 0.01	0.41 ± 1.17	0.68 ± 1.19	1.26 ± 1.70	0.35 ± 0.73	1.18 ± 1.62	0.18 ± 1.64	ns	< 0.01
TPC	1.23 ± 1.60^{a}	3.35 ± 1.48^{b}	2.50 ± 1.35^{b}	< 0.001	1.55 ± 1.76	1.55 ± 1.00	1.63 ± 1.34	1.11 ± 1.35	3.01 ± 0.79	1.23 ± 1.74	ns	< 0.001
MY	0.57 ± 1.04^{a}	2.11 ± 1.36^{b}	1.08 ± 1.26^{b}	< 0.001	0.52 ± 1.08	0.88 ± 1.53	0.18 ± 0.36	0.09 ± 0.27	0.78 ± 0.90	0.20 ± 0.62	ns	< 0.001
LAB	1.04 ± 1.34^{a}	2.53 ± 1.69^{b}	1.46 ± 1.47^{b}	< 0.01	0.62 ± 1.18	0.88 ± 1.53	1.46 ± 1.86	0.98 ± 1.33	2.47 ± 2.67	1.00 ± 1.68	ns	ns
BC	0.02 ± 0.10	0.16 ± 0.58	0.02 ± 0.13	ns	nd	nd	nd	0.03 ± 0.14	nd	0.11 ± 0.29	ns	ns
EC	nd	0.06 ± 0.28	nd	–	nd	nd	nd	nd	nd	nd	–	–
SA	0.17 ± 0.56	0.22 ± 0.51	0.25 ± 0.8	–	0.09 ± 0.14	nd	0.36 ± 0.84	0.09 ± 0.32	0.28 ± 0.64	ns	ns	ns
CLOS	nd	nd	nd	–	nd	nd	nd	nd	nd	nd	–	–
SAL	nd	nd	nd	–	nd	nd	nd	nd	nd	nd	–	–
LIS	nd	nd	nd	–	nd	nd	nd	nd	nd	nd	–	–

N total number of samples, *ENT* enterobacteriaceae, *TPC* total plate count, *MY* mould and yeast, *LAB* lactic acid bacteria, *BC Bacillus cereus*, *EC Escherichia coli*, *SA Staphylococcus aureus*, *CLOS Clostridium* spp., *SAL Salmonella* spp., *LIS Listeria monocytogenes*, *ns* not significant ($p > 0.05$), *nd* not detected, *CM* cold meals, *HM* hot meals

Different superscript letters indicate statistical differences

vegetables (i.e. raw, salads, etc.). Thus, proper food handling and adequate conservation of fresh foods along the food chain is essential is mass catering services to guarantee the food safety.

Low counts for all microbiological parameters studied for cakes are compatible by its constitution (low a_w) and manufacture (oven baked). Similar results for TPC and Enterobacteriaceae were reported [32] in the study the microbiological quality of ready-to-bake frozen pastries in canteens of the university campus. However, they reported the presence of *B. cereus*, *Salmonella* spp., or *L. monocytogenes*. Although neither *L. monocytogenes* nor *Salmonella* spp. were detected in the present study, this report indicates that this kind of products support the growth of foodborne pathogens. In consequence, food handlers' hygiene during handling and preparation is necessary to avoid cross-contamination.

Regarding hot meals, no differences were observed among different types. Overall, the best microbiological performance of soup may be associated to the cooking process (long thermal processing) as previously described for cakes.

Fish and pasta displayed, on average, two-fold count of Enterobacteriaceae than other meals studied. Although both meals are properly cooked, results may be associated because both meals are usually served accompanied with salads.

By location (Table 3), only TPC results were statistically different ($p < 0.05$). Among cold meals, higher TPC counts in cafes were observed for L1 while L2 displayed similar results in canteens. However, no differences were observed among locations ($p > 0.05$) with exception of MY. Although this result is difficult to explain, environmental contamination from outside may influenced the results [33]. Foodborne outbreaks associated to airborne pathogens is uncommon but quantitative and qualitative monitoring of bioaerosol in food environments have been discussed since eumycetes can pose different risk both for food safety and public health [34]. Hot meals showed similar results as cold meals in which higher microbiological counts were presented in foodstuffs in cafes at L1 and at canteens in L2. In the last case, statistical differences were observed for TPC and *B. cereus* counts.

