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Implementation of food quality management tools in an institutional food and nutrition unit: a case study

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Abstract

The aim of this study is to develop a hygienic-sanitary profile of an institutional Food and Nutrition Unit (FNU), by assessing the use of Good Manufacturing Practices (GMPs) before and after the implementation of food Quality Management Tools. In order to accomplish that, the authors employed a checklist to conduct a descriptive research on the hygienic-sanitary conditions of the FNU, and to assert whether the GMPs are efficient or not, the authors also assess the microbiological contamination of equipment, utensils, food handlers' hands, hot meals (rice, beans and meat) and cold meals (raw lettuce, beetroot, carrot and cabbage salads) after the implantation of Quality Management tools. Before their implementation, the FNU was sorted into Group III ("Deficient" – 0 to 50% of analyzed items) in all three studied sectors; afterwards, however, it was moved into Group II (51 to 75% of analyzed items). As a result, the researchers did not detect any contamination with coagulase-positive *Staphylococcus, Salmonella* spp or sulfite-reducing *Clostridium* at the temperature of 115°F (46°C) in any of the analyzed foodstuffs. However, they did observe the presence of coliforms at 113°F (45°C) in the raw lettuce, carrot, beetroot and cabbage salads. The microbiological quality of the rice, beans and meat samples was satisfactory. Neither coliforms at 113°F (45°C) nor coagulase-positive *Staphylococcus* were found in equipment or utensils. The food handlers' hands were free of thermotolerant coliforms, while only two of them were contaminated with coagulase-positive *Staphylococcus*. The study concludes that implemmenting Quality Management Tools, particularly the GMPs, is one of the basic requirements for consumers' health in the preparation of food; nevertheless, such tools must be paired with a periodic supervision by qualified especialists.

Introduction

According to the World Health Organization (WHO), developing countries report over one billion cases of acute diarrhea anually, caused by the consumption of contaminated foods by children under the age of five. Out of this total, five million die; such result indicates the occurrence of foodborne diseases. Due to the developing phase of their immune system, that portion of the population develops more severe symptoms and is more susceptible to those diseases (Germano and Germano, 2011).

Researchers must implement control measures in Food and Nutrition Units aiming to improve the hygienic conditions adopted in the cleaning process of any surfaces that may come into direct contact with food. Consequently, they may decrease the amount of microbiological contaminations, which pose major hazards to public health. The handler is the primary catalyst for the diseases caused by contaminated food; in most cases, such employee lacks proper training regarding the adequate hygiene practices for the preparation of foods. That condition seriously compromises the quality of the meal being prepared (Coelho *et al.*, 2010).

In food and nutrition units (FNUs), quality foods must be intact and free of contaminants of either physical, chemical or biological origin; they must also please the consumers' palate and meet their nutritional needs and expectations (Sousa, 2009). In order to ensure that quality, the food must be innocuous. Food safety management systems are other important preventive measures adopted in the preparation process; a number of industries around the world have successfully applied them. These systems direct the planning of products and processes, as well as the projecting and implementation of Good Manufacturing Practices (GMPs) and quality assurance systems, aiming to meet food safety standards (Forsythe, 2013).

According to what the authors have been exposed thus far, the objective of this study was to employ

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Food Quality Management Tools in an FNU through the implementation of GMPs; hence, they also aimed to contribute to the creation of institutional proposals and policies aiming at the improvement of food quality.

Methodology

This study was carried out in a food and nutrition unit (FNU) at an institute of professional and technical education in the city of Uberlândia, Brazil, between January 2013 and January 2014. Five hundred people eat in that unit on a daily basis (both empolyees and students). Some of these students follow a boarding regimen, and, therefore, they eat four times a day. The team responsible for the preparation of meals is divided into members of the institution staff and outsourced employees (16 food handlers, a nutritionist and a representative of an outsource company). With the exception of the potato, the onion and the tomato, the horticultural products consumed in the facility are grown in the FNU garden. Non-perishables are purchased in a grocery store.

