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Good hygiene practices and microbiological contamination in commercial restaurants

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Food services and commercial restaurants have gained more space in people's lives. Thus, people are more concerned about food security and sanitary hygiene. The present study evaluated practices of manipulation and contamination of environments and the preparation of surfaces in commercial restaurants in Vitória-ES, Brazil. Data on good practices were collected through a checklist proposal based on the RDC 216/2004; air samples were collected via the simple sedimentation technique, while surfaces (countertops and utensils) were sampled via the swab technique to analyze the presence of microbial indicators (n = 12). Regarding buildings, facilities and utensils block, 50% of the restaurants were classified as unsatisfactory. In food handlers and storage and transport of prepared food blocks, 58 and 100% of the restaurants, respectively, were classified as unsatisfactory. 83% of the restaurants being classified as unsatisfactory in documentation and registration block, with emphasis on the lack of or inadequacy of the Good Practice Manual. The hygienic and sanitary conditions were considered unsatisfactory in most restaurants evaluated, representing a low agreement with the legislation. Air contamination levels were above the recommendations, which indicates inadequate practices in some of the establishments. All establishments were unsatisfactory when mesophilic bacteria were analyzed on countertops surfaces. Values of the order of 10^5 of aerobic mesophiles for knifes were observed. These results, together with the high percentage of inadequations, indicate the need for immediate action for control and prevention as well as a greater supervision by the competent organizations. Actions to reduce the risks of contamination and to ensure greater consumer safety are crucial.

Key words: Food quality, food service, quality control.

INTRODUCTION

With urbanization, extended working hours and a greater insertion of women into the labor market, the number of meals prepared out of the home has increased. As a consequence, food services, such as those offered in commercial restaurants, have gained more space in people's lives. This change in behavior has led to a greater concern about the food offered, especially from the point of view of hygienic and

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sanitary quality assurance (Ferreira et al., 2009; Coelho et al., 2010). The main causes of food contamination are associated with the development of undesirable microorganisms, which may render food repulsive due to the deterioration or the health risks posed by the presence of pathogenic bacteria. Transmission can occur through manipulation, inadequate preservation and or environmental contamination, since most pathogenic microorganisms are not normally present in food (Ferreira et al., 2009; Di Ciccio et al., 2015).

Foodborne diseases (FBD) are diseases caused by the presence of pathogenic microorganisms in food. These diseases are one of the main consequences of the lack of hygienic and sanitary control in the collective feeding sector, where biological, physical, and chemical hazards are found (Rahman et al., 2016). According to Rahman et al. (2016), the Centers for Disease Control and Prevention (CDC) have reported numerous different foodborne pathogens that can cause infections in humans.

To ensure safety in food production, it is necessary to implement good handling practices and standard operating procedures, which are a set of rules for the correct handling of food from the raw material to the final product and define when, why, how, and where activities should be carried out, thereby indicating the records used to ensure compliance with operations (Djekic et al., 2016).

In conjunction with good practices, the assessment of the microbiological conditions of food preparation sectors becomes essential for the production of quality meals. Poor equipment and utensil hygiene has been responsible, alone or associated with other factors, for outbreaks of FBD or for alterations in processed foods (Doménech-Sánchez et al., 2011).

Surfaces used for food preparation, such as appliances or utensils, may appear to be clean, but this condition may be misleading. If the preparation surface remains moist and has food residues, it may allow the adhesion of microorganisms and possibly the formation of microbial biofilms, which makes the cleaning process more difficult and increases the risks of cross-contamination (Andrade, 2008). Food contamination can occur in different stages of the food production process, from the receipt of the raw materials to the distribution of the preparations. Exposure of pathogens to surfaces can occur by direct contact with contaminated materials or indirectly through microbiota in the air (Di Ciccio et al., 2015).

In addition to the evaluation of the preparation areas, it is important to monitor the microbiological contamination of the air, which is characterized by aerosols formed by the vegetative cells of bacteria deposited on dust particles (Andrade, 2008). In food processing/preparation areas, routine employee activities, floor drains, ventilation systems, communication between different sectors, and equipment surfaces are recognized sources of aerosols (Byrne et al., 2008; Coelho et al., 2010).

The microorganisms present in these aerosols can travel by air and reach the food during preparation stages (São José, 2012). In view of the above, the objective of this study was to evaluate the adequacy of good handling practices and the microbiological contamination of environments and preparation surfaces in commercial restaurants in Vitória, Espírito Santo, Brazil.