According to the classification of foodstuffs (Table 4) served at cafes and canteens, from a total of 156 samples, 91 were considered as satisfactory, 48 acceptable and 17 not satisfactory. Similar results were also reported [29] in food served at schools's canteens. Statistical differences were observed among the quality of foodstuffs considered "cold" and "hot" ($p < 0.05$) and among locations ($p < 0.05$) but no differences were observed between food establishments. By each microbiological analysis, a total of 13, 3, 2 and 1 sample were classified as not satisfactory for

Table 3 Microbiological counts of cold and hot meals (log CFU/g ± SD) by food establishment on each location

	Cold meals						Hot meals						*p* (cafe × canteen)
	Cafe L1	Cafe L2	*p* (L1 × L2)	Canteen L1	Canteen L2	*p* (L1 × L2)	Cafe L1	Cafe L2	*p* (L1 × L2)	Canteen L1	Canteen L2	*p* (L1 × L2)	
ENT	1.13 ± 1.39	nd	ns	1.14 ± 1.67	1.86 ± 1.85	ns	1.01 ± 1.78	nd	ns	0.59 ± 1.15	0.37 ± 0.72	ns	ns
TPC	2.53 ± 1.64	2.14 ± 1.60	ns	1.79 ± 1.69	2.26 ± 1.55	ns	1.34 ± 1.09	nd	ns	1.74 ± 1.58[b]	0.65 ± 0.95[a]	< 0.01	< 0.001
MY	1.02 ± 1.30	0.58 ± 1.02	ns	1.14 ± 1.35[b]	2.28 ± 1.06[a]	< 0.05	0.16 ± 0.40	nd	ns	0.19 ± 0.44	0.56 ± 1.11	ns	ns
LAB	1.64 ± 1.49	0.58 ± 1.09	ns	1.45 ± 1.02	2.28 ± 1.06	ns	2.09 ± 1.96	nd	ns	1.19 ± 1.68	0.56 ± 1.11	ns	ns
BC	0.02 ± 0.13	0.04 ± 0.14	ns	0.10 ± 0.49	0.10 ± 0.18	ns	nd	nd	–	0.01 ± 0.05[b]	0.14 ± 0.33[a]	< 0.01	ns
EC	nd	nd	–	0.04 ± 0.24	nd	ns	nd	nd	–	nd	nd	–	ns
SA	0.23 ± 0.76	0.25 ± 0.72	ns	0.20 ± 0.50	0.23 ± 0.66	ns	0.16 ± 0.40	nd	ns	0.15 ± 0.51	0.02 ± 0.10	ns	ns
CLOS	nd	nd	–	nd	nd	–	nd	nd	–	nd	nd	–	–
SAL*	nd	nd	–	nd	nd	–	nd	nd	–	nd	nd	–	–
LIS*	nd	nd	–	nd	nd	–	nd	nd	–	nd	nd	–	–

N total number of samples, *ENT* enterobacteriaceae, *TPC* total plate count, *MY* mould and yeast, *LAB* lactic acid bacteria, *BC Bacillus cereus*, *EC Escherichia coli*, *SA Staphylococcus aureus*, *CLOS Clostridium* spp., *SAL Salmonella* spp., *LIS Listeria monocytogenes*, *ns* not significant ($p > 0.05$), *nd* not detected

Different superscript letters indicate statistical differences

*For *Salmonella* spp. and *L. monocytogenes*, all of the samples were below the detection limit and the pathogens were not detected in 25 g

Enterobacteriaceae, TPC, mould and yeast and *S. aureus*, respectively.

Microbiological quality of several food types in a school canteen [8] reported similar not acceptable levels (about 9%). In contrast, results regarding TPC were two-fold compared than our study. By type of foodstuff, 58% of them were considered as satisfactory, 31% acceptable and 11% not acceptable. Among them, salads and sandwiches were the worse classified.

Nowadays, school lunch is a daily practice for thousand of students worldwide. School meals are usually processed in central kitchens (e.g. catering services) that distribute foods for several schools in a specific area. However, cook-serve catering is a common practice at universities' food establishment due to the high number of students. Canteens comply the general food law regarding facilities, good practices and implementation of a HACCP plan. Even so, foodborne outbreaks associated to catering services have still reported [35, 36]. Microbiological quality of meals served at schools' canteens have been previously reported [12, 32] although scarce reports are available about the microbiological quality of meals served at university canteens. Also, the differences with other studies regarding the wide variety of ingredients and dishes, lack of data about the hygienic design of kitchens and cafes or information about training an education of the staff involved make comparison difficult [37]. In addition, the absence of microbiological criteria defined by law, both for food commodities served at these establishments and for hygienic criteria for food contact surfaces (in part explained by differences of dishes/facilities previously indicated) increases the problematic evaluation of microbiological quality of food served at canteens. Regarding public health, it is necessary to reflect if compulsory presence of a food safety technician, in each school, to verify in loco the compliance and implementation of the food safety system is necessary. Although the microbiological results obtained are acceptable, the presence of a person-in-charge could be considered necessary because school canteens are increasingly receiving a greater number of students, students represent a risk population and most cases of foodborne outbreaks in Portugal have been associated to meals at canteens of public institutions (schools, kindergartens or senior residences) [38]. It is important to highlight that families demand a more balanced diet with quality food. This new consumer trends implies aspects such as less thermal processing or increase use of raw foods such as vegetables and fruits, which implies a challenge for food safety. Although the implementation of a microbiological control program in this type of food establishment is economically unfeasible, periodic microbiological sampling could be an excellent source of information for process verification. Thus, the results of the

