

Hygiene conditions of the self-service restaurants by evaluating the microbial quality of the mixed-food preparations

## Condições higiênico-sanitárias de restaurantes comerciais tipo self-service pela avaliação da qualidade microbiológica de alimentos de preparações mistas

RIALA6/1192

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Recebido: 05.09.2008 – Aceito para publicação: 30.04.2009

### ABSTRACT

Hygiene conditions of the self-service restaurants located at the central region of Maringá city, Paraná, were evaluated by surveying the microbiological quality of the food provided for customers. Thirty-four mixed-food preparations samples were collected from the self-service counters of 18 restaurants, which serve 100 or more meals/day. In order to evaluate on the Good Practices procedures observance, a checklist was administered to five restaurants, just to those considered critical and presenting microbiological standards above the limits allowed by the Resolution N° 12/2001-Brazilian Ministry of Health. One of the eighteen investigated restaurants received training on Good Practices procedures, which was evaluated by means of the checklist before and nine months after training. The microbiological analyses showed eight food samples contaminated with coliforms at 45°C, and one sample with coagulase-positive staphylococci. No contamination by *Salmonellas* sp. was found in all of the analyzed samples. Based on the number of *non-conformities* found in the checklist items those considered as crucial for safe food preparation, all of five restaurants were classified as critical. One restaurant, which was trained on the Good Practices procedure, received *non-conformity* ranking of 60.9% and 50.9% before and after the training, respectively, and these data indicated that little progress had been made. Education programs implementation both food handlers and consumers is a strategy for reducing the occurrence of food-borne diseases.

**Key words.** food microbiology, food contamination, restaurants, food quality.

### RESUMO

No presente estudo foi realizada a avaliação das condições higiênico-sanitárias quanto à qualidade microbiológica em restaurantes self-service da região central de Maringá, Paraná. Foram coletadas amostras de alimentos de preparações mistas de restaurantes que servem cem ou mais refeições/dia. Trinta e quatro amostras de alimentos foram coletadas nas áreas de distribuição de dezoito restaurantes para análise microbiológica. Foi aplicado um *check-list* para avaliar o cumprimento de Boas Práticas em cinco restaurantes, que foram considerados críticos e que apresentaram resultados de padrões microbiológicos acima dos permitidos pela Resolução n° 12/2001 do Ministério da Saúde. Um dos dezoito restaurantes pesquisados recebeu treinamento em Boas Práticas, e a avaliação foi efetuada pela aplicação do *check-list* antes da orientação e nove meses após o treinamento. As análises microbiológicas mostraram contaminação por coliforme a 45°C em oito amostras de alimento e uma amostra contaminada por estafilococos coagulase positiva. Em nenhuma amostra foi detectada *Salmonella* sp. Baseando-se no número de *Não conformidades* apresentado em relação aos itens considerados como imprescindíveis para a produção de alimentos seguros, todos restaurantes foram classificados críticos. Um restaurante apresentou resultados de 60,9% e 50,9% de *Não Conformidades*, respectivamente antes e após o treinamento de Boas Práticas, indicando que houve pouco avanço quanto a melhoria de qualidade dos serviços realizados. A implementação de programas educativos para consumidores e manipuladores é relevante como estratégia para reduzir a ocorrência de doenças transmitidas por alimentos.

**Palavras-chave.** microbiologia dos alimentos, contaminação de alimentos, restaurantes, qualidade dos alimentos.

## INTRODUCTION

There have been many changes in the population's eating habits in recent decades<sup>1</sup>, caused by diverse reasons. The success and continued growth of self-service restaurants are due to their practicality and quick service, as well as the appeal of homemade meals at lower prices, achieved by the reduction of services offered at the customer's table.

This change in people's eating habits has led to concerns about preventing foodborne diseases<sup>1</sup>. In Brazil, very few occurrences of foodborne diseases are observed by the health services, although they are supposed to be higher due to a lack of knowledge about basic sanitation, a lack of basic hygiene in the production of food, and even due to the deficiency of disease notification systems<sup>2</sup>.