MATERIALS AND METHODS

A cross-sectional study was conducted in commercial restaurants, located in Vitória-ES, between August and September 2015. For sample, locations close to the institution were preferred and then the microbiological analyses were carried out, totaling 12 self-service restaurants. The establishments were contacted by means of an invitation letter to present the research objectives, and then permission to visit was requested. All persons responsible for the participating establishments signed an authorization term guaranteeing the research (application of checklist and collection of air samples and surfaces). The analyses were conducted in the Laboratory of Microbiology of the Department of Pharmaceutical Sciences - Health Sciences Center, Federal University of Espírito Santo.

Assessment of good practices

Data collection on good manipulation practices was done through direct observation during visits by a trained researcher. For the evaluation, a checklist was proposed based on Resolution RDC 216/2004 (Brazil, 2004), divided into three parts: company identification, evaluation, and classification of the establishment. The checklist presented 12 question blocks evaluated in each restaurant, totaling 91 items, as follows: 'buildings, facilities, furniture and utensils' (17 items); 'Hygiene of facilities, equipment, furniture and utensils' (nine items); 'Integrated control of vector and pest' (three items); 'Water supply' (four items); 'Waste management' (three items); 'food handlers' (nine items); 'Food, ingredients, and packaging' (six items); 'Food preparation' (20 items); 'Storage and transport of prepared food' (three items); 'Exposure to the consumption of prepared food' (seven items); 'Documentation and registration' (eight items); 'Responsibility' (two items). Each item had three possible answers: 'Conform', 'Not Conform', and 'Not applicable' (NA). Subsequently, the classification was based on the scoring criteria established in item D of RDC 275/2002 (Brazil, 2002), namely: Good (76 to 100% attendance of items), Regular (51 to 75% attendance of items), and Unsatisfactory (0 to 50% of attendance of the items).

Microbiological analyses

Microbiological analyses consisted of the evaluation of air contamination and food preparation surfaces. Air sampling was carried out using the simple sedimentation technique in Petri dishes containing appropriate culture media for each microbial group evaluated, according to the methodology proposed by Evancho et al. (2001). Aerobic mesophile microorganism counts were performed on plates containing standard agar for counting (Acumedia®) after incubation for 24 to 48 h at 37°C. For counting of molds and yeasts, potato dextrose agar (Acumedia®), acidified with 1.5 mL of 10% tartaric acid for each 100 mL of medium, was

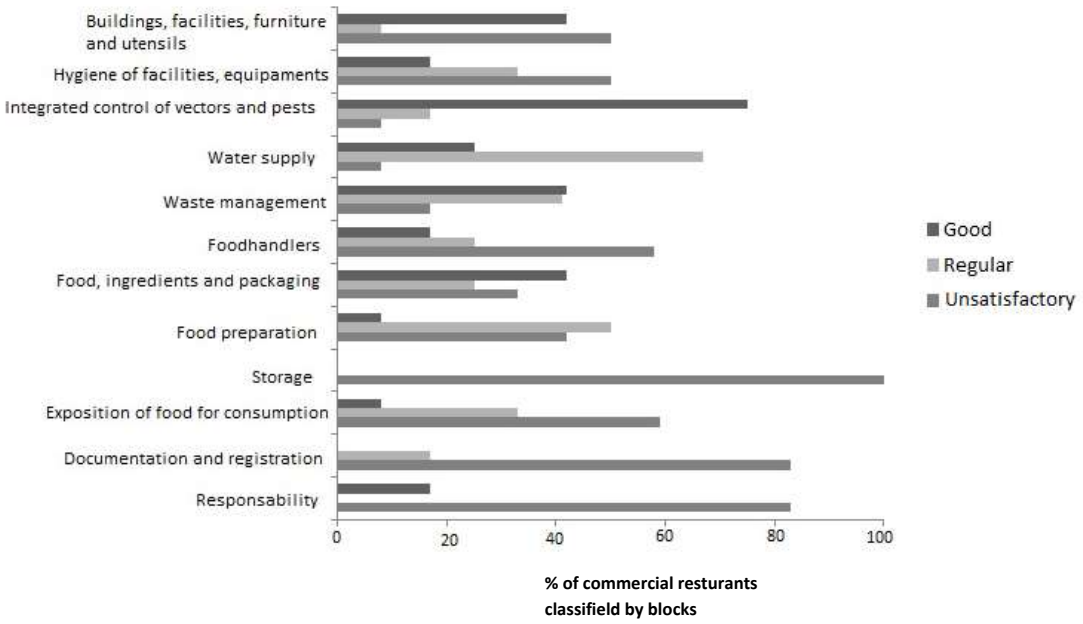

Figure 1. Classification by blocks regarding hygienic and sanitary conditions of commercial restaurants in Vitória-ES, Brazil, 2015.