Initial diagnosis of the hygienic-sanitary conditions in the FNU

Since the objective of this study was to diagnose the hygienic-sanitary conditions in the FNU, a checklist based on the Resolution No. 275 (Brasil, 2002), was used. Such instrument was employed in order to assess the food manufacturing establishments that adopt Good Manufacturing Practices. The following criteria were assessed, according to the checklist: Building and Facilities; Equipment, Utensils and Furniture; Food Handlers; Preparation and Transportation of Foods; and Documentation. Based on this list, the FNU was sorted according to the percentage of compliance detected: Group I – Good (76 to 100% of analyzed items); Group II – Medium (51 to 75%); and Group III – Defficient (0 to 50% of analyzed items).

Creation and implementation of food quality management tools

Proceeding with the survey, Standard Operating Procedures (SOPs) and a guide of Good Manufacturing Practices in the FNU were designed and implemented. Both documents are listed in Resolution No. 275 and Resolution No. 216 (Brasil, 2002 and 2004b). The following SOPs were created: Integrated Pest Management; Water Reservoir Sanitation; Food Handlers' Health and Hygiene; Sanitation of Equipment, Utensils and Facilities.

Training of the FNU staff members for good manufacturing practices

A training course was designed and offered for the FNU food handlers by the Center for Studies on the Preparation of Safe Food and the Health Surveillance Departament in the city of Uberlândia. Such course totaled a workload of 40 hours (30 theoretical and 10 practical), and is required by Resolution No. 216 (Brasil, 2004b). It consisted of lectures and audiovisual resources, such as a video projector. During the training course, a textbook containing essential content was used by the participants. They used the Brochure of Good Practices for Food Services, listed in Resolution No. 216 (Brasil, 2004a). The training course approached the following topics: Basic Microbiology and Pathogenic Microorganisms, both beneficial and harmful; Primary Foodborne Diseases; Physical, Chemical and Biological Hazards; Notions of Conservation; Hygienic Handling of Foods; Introduction to Good Practices; and Interpretation of Resolution No. 216 (Brasil, 2004b). In order to measure the food handlers' learning level of the content studied throughout the course, they responded to a questionnaire (both before and after the lectures) comprising ten multiple choice questions on the primary concepts.

Assessment of the hygienic-sanitary conditions in the FNU after the implementation of the quality management tools

The checklist put forward by Resolution No. 275, as of 21st October 2002 (Brasil, 2002) was used for a second time. Furthermore, the researchers conducted microbiological analyses of meals, equipment and utensils' surfaces and the food handlers' hands, aiming to assert the efficiency of their proposal.

Microbiological assessment – samples and sampling

The microbiological assessments were carried out according to the methodology described by Silva *et al.* (2010) in the Microbiology Laboratory at Instituto Federal do Triângulo Mineiro (IFTM) – Uberlândia Campus, Brazil. Three samples of each foodstuff were randomly selected and aseptically collected by the researchers, one per week (totalizing three sampling weeks). Each, weighing 100 grams, was divided into three 25 gram portions, totalizing three replicates per week. The analyses were conducted in triplicate. Amongst the utensils, the authors sampled 10% of the forks (N=80; n=8), 10% of the knives (N=80; n=8) and 10% of the trays (N=100; n=10). As for the equipment, they sampled the meat grinder, the vegetable processor, the bakery spiral mixer, and the butchery and bakery tables. Finally, eight food

handlers were selected and had their hands hygiene analyzed.

Food handlers' hands hygiene

The method used was "swabs" dipped in a 0.1% saline solution, to aseptically collect the samples (Silva *et al.*, 2010).

Kitchen equipment and utensis hygiene

In an area of 2 x 2 inches on the surfaces of the butchery and bakery tables, the vegetable processor, the meat grinder, the bakery spiral mixer and the trays tests were performed for the presence of coliforms at 113°F (45°C) and coagulase-positive *Staphylococcus*. As recommended by the American Public Health Association (APHA, 2001) and the World Health Organization (WHO) and cited by Silva Jr. (2001), forks and knives were also examined. The method used was "swabs", dipped in a 0.1% saline solution, to aseptically collect the samples (Silva *et al.*, 2010).

Microbiological quality of cold meals ready for consumption

As recommended by Resolution No. 12, as of 2nd January 2001 (Brasil, 2001), the researchers tested for the presence of coliforms at 113°F (45°C) and coagulase-positive *Staphylococcus* on the beetroot, carrot, lettuce and cabbage salads. They conducted the sampling when the foods had been exposed for 30 minutes on the cold meal table (at the temperature of 44, 5º F). For such end, these samples were aseptically collected with sterile bags, and sent to the laboratory in isothermal containers (Silva *et al*., 2010).