According to epidemiological information from the Secretaria de Saúde do Estado do Paraná, the most frequent foodborne diseases agents are bacteria such as *Salmonella* sp, *Escherichia coli*, *Staphylococcus aureus*, *Shigella* sp, *Bacillus cereus* and *Clostridium* sp. Among the foods most frequently involved are those of mixed preparation (which include raw materials of both vegetable and animal origin, such as mayonnaise and pancakes, etc.) at 42% and those of animal origin at 34.7% of cases<sup>3</sup>.

The foodborne diseases are one of the main problems of public health worldwide<sup>1</sup> and there is a global concern with strategies for their control and for ensuring that safe food products reach the consumer<sup>4</sup>. According to Antunes<sup>3</sup>, the handling procedures of the foods and the health of the food handlers themselves are of fundamental importance in the epidemiology of foodborne diseases, which can be controlled by the adoption of Good Practices by food-producing establishments.

According to the Resolution nº 216/2004 (govt. edict), published by the Ministério da Saúde, the Good Practices (GP) are obligatory procedures for food services in order to guarantee hygienic conditions in food preparation<sup>5</sup>.

To implement the GP, the first step is to administer a checklist (questionnaire) to evaluate Conformities and Non-Conformities in all the food production stages. Based on the result of the initial evaluation, a Plan of Action is created according to the Non-Conformities found, and then the correct procedures are established. The most critical items for controlling risks to the consumers' health should be prioritized<sup>6</sup>. According to Tomich et al.<sup>7</sup>, the checklist has been used in food production and

retail establishments for evaluating the use of GP and as a basis for visiting health and safety inspectors, as well as for verification by the establishment itself.

The microbiological analysis of food is fundamental to the evaluation of hygienic conditions and the use of GP in restaurants. The microbial determinations enable the evaluation of the product with regard to the application of hygienic practices throughout the whole process of production, from manufacture and display up to consumption<sup>8</sup>.

In the light of this, this work aimed to verify the hygiene conditions in commercial self-service restaurants by evaluating the microbial quality of the mixed-preparation foods they serve, and to offer GP training to a restaurant in which a high rate of non-conformity was observed.

## MATERIAL AND METHODS

### ■ Sample

Out of the 72 restaurants located in the city center of Maringá, Paraná State, Brazil, registered in 2003 by the Secretária de Saúde Municipal for the coordination of the Sanitary Vigilance program, a sample of 18 self-service commercial restaurants, which served over 100 meals/day, were studied.

### ■ Sample Collection

For the microbiological analysis, samples of boiled, baked, roasted and fried food, all from mixed preparations, i.e. foods that include raw materials of both animal and vegetable origin (e.g. mayonnaise, meat pies, pancakes, etc), according to the definitions described in the foodborne diseases outbreak tables of the Paraná Secretaria de Saúde do Estado do Paraná<sup>3</sup> were analyzed. The samples were collected by technicians from the Vigilância Sanitária Municipal program in April 2004 and July 2005. Thirty-four samples of 200g of food were collected, and, depending on the menus of the respective restaurants, between one and three samples being taken from each restaurant.

The collections occurred at the self-service counters of the restaurants, at least one hour before the buffets were opened to the public. The samples were stored in sterilized plastic packs, which were labeled and carried in isothermal containers, accompanied by reports identifying the restaurant, date, time and method of collection. The samples were kept under refrigeration between 0 and 4° C up to the time of the microbiological analysis.

### ■ Microbiological Analysis

Based on Resolution n° 12/2001 of the Ministério da Saúde, which is responsible for establishing the sanitary microbiological standards for food<sup>9</sup>, the microbial contaminants with the highest prevalence rates in mixed-preparation foods are: *Coliforms* at 45°C, *Staphylococcus coagulans positive* and *Salmonella sp.* Rates of *Coliforms*, at 45°C, over the permitted limits, indicate the absence of, or faults in, Good Practices of Hygiene. The presence of *Salmonella sp.* is considered a public health problem and is not tolerated by Brazilian legislation.

Food analyses were performed by the Most Probable Number (MPN) method for the quantification of *Coliforms* at 45°C, *Staphylococcus coagulans positive* counting and *Salmonella sp* research. The research was carried out according to American Public Health Association methodology, described in the Compendium of Methods for the Microbiological Examination of Foods<sup>10</sup>.