used for incubation at 25°C for five to seven days. Gram-negative enteric bacteria were observed in MacConkey agar medium (Acumedia®), and the plates were incubated at 37°C for 48 h. The results, expressed as colony-forming units/cm^2 /week (CFU/cm^2/week), were calculated according to the following formula (Andrade, 2008):

Viable particles for cm^2/week = (CFU 10,080*)/ [(π r^2) t],

where r = the radius of the Petri dish, in cm; π = 3.141516; T = time of exposure of Petri dishes (minutes); and * = minutes for a week.

For the analysis of the microbiological conditions of the preparation surfaces (benches and utensils), the swab technique was applied according to the American Public Health Association (APHA), as described by Evancho et al. (2001). On each bench surface (pre-preparation of meats and vegetables) and board, we collected samples at two 25-cm² points, using a previously sterilized mold; sampling was performed after the routine cleaning of the establishments. For the surfaces of utensils (knifes), collection was performed on any area that comes into contact with food. Utensil samples were collected for each establishment, sampling a knife and a board, the most used utensils in the pre-preparation process. The selection of these utensils for the collection of the samples was based to the high risk of cross contamination that can occur with the use of inappropriate materials. The samples were transported to the laboratory in isothermal boxes immediately after collection; decimal dilutions were prepared for sowing in Petri dishes for incubation and subsequent counting.

Statistical analyses

The data obtained in the evaluation of hygienic and sanitary conditions through the checklist were entered into Microsoft Excel® and analyzed for the percentage of items matching by blocks. For the analysis of the results in regard to the contaminating microbiota in the air and on the preparation surfaces of the restaurants, an evaluation was made regarding the compliance with the proposed recommendations APHA as described by Evancho et al. (2001). Descriptive analysis of the data was performed, presenting means, percentages of the counts and their standard deviations.

RESULTS AND DISCUSSION

Adequacy of commercial restaurants in terms of good block manipulation practices

Figure 1 shows the classification by blocks of hygienic and sanitary conditions of the commercial restaurants evaluated. This classification is based on the 12 aspects included in the checklist of good practices, which enabled a more detailed assessment of the main inadequacies observed.

Regarding buildings, facilities, furniture, and utensils, 42% of the restaurants were classified as good and 50% as unsatisfactory. Among the irregularities identified, the following stand out: lack of ordering in the flow of operations; access of the common food area to other areas of the establishment; doors and windows without barriers (rubber sealing, millimeter screens); exposed luminaires without protection; air flow directly over food; floors, walls, and ceilings with cracks, leaks, and infiltrations; paper towel shortage, trash cans without covers or with manual operation and absence of an exclusive lavatory for hand hygiene in the handling area. All inadequacies indicate critical conditions for the production of meals. Similar results were found in the

study by Genta et al. (2005), where nonconformity index values ranged from 12.5 to 53.1% in commercial restaurants.

In the block referring to the hygiene of facilities, equipment, furniture, and utensils, 50% of establishments were classified as unsatisfactory. The main inadequacies observed were as follows: poor conditions of conservation and hygiene of equipment; lack of training of the employees to carry out the hygiene operations and the maintenance of them; use of common uniforms for handling food and for cleaning the environment and facilities; sanitizing products not regulated by the Ministry of Health. Rossi (2006) also found unsatisfactory results for this block and observed less than 50% of adequacy in self-service commercial restaurants.

Regarding vector and pest control, 75% of the restaurants were classified as good, while only 8% of commercial establishments were classified as unsatisfactory. A set of preventive actions was observed, such as chemical control carried out by a specialized company, according to the specific legislation. According to RDC 216/2004 (Brazil, 2004), buildings, facilities, equipment, furniture, and utensils must be free of vectors and urban pests, and in the case of chemical control, they must be sanitized later to remove any residues. Germano et al. (2001) stress that the presence of animals may be related to deficient structures and a lack of knowledge about preventive, corrective, and control programs.