Microbiological quality of hot products ready for consumption

As recommended by Resolution No. 12, as of 2nd January 2001 (Brasil, 2001), the researchers tested for the presence of coliforms at 113°F (45°C) and coagulase-positive *Staphylococcus* on the rice and the beans. As for the poultry, they also tested the presence of sulfite-reducing *Clostridium* at the temperature of 115º F (46°C). They conducted the sampling when the foods had been exposed for 30 minutes on the hot products table (at the temperature of 149º F). For such end, these samples were aseptically collected with sterile bags, and sent to the laboratory in isothermal containers (Silva *et al*., 2010).

Statistical design and analyses of results

The data collected by the authors of this study, both before and after the implementation of quality management tools and the training course (with the exception of the microbiological assessment), were charted and compared through nonparametric statistics. The researchers also submitted these data to descriptive statistics for a more specific assessment; afterwards, they calculated the average values. The authors carried out a Binomial Test for comparing two proportions ($p<0.05$) in order to analyze the data concerning hygienic-sanitary conditions. To assess the food handlers' knowledge, they carried out the Wilcoxon signed-rank Test ($p<0.05$). Finally, the researchers used the computer program SPSS (Statistical Package for Social Sciences version 17.0, Inc. 2008) for Windows.

Results and Discussion

Assessment of the hygienic-sanitary conditions in the FNU before and after the implementation of quality management tools

Table 1 presents the general hygienic-sanitary profile of the FNU and compliance and non-compliance percentages according to each assessed criterion, obtained through the use of a checklist before and after the implementation of food Quality Management Tools.

By carrying out the Binomial Test ($p<0.05$), a substantial difference between the percentages of compliance and non-compliance before and after the implementation of Quality Management Tools was detected. An increase in the level of compliance and a decrease in the level of non-compliance between both stages were found. Such results stress how important it is to use Good Practices for the improvement of the hygienic-sanitary conditions of food producers.

Before the Quality Management Tools, the FNU was sorted into Group III ("Defficient" – 0 to 50% of analyzed items), according to the recommendations made by Resolution No. 275 (Brasil, 2002), which can be characterized as inadequate conditions under the hygienic-sanitary perspective. In that sense, the FNU failed to obey the governing laws, therefore it was considered to be dissatisfactory for the preparation of safe foods.

The non-compliance percentage detected by this study is similar to the results obtained by Sampaio *et al*. (2007) apud Seixas *et al.* (2008) in a survey carried out in restaurants in the city of Rio Vermelho, Brazil. They concluded that the establishments that did not implement the GMPs met a maximum of 45.8% of the quality criteria.

After implementing the tools, however, the FNU was moved into Group II ("Medium" – 51 to 75% of analyzed items), which indicates a substantial improvement on the compliance percentage detected. Akutsu *et al.* (2005) assessed the use of Good

Table 1. Compliance and non-compliance percentages general and for each assessed criterion before and after the implementation of food Quality Management Tools in the FNU.

	BEFORE	AFTER		BEFORE	AFTER	
	Compliant	Compliant	P-value	Non-compliant	Non-compliant	P-value
General hygienic-sanitary profile	28.07*	58.14*	0.0001*	54.97*	28.48*	0.0001*
Building and Facilities	38.50	56.96	0.0169*	51.30	32.92	0.0157*
Equipment, Utensils and Furniture	33.30	66.67	0.0308*	66.70	33.30	0.0308*
Food Handlers	50.0	85.71	0.0430*	50.00	14.29	0.0430*
Preparation and Transportation of Foods	12.10	48.49	0.0013*	48.50	21.21	0.0201*
Documentation	0.00	52.00	-	68.00	28.00	0.0046*

*Concerning the Binomial Test for the comparing of proportions ($p<0.05$) / Not significant ($p>0.05$)

Table 2. Assessment of the food handlers' knowledge before and after the training course.

(n=13)	Before 40 h course	After 40 h course	P-VALUE
AVERAGE	4.0	8.0	0.0033*

*Concerning the Wilcoxon signed-rank test ($p<0.05$).