### ■ Checklist

A checklist, based on the Safe Food Program (PAS), was created to evaluate the hygiene conditions of the restaurants that had contaminated samples, and was used between 2001 and 2004 for the implementation of GP<sup>6</sup>. The checklist was simplified to group similar questions and to eliminate items not required by legislation for self-service restaurants, which related to table service, and other items that did not apply to the individual establishments studied. Sixty-four critical items and thirty-eight non-critical items from the original model were maintained, producing a total of 112 items. According to Tomich et al.<sup>7</sup>, the critical items are those regarded as essential for protection against foodborne diseases, and which need immediate correction when it is found that they are not followed. When an establishment has Non-Conformities in the critical items, it is regarded as a critical problem in the production of their food<sup>6</sup>.

The possible answers in the checklist were: “In Conformity” (C), when the restaurant followed the observed criterion; “Non-Conformity” (NC), when the restaurant did not follow the observed criterion; and “Not-Applicable” (NA), when the item was not applicable to the place or sector evaluated<sup>6</sup>. The restaurants were classified as ‘critical’ when they had one or more Non-conformity for items regarded as critical for the safe production of food.

### ■ The Good Practices Training Program

The training program lasted about 3 months. All the workers, including the manager, took part in the training.

The program lasted for a total of 15 hours, and its content was based on the *Cartilha do Manipulador de Alimentos* (Food Producers’ Guide) by PAS<sup>11</sup>. The main topics covered were: a) the safe preparation of food, b) physical, chemical and biological food risks, c) personal hygiene, d) personal work conduct, e) the physical structure and layout of the production and service areas and equipment and environmental hygiene, f) water quality, g) disease control, h) choosing suppliers and the purchasing of goods, j) safety criteria in the production stages and the maintenance and display of food, and h) the importance of team work.

### ■ Statistical Methods

The qualitative analysis of the microbiological and checklist results was carried out through the use of tables and graphs. Analysis of variance (ANOVA) and Tukey tests, with a 5% level of significance, were used to evaluate the differences among the restaurants with regard to Non-Conformities. The software package Statistica 6.0/2001 (Stat Soft, Inc. Tulsa, OK, EUA) was used.

## RESULTS

The results obtained from the microbiological analyses were evaluated according to Resolution n° 12/2001<sup>9</sup>, whose established standards for ready-made savory products to be consumed with or without stuffing, mixed salads, ready-made mixed-meat dishes, cereal and flour are: 10<sup>2</sup>/g for *Coliforms* at 45°C, 10<sup>3</sup>/g for *Staphylococcus coagulans positive* and a total absence for *Salmonella sp.*

Table 1 shows results from the microbiological analyses of the 34 samples collected in the 18 establishments. Contamination by *Coliforms* at 45 °C was over the limits permitted by law in 8 samples (23.5%) and contamination by *Staphylococcus coagulans positive* was over the limits in one sample (2.9%). Contamination by *Salmonella sp.* was not found in any of the samples. Restaurants 14 and 15 showed contaminated results in more than one sample. From the 18 restaurants researched, six (33.3%) showed positive contamination results and 12 (66.6%) did not show any contamination in the samples analyzed.

**Table 1.** Microbiological analyses results of 34 samples of mixed-food preparations collected in 18 self-service restaurants in the city center of Maringá, Paraná State, during 2004 and 2005