In terms of water supply, adequate conditions were diagnosed in only 25% of the establishments and 67% were classified as regular. Water is used in the preparation of food and in the hygiene of the contact surfaces of these products; good water quality is therefore of utmost importance. Water quality control is necessary to avoid possible health risks for consumers in this type of environment (Andrade, 2008).

Considering waste management, the percentage of adequacy in restaurants was 42% (good), while only 17% were inadequate (unsatisfactory). However, we observed that residues were deposited in inappropriate places, in some establishments near the entrance of the dining rooms. Garbage is a source of food contamination, as it favors the appearance of vectors and urban pests. According to RDC 216/2004, waste must be frequently collected and stored indoors, away from the food preparation area (Brazil, 2004).

Regarding food handlers, only 17% of the restaurants were classified as good and 58% as unsatisfactory. Handlers did not sanitize hands carefully when they arrived at work, either before or after handling food. In addition, a lack of orientation posters on the correct washing and antisepsis procedures of the hands and improper behavior of the food handlers who spoke, whistled, and coughed during the preparation of meals were noted. There were no records of periodic training of employees on topics such as personal hygiene, foodborne diseases, and food hygiene. In a study by Genta et al (2005), this block presented between 12.5 and 56.3% of inadequacy.

Various studies confirmed the presence of pathogenic microorganisms in food handlers' hands, which makes them a significant vehicle of foodborne diseases (Soares, et al., 2012; Ferreira et al., 2013). According to legislation (Brazil, 2004), the health state of the food handlers and the hygienic practices directly influence the hygienic and sanitary safety of foods, with the majority of cases of food infections and intoxications occurring due to the contamination of food by food handlers.

For the raw materials, ingredients, and packaging block, 42 and 25% were classified as good and fair, respectively. The main inadequacies were related to the place of the reception of raw material, which was connected to the distribution hall; shelves that did not exhibit the minimum spacing necessary to guarantee adequate ventilation, cleaning and disinfection of the place were inadequate, and food packaging was inappropriate. According to the guidelines, all material used for the packaging of ingredients and raw materials must effectively avoid contamination and must not subject food to undesirable substances that exceed the limits proposed by the competent bodies (Brazil, 2004).

In the food preparation block, only one restaurant (8%) was adequate, while 42% were classified as unsatisfactory. In these establishments, time and temperature control in the preparations were not checked, food was defrosted incorrectly, the ingredients had no labels with expiration dates, and the quantities of employees, equipment, furniture, and/or utensils were not compatible with the complexity of food preparations. Rossi (2006) identified that few restaurants met these requirements in terms of temperature and time control procedures; 10% of the 30 establishments analyzed had a preventive maintenance and equipment calibration program, and in only 13.3% of the restaurants, there were spreadsheets for temperature recording.

In terms of storage and transport of the prepared food, 100% of the restaurants were classified as unsatisfactory; this is extremely worrying, as this stage confers significant risks of contamination and microbial multiplication. In this block, we observed the following inadequacies: a lack of identification of prepared foods that are kept in the storage area or awaiting transportation, not conferring protection against contaminants; no monitoring of the time and temperature during the storage, transport, and distribution stages; the vehicles also carried other loads, thus compromising the quality of the food. It is extremely important to control storage time and temperature as well as the sanitary conditions of foods already prepared in order to avoid microbial

Table 1. Microbiological contamination of air in commercial restaurants, Vitória-ES, Brazil, 2015.

Surface	Count intervals (CFU/cm²/week)		
	Aerobic mesophiles	Molds and yeasts	Enterobacteria
Meat preparation sector*	ND - 5.0 x 10^2	ND - 8.5 x 10^2	ND - 3.6 x 10^2
Fruit and vegetable preparation sector*	1.3 x 10^2-9.8 x 10^2	ND - 1.1 x 10^2	ND - 8.6 x 10^2

ND= Not detected; *Simple sedimentation method.

contamination. In many cases, this is a critical control point, since there will be no stages to eliminate or minimize the presence of contaminants.