Practices in commercial restaurants in the city of Brasília, the Capital of Brazil. They concluded that these establishments were to be sorted into Groups II (33.3%) and III (66.7%), a similar result to that of this study.

Regarding the FNU, the authors detected a substantial difference between the percentage of compliant (before and after) and non-compliant items (before and after) concerning the criteria Building and Facilities; Equipment, Furniture and Utensils; Food Handlers; and Preparation and Transportation of Foods. As for the Documentation, the results show a substantial difference among non-compliant items.

As for the non-compliant items for the criterion Food Handlers, the researchers asserted the following: the staff members did not wash their hands between each task; there were neither posters nor signs to guide them through the correct washing process, as well as no periodic supervision on their health; there were no records on any obligatory tests performed on the employees; and, finally, there was no training program. Such results are similar to those found by other authors cited below.

As Campos *et al.* (2009) assessed hygiene conditions and food handlers of public schools in the city of Natal, Brazil, they also observed the lack of periodic health examinations in 51.9% of the surveyed handlers. In their study, Medeiros *et al.* (2012) noted that none of the twenty-three food services in the city of Santa Maria, Brazil, offered their employees periodic training on personal hygiene, food handling and foodborne diseases.

After the training course and the implementation of GMPs, the authors noted a noteworthy improvement in the compliance percentage; following the implementation of Quality Management Tools, the criterion Food Handlers reached a compliance level of 85.71%. One of the goals of the training course was to highlight the importance of GMPs in the preparation of foods, as well as the adoption of Standard Operating Procedures and Good Manufacturing Practices as quality management tools. Such documents standardize the manufacturing of food, thus contributing to the sanitary quality of products.

The results found by this study were more positive than those found by Medeiros *et al.* (2012), who assessed the hygienic conditions of food services in the city of Santa Maria. They focused on the hygiene, health and training of the food handlers and obtained an average compliance percentage of 56%. Panza and Sponholz (2008) note that both the personal hygiene and the behavior exhibited during the handling of foods must be frequently monitored and approached by training courses. That corroborates the results found by this study; following the use of a checklist and offering a training course to the FNU handlers, the percentage of items that obey the governing sanitary laws showed a substantial improvement.

Concerning the criterion Building and Facilities, the primary non-compliant items detected were the following, according to the requirements of Resolution No. 216 (Brasil, 2004b): the wearing out of floor grouts, small drains (which hinder the water drainage during the sanitation of facilities), infiltrations in the cafeteria ceiling, external and restroom doors with manual door knobs and showing signs of oxidation, faucets with manual activation in sanitary facilities and in handling areas; the use of household detergent and recycled paper towel

Table 3. Microbiological profile of foods according to each analyzed bacteriological agent.

	Coliforms at 113°F (45°C) (MPN/g)	Standard Deviation	*Coagulase*-positive *Staphylococcus* (CFU/g)	Standard Deviation	*Salmonella* spp (absent in 25g)	Sulfite-reducing *Clostridium* at 115° F (CFU/g)	Standard Deviation
Lettuce	120.00	0.00	---	---	absent	---	---
Carrot	39.34	24.03	---	---	absent	---	---
Beetroot	236.70	46.18	---	---	absent	---	---
Cabbage	67.70	6.35	---	---	absent	---	---
Rice	< 3	0.00	< $1x10^1$	0.00	absent	---	---
Beans	< 3	0.00	< $1x10^1$	0.00	absent	---	---
Meat	< 3	0.00	< $1x10^1$	0.00	absent	< $1x10^1$	0.00

Average values and standard deviation for the three replicates of each food product for the three weeks studied

for the sanitation of hands; burned-out light bulbs in the horticulture sanitation area; the absence of a proper sink for the sanitation of hands in the handling area; an inoperative exhaust fan due to a lack of maintenance in the cooking area; ripped millimetric wire netting; and infiltrations in the ceiling and wall in male dressing rooms. These non-compliant items represent a threat for food safety and may contribute to the increase of their contamination (reaching unacceptably high levels).

The FNU underwent a renovation process after being notified by the local Health Surveillance Departament during an inspection for the renewal of the Sanitary Permit. The responsibles for the FNU elaborated an action plan in response to such notification; afterwards, they carried out the necessary renovations in the physical structure of the unit. That process substantially improved the hygienic-sanitary conditions of that FNU regarding the criterion Building and Facilities. The major adaptations detected were: the replacement of the floor and its grouts; the repairing of the ceiling in the external area; the painting of all doors, as well as the outer areas of the bakery and butchery rooms; the replacement of millimetric wire netting and the burned-out bulbs in the horticultural sanitation area, and the painting of the walls and ceiling of all dressing rooms.