Restaurant Code	SAMPLE 1		SAMPLE 2		SAMPLE 3	
	Coliforms at 45°C (MPN/g)	Staph. coag. posit. (CFU/g)	Coliforms at 45°C (MPN/g)	Staph. coag. posit. (CFU/g)	Coliforms at 45°C (MPN/g)	Staph. coag. posit. (CFU/g)
1	<3	<10 <sup>2</sup>				
2	4	<10 <sup>2</sup>	<3	<10 <sup>2</sup>		
3	<3	<10 <sup>2</sup>	<3	<10 <sup>2</sup>		
4	<3	<10 <sup>2</sup>	<3	<10 <sup>2</sup>		
5	<3	<10 <sup>2</sup>	<b>4.6x10<sup>2</sup></b>	<10 <sup>2</sup>		
6	<3	<10 <sup>2</sup>	<b>≥2.4x10<sup>3</sup></b>	<10 <sup>2</sup>		
7	<3	<10 <sup>2</sup>	9.3x10 <sup>1</sup>	<10 <sup>2</sup>		
8	<3	<10 <sup>2</sup>	<3	<10 <sup>2</sup>		
9	<3	<10 <sup>2</sup>	<3	<10 <sup>2</sup>		
10	9	<10 <sup>2</sup>	<3	<10 <sup>2</sup>		
11	<3	<10 <sup>2</sup>	<b>1.1 x 10<sup>3</sup></b>	1.5 x 10 <sup>2</sup>		
12	<3	<10 <sup>2</sup>	<3	6.5 x 10 <sup>2</sup>		
13	<3	<10 <sup>2</sup>	<3	<10 <sup>2</sup>		
14	<3	<10 <sup>2</sup>	<b>≥2.4x10<sup>3</sup></b>	<10 <sup>2</sup>	<b>≥2.4x10<sup>3</sup></b>	<10 <sup>2</sup>
15	<b>≥2.4x10<sup>3</sup></b>	<10 <sup>2</sup>	<b>1.5x10<sup>2</sup></b>	<10 <sup>2</sup>		
16	<3	<10 <sup>2</sup>	<3	<10 <sup>2</sup>		
17	<b>≥2.4x10<sup>3</sup></b>	<b>1.4x10<sup>3</sup></b>				
18	<3	<10 <sup>2</sup>				

Standards established by RDC No. 12/2001: Coliforms at 45°C = 10<sup>2</sup>/g, Staphylococcus coagulans positive = 10<sup>3</sup>/g.

The mixed preparations which were contaminated by *Coliforms* at 45°C were: lasagna bolognese, chicken salad, vegetable salad, beef pancake, chicken pancake, chicken pizza, ham and cheese spaghetti and rondelli. From them, the most critically contaminated mixed preparation was the chicken pancake from Restaurant 17, which was contaminated by *Coliforms* at 45°C and also *Staphylococcus coagulans positive*.

In order to administer the checklist in the restaurants with contaminated samples, the intervention of the Vigilância Sanitária Municipal program was necessary. When the owners of these establishments were informed about the microbiological analysis results, they were also informed about the need to assess the hygiene conditions of their restaurants. However, Restaurant 17 was not evaluated by the checklist because the establishment was closed down during the research period.

Table 2 shows the results of the checklists administered to the five remaining restaurants whose samples did not pass the microbiological standards established by the Resolution nº 12/2001. The following critical-item Non-Conformities were found: a) premises and layout – most of the restaurants (80%) did not have basins for washing hands, neutral toilet soap, aseptic products, paper towels and trash cans with pedals; b) hygiene – non-observation of the disinfection stages of food preparation was encountered in 80% of the restaurants; c) handling (manipulation) – 60% of the restaurants had staff with incomplete uniforms, 80% had inadequate procedures for personal and hand hygiene, inadequate work practices were observed in 60%, and none of the restaurants provided an achievement program for the food handlers; d) supplier and raw material quality control – 40% of the restaurants with contaminated

**Table 2.** Results of the checklist administered to the five restaurants which had contaminated samples of mixed-food preparations (excluding non-applicable items)