Table 4 Microbiological quality of different food types

MO	Microbiological quality	Rice	Cakes	Chicken	Fish	Meat	Pasta	Salads	Sandwich	Soup
SA	Satisfatory	8	26	3	10	24	4	16	40	16
	Acceptable	0	2	0	2	0	1	1	2	0
	Non satisfatory	0	0	0	0	0	0	0	1	0
LAB	Satisfatory	8	28	3	12	24	5	17	43	16
	Acceptable	0	0	0	0	0	0	0	0	0
	Non satisfatory	0	0	0	0	0	0	0	0	0
BC	Satisfatory	8	28	3	12	24	5	16	41	15
	Acceptable	0	0	0	0	0	0	1	2	1
	Non satisfatory	0	0	0	0	0	0	0	0	0
CLOS	Satisfatory	8	28	3	12	24	5	17	43	16
	Acceptable	0	0	0	0	0	0	0	0	0
	Non satisfatory	0	0	0	0	0	0	0	0	0
EC	Satisfatory	8	28	3	12	24	5	16	43	16
	Acceptable	0	0	0	0	0	0	1	0	0
	Non satisfatory	0	0	0	0	0	0	0	0	0
ENT	Satisfatory	7	25	3	9	23	3	6	30	15
	Acceptable	0	2	0	1	1	1	4	12	1
	Non satisfatory	1	1	0	2	0	1	7	1	0
LIS	Satisfatory	8	28	3	12	24	5	17	43	16
	Acceptable	0	0	0	0	0	0	0	0	0
	Non satisfatory	0	0	0	0	0	0	0	0	0
MY	Satisfatory	7	24	2	12	24	4	6	30	15
	Acceptable	1	4	1	0	0	1	10	12	1
	Non satisfatory	0	0	0	0	0	0	1	1	0
SAL	Satisfatory	8	28	3	12	24	5	17	43	16
	Acceptable	0	0	0	0	0	0	0	0	0
	Non satisfatory	0	0	0	0	0	0	0	0	0
TPC	Satisfatory	7	26	3	12	23	5	12	36	14
	Acceptable	1	1	0	0	1	0	4	6	2
	Non satisfatory	0	1	0	0	0	0	1	1	0

MO microorganisms, *ENT* enterobacteriaceae, *TPC* total plate count, *MY* mould and yeast, *LAB* lactic acid bacteria, *BC Bacillus cereus*, *EC Escherichia coli*, *SA Staphylococcus aureus*, *CLOS Clostridium* spp., *SAL Salmonella* spp., *LIS Listeria monocytogenes*, *ns* not significant ($p > 0.05$), *nd* not detected

Different superscript letters indicate statistical differences

current work can be used as a reference for the elaboration of national recommendations.

Conclusion

Catering services of universities' canteens represent a food safety challenge associated to the large variety of raw products, food handled by many individuals, different food storage conditions or different types of food processing. The present study showed that university canteens presented a high level of quality due to the low microbiological counts as well by the absence of risks for the consumers, since *Clostridium* spp., *L. monocytogenes* and *Salmonella* spp. were not detected.

Regarding cold meals, salads presented the highest microbiological counts for hygiene indicators as well for foodborne pathogens (*S. aureus* and *E. coli*). These results could be explained by factors such as poor disinfection procedures, cross-contamination and absence of thermal processing. Although sandwiches displayed lower microbiological counts than salads, no microbiological differences were observed among these groups. Some attention should be taken regarding the presence of *B. cereus* in salads. Since the risk of foodborne intoxication is negligible due to the low counts detected, the resistance of

Bacillus spores can arise as an emerging risk. In addition, the new tendencies of healthy diets that suggest an increase of vegetables consume (i.e. salads), may imply a food safety risk because since some foodborne pathogens such as *Listeria* spp., *Bacillus* spp. or *Clostridium* spp. are ubiquitous in nature. Thus, catering companies should pay attention to hygienic food handling and adequate conservation of fresh foods along the food chain to guarantee the safety of food served. Hot meals presented better microbiological results than cold meals. Although thermal processing (i.e. cooking) guarantees its safety, counts of TPC and Enterobacteriace indicate that special attention should be taken regarding cross-contamination.

Besides, implementation of HACCP plan is essential to guarantee the food safety, periodic microbiological analysis of meals served at canteens can be used as a surveillance program to improve an efficient management of food safety in catering foodservices.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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