Regarding the consumption of prepared food, only 8% of the restaurants were classified as adequate (Good), while 59% were classified as unsatisfactory. In the latter, the prepared food was not controlled for temperature. The monitoring of time and temperature is essential to avoid microbial growth and the contamination of prepared foods. In addition, equipment and utensils were in poor condition; equipment exposed to food had no protective barriers; areas of exposure and preparation of disorganized food and without appropriate hygienic and sanitary conditions; money and food were handled by the same employee (Brazil, 2004).

For the documentation and registration questionnaire, the results presented a percentage of worrisome inadequacies, with 83% of the restaurants being classified as unsatisfactory, with emphasis on the lack of or inadequacy of the Good Practice Manual (GPM) and the Standard Operating Procedures (SOP). The results obtained by Genta et al. (2005) corroborate with our findings; the authors observed that none of the evaluated establishments had a GPM. It is worth mentioning that those responsible for the establishments evaluated could not produce training courses on food handling. Souza et al (2013) verified that after the implementation of GPM in a food and nutrition unit, significant changes occurred in the establishment, which were even more expressive after the training of the employees, who started to place more emphasis on hygiene. Finally, in terms of liability, the lack of training of personnel, from the technical leaders to the food handlers, stands out.

Evaluation of the microbiological contamination of air

Table 1 shows ranges of counts for aerobic mesophiles, molds, yeasts, and enterobacteria present in air samples of environments in commercial restaurants evaluated. When adopting the limit of 30 CFU/cm²/week for aerobic mesophiles stipulated by the APHA (Evancho et al., 2001), the levels were above the recommendations, which indicates inadequate practices in some of the establishments.

For the evaluated restaurants, the sectors associated to the pre-preparation of vegetables presented the highest air contamination with aerobic mesophiles and enterobacteria, with the values of 9.8 x 10^2 and 8.6 x 10^2 CFU/cm^2/week, respectively. Coelho et al. (2010) identified a mesophilic count of 10^3 CFU/cm^2/week in commercial restaurants in the beef pre-processing sector, which is 30 times higher than that recommended by the APHA (Evancho et al., 2001). Our results were similar to those found by Tomich et al. (2005), who reported that 85.7% of the samples collected from a food industry presented scores above the limits proposed by the American legislation. However, the absence of specific recommendations in Brazil for each group of microorganisms makes it difficult to evaluate the results obtained.

For molds and yeasts, the air in the pre-prepared meat sector also presented a higher contamination, with 8.5 x 10^2 CFU/cm^2/week, in relation to the other microorganisms analyzed. The facts that there were no on-site partitions and that the kitchen and the external environment (bathrooms, dining rooms, reception, and customer service) were connected through doors without automatic closing and windows without screens may have favored the observed high contamination. Air filtering and other quality control measures are essential, such as air distribution in the processing areas and evaluation of the layout of the establishment (São José, 2012).

Evaluation of the contamination of food preparation surfaces

High counts of aerobic mesophiles were observed on benches and utensils (Table 2). Values of the order of 10^5 for knifes were observed, and when considering the APHA (Evancho et al., 2001) recommendations, counts of up to 2 CFU/cm² for countertop surfaces and 100 CFU/utensil were found; a large part of the surfaces were in unsatisfactory conditions.

In terms of mesophiles on bench surfaces, 100% of the establishments were unsatisfactory, while for

Table 2. Microbiological contamination of bench and utensil surfaces in commercial restaurants in the city of Vitória-ES, 2015.

Surface	Count intervals (CFU/cm² ou CFU/utensil)		
	Mesophile aerobics	Molds and yeasts	Enterobacteria
Meat preparation bench*	2.1×10^4 - 1.1×10^6	ND - 3.2×10^4	ND - 3.9×10^5
Fruit and vegetable preparation bench *	4.0×10^2 - 1.2×10^6	3.0×10^1 - 9.3×10^3	ND - 3.0×10^5
Knife*	ND - 7.6×10^5	ND - 1.2×10^4	ND - 3.5×10^5
Cutting board*	ND - 1.1×10^6	ND - 5.6×10^4	ND - 5.3×10^5

ND= Not detected; *Simple sedimentation method.

mesophiles on utensils, 79.1% were inadequate. It is worth noting that there are productive areas that are more prone to surface contamination, such as the pre-processing of fruits, vegetables, and raw meats (Lahou et al., 2012). This is mainly because food arriving in these sectors has already been contaminated in the production places, and the microorganisms can accumulate due to inappropriate hygiene techniques.