Aspects Evaluated	Restaurant 05 <sup>b</sup>		Restaurant 06 <sup>ab</sup>		Restaurant 11 <sup>ab</sup>		Restaurant 14 <sup>ab</sup>		Restaurant 15 <sup>a</sup>	
	C <sup>1</sup>	NC <sup>2</sup>	C <sup>1</sup>	NC <sup>2</sup>	C <sup>1</sup>	NC <sup>2</sup>	C <sup>1</sup>	NC <sup>2</sup>	C <sup>1</sup>	NC <sup>2</sup>
Layout and installations	27 (84.4%)	5 (15.6%)	16 (50%)	16 (50%)	16 (50%)	16 (50%)	22 (68.8)	10 (31.2%)	15 (46.9)	17 (53.1)
Equip/ furniture/ appliances	1 (100%)	0 (0%)	1 (100%)	0 (0%)	1 (100%)	0 (0%)	1 (100%)	0 (0%)	1 (100%)	0 (0%)
Hygiene	7 (87.5%)	1 (12.5%)	7 (87.5%)	1 (12.5%)	5 (62.5%)	3 (37.5%)	5 (62.5%)	3 (37.5%)	4 (50%)	4 (50%)
Food handler	14 (87.5%)	2 (12.5%)	8 (50%)	8 (50%)	3 (18.8%)	13 (81.2%)	6 (37.5%)	10 (62.5%)	3 (18.8%)	13 (81.2%)
Supply/ raw materials	5 (83.3%)	1 (16.7%)	2 (33.3%)	4 (66.7%)	1 (16.7%)	5 (83.3%)	3 (50%)	3 (50%)	1 (16.7%)	5 (83.3%)
Storage	18 (100%)	0 (0%)	10 (55.6%)	8 (44.4%)	5 (27.8%)	13 (72.2%)	7 (38.9%)	11 (61.1%)	8 (44.4%)	10 (55.6%)
Pre-preparation *	8 (88.9%)	0 (0%)	3 (33.3%)	4 (44.4%)	4 (44.4%)	4 (44.4%)	5 (55.6%)	3 (33.3%)	4 (44.4%)	4 (44.4%)
Preparation **	8 (88.9%)	1 (11.1%)	6 (66.7%)	3 (33.3%)	3 (33.3%)	6 (66.7%)	2 (22.2%)	6 (66.7%)	1 (11.1%)	8 (88.9%)
Self-service counter	7 (100%)	0 (0%)	3 (42.9%)	4 (57.1%)	1 (14.3%)	6 (85.7%)	1 (14.3%)	6 (85.7%)	1 (14.3%)	6 (85.7%)
Use of leftovers	4 (100%)	0 (0%)	3 (75%)	1 (25%)	1 (25%)	3 (75%)	1 (25%)	3 (75%)	1 (25%)	3 (75%)
Collection of samples	0 (0%)	1 (100%)	0 (0%)	1 (100%)	0 (0%)	1 (100%)	0 (0%)	1 (100%)	0 (0%)	1 (100%)
Use of GP manual	0 (0%)	1 (100%)	0 (0%)	1 (100%)	0 (0%)	1 (100%)	0 (0%)	1 (100%)	0 (0%)	1 (100%)
<b>Total</b>	<b>99</b> <b>(88.4%)</b>	<b>12</b> <b>(10.7%)</b>	<b>59</b> <b>(52.7%)</b>	<b>51</b> <b>(45.5%)</b>	<b>40</b> <b>(35.7%)</b>	<b>71</b> <b>(63.4%)</b>	<b>53</b> <b>(47.3%)</b>	<b>57</b> <b>(50.9%)</b>	<b>39</b> <b>(34.8%)</b>	<b>72</b> <b>(64.3%)</b>

<sup>1</sup> = Conformity, <sup>2</sup> = Non-Conformity.

\*The aspect of 'Pre-preparation' had one item that was not applicable in Restaurants 5, 11, 14 and 15, and two items in Restaurant 6.

\*\*The aspect of 'Preparation' had one item that was not applicable in Restaurant 14.

Different letters in the same line indicate statistically significant differences among the restaurants ( $p \leq 0.05$ ).

samples did not qualify the supplier as to product quality and 80% did not inspect the products on reception; e) storage – only one of the establishments had thermometers in their refrigeration equipment, and checked the expiry dates of the products; f) production (pre-preparation stages, food preparation and display) – it was observed that none of the restaurants used thermometers to control food temperature, and only one controlled raw-material exposure time at room temperature and the ready-made product exposure time on the self-service counter; g) the utilization of leftovers and the use of a Manual of Good

Practices – 40% of the restaurants monitored the use of leftovers. However, none of them collected menu samples or possessed a Manual of Good Practices.

For the issue of pre-preparation of food, Restaurant 5 followed all the GP criteria. In the final preparation stage and during the display of the ready-made products, the rate of Non-Conformity also was the lowest.