Veiga *et al.* (2006) assessed the building structure of ninety-seven food establishments. Most notably, they noted a lack of maintenance on floors, walls, ceilings, and coverings. 97% of these establishments presented poor storage conditions, such as defects, cracks, holes, humidity, moldering, peeling and damaged tiles. As for the criterion Equipment, Utensils and Furniture, the authors observed the use of an all-purpose cleaner on the bakery equipment, which might lead to a contamination derived from the product scent. In addition, the state of preservation of the cafeteria stove was considered inadequate, which could lead to the contamination of the food prepared in the FNU.

Regarding the criterion Preparation and Transportation of the Food, the researchers detected the absence of cold rooms specific to each material. For instance, the milk and both the raw and the prepared vegetables were stored in the same place, which might cause a cross-contamination between different products. Finally, concerning the criterion Documentation, the authors noted the absence of a guide of Good Practices and Standard Operating Procedures before the implementation of the food Quality Management Tools. Saccol (2007) concurs to what Stangarlin *et al.* (2008) conclude and note that one of the primary difficulties found in food services is the non-existence of SOPs and guides of GMPs. These researchers observed that 92% of food services in the city of Santa Maria did not follow any guides – evidencing the lack of compliance to Resolution No. 216, which demands the creation of such document (Brasil, 2004b).

In their study, Gomes *et al.* (2012) found similar results on public schools in the state of Goiás, Brazil. They noted that these institutions complied only partially to the law requirements, and concluded that 44.9% of the investigated cafeterias did not comply whatsoever to the assessed items (Personal Hygiene, Building Conditions, Equipment and Utensils, Operation Hygiene and Processing) between 2004 and 2005, while 37.1% of them did in 2012; these percentages endanger the hygienic-sanitary quality of the food.

Mezzari and Ribeiro (2012) used a checklist on a municipal school in the city of Campo Mourão, Brazil. They noted a 50% non-compliance percentage regarding the GMPs, which is considered high. During their research on the adoption of Good Manufacturing Practices in food services in Brazilian public schools, Santana *et al.* (2009) observed a number of non-

Table 4. The presence of coliforms at 113°F (45°C) and coagulase-positive *Staphylococcus* on equipment and utensils used in the FNU at IFTM (Uberlândia Campus) after the implementation of food Quality Management Tools, 2013.

Equipment and utensils	Coliforms at 45°C (MPN/cm²)	*Coagulase*-positive *Staphylococcus* (CFU/cm²)
Meat grinder (n=1)	< 3	< 1x10¹
Butchery table (n=1)	< 3	< 1x10¹
Bakery spiral mixer (n=1)	< 3	< 1x10¹
Bakery table (n=1)	< 3	< 1x10¹
Vegetable processor (n=1)	< 3	< 1x10¹
Forks (n= 8)	< 3	< 1x10¹
Knives (n=8)	< 3	< 1x10¹
Trays (n=10)	< 3	< 1x10¹

Average values for the three repetitions of equipment and utensils, estimated per week.

compliant items, such as: inappropriate location and ventilation, improperly cleaned areas and surfaces (which might get in contact with food), lack of safety screens surrounding light fixtures and of millimetric wire netting on the windows (to keep insects away), as well as no maintenance in equipment and utensils. These authors' results corroborate the findings of this research before the implementation of food Quality Management Tools, which may demonstrate the establishments' disregard for the compliance with the Brazilian law (Brasil, 2004b).

Assessment of the knowledge acquisition by the FNU food handlers

According to the Wilcoxon signed-rank Test ($p<0.05$), the assessment of knowledge acquisition on the GMPs before and after the training course underwent substantial changes (Table 6). Before the course, the employees had an average grade of four (4) points; afterwards, they averaged eight (8) points. These results show that such courses are effective means of improving the handlers' knowledge while also directly affecting the quality of the food.