Similar results were found by Coelho et al. (2010), where 71% of the equipment and utensils showed values above those established by the APHA (Evancho et al., 2001). In a study by Andrade et al. (2003), 18.6% of the equipment and utensils used in the preparation of food had aerobic mesophile counts of up to 2 CFU/cm^2 of surface. The APHA recommendation (Evancho et al., 2001) is considered very rigid for Brazilian restaurants, taking into account, in particular, ambient temperature conditions in Brazil that are quite different from those in America.

The highest counts were found on boards used for the preparation of meats and vegetables, suggesting that there is no adequate application of good handling practices and SOP. Poor hygiene of equipment and utensils has been responsible, alone or associated with other factors, for outbreaks of foodborne illness (Doménech-Sánchez et al., 2011). All surfaces in contact with food may exhibit residues of organic matter, which may influence the survival of food-borne pathogens in this environment (Djekic et al., 2016). In addition, when assembling the food preparation environment, with benches, equipment, and utensils, the technician should be aware of the appropriate choice of materials. In contrast to aerobic mesophiles, counts for molds and yeasts (Table 2) varied between not detected (ND) up to 10^4 CFU were, which may be related to the measures adopted for the control of vectors and urban pests and circulating air currents in the food preparation environment (Brazil, 2004).

Boards had the highest levels of molds and yeast counts, reaching 5.6×10^4 CFU/cm², indicating the possibility of cross contamination because of the lack of routine sanitization. Similar results were found by Battaglini et al. (2012), where cutting boards were the surfaces that presented the highest mean yeast counts (2.1×10^4 and 1.5×10^4 CFU/cm^2).

Rodríguez et al. (2011), when evaluating handling practices and microbiological conditions of ready-to-eat products, verified that the highest contaminations were recorded on cutting board surfaces and taps. Cutting boards represent a constant risk of contamination in restaurants and the domestic environment. Although they are popular in both environments, there may be significant cross-contamination risks when using these utensils (DeVere and Purchase, 2007).

In the group of enterobacteria, tables presented the most unsatisfactory values, while the lowest counts were observed on knives. These microorganisms, of which some are pathogenic, are involved in food deterioration processes and used as indicators of hygienic and sanitary quality. Enterobacteria may indicate inadequate sanitary conditions when present in food or on surfaces (Silva Jr, 2014; Souza et al., 2015).

The type of material used in the analyzed surfaces may have contributed to the results found in this study. A number of countertops in the meat and vegetable preparation sector were made of marble, while the handling boards were made of allyl and unfit for use. Regarding the knives, all had a stainless-steel cutting surface; however, in some establishments, they were inadequate because of signs of corrosion. Food preparation equipment and utensils must be made of special materials to prevent them from absorbing or releasing particles that may interfere with the composition of foodstuffs; they must be kept in a good state of preservation.

The presence of microorganisms on food preparation surfaces indicates that cleaning is not efficient, resulting in considerable risks. Food preparation surfaces must be smooth, hard, and without cracks, ensuring lower microbial adhesion. These characteristics ensure adequate hygiene procedures (Andrade, 2008; São José, 2012; Sol et al., 2018).

The hygienic and sanitary conditions were considered unsatisfactory in most commercial restaurants evaluated, representing a low compliance with the criteria required by the legislation. In this way, the importance of preventive actions and measures that can reduce the risks of contamination and guarantee greater security is highlighted. Food safety is essential in food service because of the high numbers of meals served

day by day (Rebouças et al., 2017).

Nutritionists are responsible for complying with and enforcing the health surveillance legislation, which in turn include sanitary surveillance, promotion, and participation in educational activities in this area. The role of this professional is indispensable to correct the flaws and nonconformities in the establishments and to enforce legislation.

Conclusion

Based on the results obtained, there is a clear need for adjustments in the analyzed restaurants as well as for the implementation of Good Practices and a greater oversight of the competent bodies, since most restaurants did not comply with the RDC 216/2004, mainly in terms of food storage, documentation, registration, and responsibilities. The inadequacies detected in the evaluation of good practices may have resulted in the high levels of contamination observed for both the preparation surfaces and the ambient air. This shows the need for regulated microbiological standards in Brazil to evaluate the quality of air and surfaces in the food production environment.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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