Restaurant 15, which had two samples contaminated by *Coliforms* at 45°C, was the establishment that showed the greatest rate of Non-Conformity (64.3%). In Restaurant 5, despite having the lowest rate of

**Table 3.** Non-Conformity results for critical items in the restaurants that had contaminated samples

Aspects evaluated	Total number of critical items evaluated	Number of Non-Conforming critical items				
		Restaurant 5 <sup>b</sup>	Restaurant 6 <sup>ab</sup>	Restaurant 11 <sup>a</sup>	Restaurant 14 <sup>a</sup>	Restaurant 15 <sup>a</sup>
Layout and installations	19	4 (21.1%)	11 (57.9%)	12 (63.2%)	8 (42.1%)	11 (57.9%)
Equip/ furniture/ appliances	1	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Hygiene	4	1 (25%)	1 (25%)	3 (75%)	3 (75%)	3 (75%)
Food handler	11	1 (9.1%)	6 (54.5%)	9 (81.8%)	6 (54.5%)	9 (81.8%)
Supply/ raw materials	2	0 (0%)	1 (50%)	2 (100%)	1 (50%)	2 (100%)
Storage	9	0 (0%)	5 (55.6%)	8 (88.9%)	6 (66.7%)	6 (66.7%)
Pre-preparation	4	0 (0%)	3 (75%)	2 (50%)	2 (50%)	2 (50%)
Preparation	4	1 (25%)	3 (75%)	3 (75%)	3 (75%)	3 (75%)
Self-service counter	6	0 (0%)	3 (50%)	6 (100%)	6 (100%)	6 (100%)
Use of leftovers	2	0 (0%)	0 (0%)	1 (100%)	1 (100%)	1 (100%)
Collection of samples	1	1 (100%)	1 (100%)	1 (100%)	1 (100%)	1 (100%)
Use of GP manual	1	1 (100%)	1 (100%)	1 (100%)	1 (100%)	1 (100%)
<b>Total</b>	<b>64</b>	<b>9 (14.1%)</b>	<b>35 (54.7%)</b>	<b>49 (76.6%)</b>	<b>39 (60.9%)</b>	<b>47 (73.4%)</b>

Different letters in the same line indicate statistically significant differences among the restaurants ( $p \leq 0.05$ ).

**Table 4.** Non-conformity results obtained through checklist administration in Restaurant 3 before (checklist 1) and nine months after (checklist 2) Good Practices training (excluding non-applicable items)

Aspects Evaluated	Total number of items evaluated	Number of critical items evaluated	Checklist 1 <sup>a</sup>		Checklist 2 <sup>a</sup>	
			Total number of Non-Conforming items	Number of Non-Conforming critical items	Total number of Non-Conforming items	Number of Non-Conforming critical items
Layout and installations	32	19	13 (40.6%)	9 (47.4%)	13 (40.6%)	7 (36.8%)
Equipment/ furniture/ appliances	1	1	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Environmental hygiene/ appliances	8	4	6 (75%)	4 (100%)	4 (50%)	3 (75%)
Food handler	16	11	7 (43.8%)	3 (27.3%)	7 (43.7%)	4 (36.4%)
Supplier and raw material control	6	2	3 (50%)	0 (0%)	3 (50%)	0 (0%)
Storage	18	9	13 (72.2%)	6 (66.7%)	10 (44.5%)	4 (44.4%)
Pre-preparation*	9	4	6 (66.7%)	2 (50%)	2 (22.2%)	2 (50%)
Preparation*	9	4	6 (66.7%)	3 (75%)	6 (66.7%)	3 (75%)
Self-service counter	7	6	7 (100%)	6 (100%)	6 (86.7%)	5 (83.3%)
Use of leftovers	4	2	4 (100%)	2 (100%)	3 (75.0%)	2 (100%)
Collection of samples	1	1	1 (100%)	1 (100%)	1 (100%)	1 (100%)
Use of GP manual	1	1	1 (100%)	1 (100%)	1 (100%)	1 (100%)
<b>Total</b>	<b>112</b>	<b>64</b>	<b>67 (59.8%)</b>	<b>37 (57.8%)</b>	<b>56 (50%)</b>	<b>32 (50%)</b>

<sup>a</sup>The aspects of 'Pre-preparation' and 'Preparation' had one item that was not applicable for the 'Total number of items evaluated' field in all of the restaurants. Different letters in the same line indicate statistically significant differences between the checklists ( $p \leq 0.05$ ).

Non-Conformity (10.7%), one of the samples was found to be contaminated by *Coliforms* at 45°C. With the aim of confirming these descriptive data, an ANOVA was performed on the Non-Conformities data presented in Table 2. A significant result ( $p=0.0424$ ) was obtained in the F-Snedecor test, and the differences among the restaurants were revealed by Tukey tests, whose results are identified by letters in the table.

None of the five restaurants evaluated by the checklist showed 100% Conformity for the 64 critical items. Restaurant 5, which had the lowest Non-Conformity rate of the five restaurants for critical items, did not conform to nine (14.1%) of these items. Restaurant 11, which had the highest rate of Non-Conformity, did not conform to 49 (76.6%) of the 64 items. High Non-Conformity rates were observed for the critical items relating to cleaning, food handlers and storage criteria (Table 3). A significant result ( $p=0.0006$ ) was found when an ANOVA was applied to this data for the F-Snedecor test. Again, the differences among the restaurants are identified by letters in the table.

From the 18 restaurants studied, only Restaurant 3 allowed GP training, although none of its samples were found to be contaminated. Corrective actions were recommended for the Non-Conformities reported by the checklist. A quality control team with a supervisor and monitors was also recommended to ensure the continuation of the requirements of the safety criteria established by the GP.

Nine months after the training, a second inspection was carried out and the checklist was again administered, finding that the quality control team had not been installed; food handlers had been replaced by new employees who had not received GP training and that the recommendations suggested by the action plan had not been carried out.

Table 4 shows the Non-Conformity results obtained by the checklist before and after the GP training in Restaurant 3. According to the table, the Non-Conformity rate for critical items (57.8%) obtained by the first checklist classified Restaurant 3 as being critical, and the results of the second checklist (50%) maintained the same classification. The results were submitted to an analysis of variance (ANOVA), regarding the results of the checklists as the cause of the variation. A non-statistically significant result ( $p=0.6190$ ) was obtained for the F-Snedecor test, confirming the lack of a significant improvement between the first and second administrations of the checklist.

There was a fall in the Non-Conformity rates for the aspects of hygiene, storage, pre-preparation,

distribution and use of leftovers. The other aspects assessed, i.e. premises and layout, suppliers and raw material control, preparation, collection of samples and use of a Good Practices manual remained unaltered. For the aspect of food handling, there was a small increase in Non-Conformities for the critical items, mainly for those related to appropriate work conduct and existence of continuous training in food and personal hygiene. However, even though Restaurant 3 showed a high rate of Non-conformity, it was not found to have any contaminated samples in between the administration of the first and second checklists.

## DISCUSSION

The results obtained by the microbiological analyses of mixed-food preparations from 18 restaurants indicated that the samples which were contamination by *Staphylococcus coagulans positive* and *Coliforms* at 45°C were the samples for which greater pre-preparation handling or manipulation occurred; such as, lasagna, pasta, pancakes, and chicken and mixed salads, with some of them requiring re-heating (e.g. lasagna) and others requiring refrigeration (e.g. chicken salad) before being served. To avoid foodborne diseases, food should be prepared in accordance with rigorous hygiene-control measures and kept in storage, or on the self-service counter itself, for an appropriate amount of time and at an appropriate temperature, thereby preventing the growth of pathogenic microorganisms<sup>8,12</sup>.

Although *Salmonella* sp were not found in any of the samples collected from the establishments studied, data from the state of Paraná (1999) revealed that of the 89 cases of foodborne diseases registered, 55 (61.8%) were confirmed for the microbial etiology, with 32 (35.96%) being caused by *S. aureus* and 16 (17.09%) by *Salmonella* sp<sup>3</sup>. The absence of contamination by *Salmonella* sp. may be due to the low resistance of this microorganism to temperatures above 60°C and also to the fact that the preparations did not include raw eggs or undercooked poultry meat<sup>8</sup>.

The fact that only one sample exceeded the acceptable limit for *Staphylococcus coagulans positive* is due to the use of heated food counters, used to keep the food hot while it is on display<sup>8,12</sup>.

In light of the fact that research on *Coliform* rates can be used as an indicator of hygiene conditions, providing a warning of the eventual presence of



enteropathogens<sup>12,13,14</sup>, 33.3% of the 18 restaurants studied served food that was not fit for consumption.

The negative microbial contamination results in 12 out of the 18 restaurants studied do not guarantee the quality of hygiene in the restaurants, as the Resolution n° 12/2001 only takes sanitary standards into consideration<sup>8</sup>.

For the 5 restaurants with contaminated samples can be observed that most of the evaluated items showed high rates of Non-Conformity. Praxedes<sup>15</sup> claims that the food handlers, either in themselves, or through inadequate procedures for handling food, represent a considerable source of contamination, and recommends correct hygiene practices, suitable uniforms, correct procedures during food production and care in avoiding cross contamination, among other things, as examples of what can be done to reduce the risk of foodborne diseases.

Even though the inadequate control of temperature during storage is a possible cause of food contamination<sup>12,16</sup>, it was observed that most restaurants did not control storage temperatures, and this could, therefore, have been a factor that contributed to the occurrence of contaminated samples. The control of the two variables of time and temperature during pre-preparation stages, food preparation and display is important in controlling bacterial growth, as depending on the exposure time and temperature of the food, bacterial multiplication will be faster or slower, thereby potentially increasing the risk of contamination<sup>16</sup>.

Yet more critical-item Non-Conformities were observed and none of the evaluated restaurants followed the established criteria for the appropriate use of leftovers, the collection of sample and use of a GP manual. The Manual of Good Practices describes the procedures for safe food production adopted by each establishment, is required by law and must be updated every time the company makes changes in its physical or operational structure<sup>8</sup>.

As the critical items are considered essential for the safe production of food<sup>8,17</sup>, the occurrence of contaminated samples in restaurant 5, which had the lowest Non-Conformity rate, could be due to the non-compliance with some of the items, such as: a lack of basins for washing hands, the absence of cleaning procedures for utensils, equipment and the preparation and service environments, the absence of thermometers for controlling the temperature of the foods, and the absence of a continuous training program in hygiene for the food handlers.

The microbial contamination results of the food in the restaurants studied, which typically had Non-Conformity rates of above or around 50% (Table 2), indicate that in some stages of food production, microbiological risk was not properly controlled, either in handling procedures, food temperature control or due to problems resulting from inadequate hygiene and installations. Such Non-Conformity rates indicate that these establishments have critical sanitary conditions.

The similar results found in the two evaluations carried out in Restaurant 3 (Table 4) can be explained by the non-observance of the corrective actions (recommended by the plan of action) of existing Non-Conformities, by the discontinuity of the new workers' achievement program and by the lack of a person responsible for the effective application of the GP in the company. According to Zaccarelli<sup>18</sup>, a continuous program of health education for food handlers is of great help in the implementation of quality programs such as the GP. Thus, a team should be created to keep the program and training running, and to continue observing the safety criteria established by GP.

Despite the importance of the critical items for safe food production, based on GP criteria, which are deemed essential by the govt. edict Resolution n° 216/2001 of the Ministério da Saúde<sup>5</sup>, the five establishments with contaminated samples and the restaurant that received GP training, all evaluated by the checklist, did not follow the current legislation for food production in the country. As a result of this research, it was suggested to the owners of the restaurants that they organize and administer courses or seminars for food handlers, focusing on the critical Non-Conformities. Further checklist evaluations and microbiological analyses of the contaminated preparations were also proposed, with the aim to promoting improvements in hygiene conditions and, ultimately, safer food for their consumers.

For Restaurant 3, a re-administration of the GP training for food handlers was suggested, as well as the fulfillment of the guidelines proposed in the action plan after the original checklist evaluation.

Due to the scarcity of studies on hygiene conditions in commercial restaurants and also to their importance in helping to prevent foodborne diseases, it is strongly recommended that further studies be carried out and the implementation of education programs for both food handlers and consumers how a strategy for reducing the occurrence of foodborne diseases.

#### ACKNOWLEDGEMENTS

The authors would like to thank the Vigilância Sanitária do Município de Maringá for their support and contribution in the collection of food samples from the restaurants. The authors are also grateful to the Safe Food Program for authorizing the use of the GP checklist and the didactic guidelines for training.

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