The training course aims to improve the food preparation process, in order to allow the employees to either acquire knowledge or perfect the knowledge they already possess (Santos and Bonnas, 2012). The authors noted that, after the training course, the food handlers took off any pieces of jewelry, such as rings and earrings. In addition, they currently use the correct hand sanitation procedures during the food handling, with alcohol 70% antiseptic.

Although the result of the assessment was satisfactory, it is important to regularly recycle the employees' work knowledge. Also, their work routine must be frequently checked by a qualified specialist, in order to ensure an effective learning and use of the approached concepts (Angelillo *et al*., 2000; Clayton *et al.*, 2002). Thus, both the training course and the proper supervision are reliable means to change the food handlers' hygiene habits. However, that rule does not apply to Brazil. A study conducted in public schools in the city of Natal, Campos *et al.* (2009) reported that 74.1% of food handlers do not undergo periodic training. The primary factor as to why the proposed training programs have such a small impact is linked to the employees' education level, which is either poor or inefficient (Çakiroğlu and Uçar, 2008). One of the reasons behind the lack of complete training programs for staff members who work directly in the food preparation process is the risk of loss of investment due to a high staff turnover, especially in small and medium businesses (Jianu and Chis, 2012).

Microbiological assessment after the implementation of food quality management tools

The authors conducted microbiological analyses on foods, equipment, utensils and on handlers' hands, aiming to assert the effects of the GMPs on the quality of the foods served at the FNU, as well as the efficiency of the training course. The results are presented in Tables 3, 4 and 5, respectively.

Microbiological quality of foods

No contamination with coagulase-positive *Staphylococcus* (CFU/g), *Salmonella* spp (absent in 25 g) or sulfite-reducing *Clostridium* at the temperature of 115º F (CFU/g) in any of the studied foodstuffs (Table 3) was detected. Coliforms at 113°F (45°C) (MPN/g) were evidenced in the raw lettuce, carrot, beetroot and cabbage salads. Brazilian governing laws establish that only a maximum amount of 102 (MPN/g) coliforms can be tolerated in these foodstuffs (Brasil, 2001). Therefore, the lettuce and beetroot samples were dissatisfactory. As for the raw carrot and cabbage salads, both were in accordance with the tolerable averages for thermotolerant coliforms. Finally, the results noted that the rice, beans and meat samples had a satisfactory microbiological quality.

The presence of coliforms at 113°F (45°C) indicates a fecal contamination. There are three primary causes for the contamination of the food products analyzed in this study: incorrect hygiene habits used by the FNU handlers; residues of organic fertilizers used in the cultivation of such products; and an inefficient sanitation of raw salads. Santana *et al.* (2009) assessed the microbiological quality of meals and the use of GMPs in fifteen public schools in the city of Salvador, Brazil, between

Table 5. Microbiological profile of food handlers' hands according to each bacteriological agent studied.

(n=8)	Coliforms at 45°C (MPN/hand)	Standard Deviation	*Coagulase*-positive *Staphylococcus* (CFU/hand)	Standard Deviation
Food hand	< 3	0.00	$2.37x10^1$	120.20

Average values and standard deviation of hands of food handlers.

August 2002 and December 2003. After the adoption of these practices, those authors did not detect any coliforms at 113°F (45°C) or coagulase-positive Staphylococcus in carrot and lettuce salads served in school number 10. In that sense, their results differ from those obtained by these researchers as for the thermotolerant coliforms, which indicates the need for supervision in the preparation process (in order to eliminate the sources of contamination).

Marzano and Balzaretti (2013) carried out a similar research on twenty-six Italian schools. They tested for the microbiological risks and hygiene practices in food preparation processes and detected the bacteria *Salmonella* spp in 5.8% of samples of raw vegetables ready for consumption. The authors of this study did not detect the presence of such microorganism in any of the analyzed food products, which evidences their sanitary quality.

Microbiological quality of equipment and utensils

According to the conducted microbiological assessments (Table 4), none of the studied equipment and utensils showed signs of contamination with coliforms at 113°F (45°C) or coagulase-positive Staphylococcus. These results evidenced a satisfactory microbiological quality for such analyses, in accordance with APHA (2001), which establishes a limit of 2 CFU/cm^2 coliforms at 113°F (45°C) for equipment, and the WHO, which establishes a limit of 100 CFU/utensil and 5.0 x 10^1 CFU/cm^2 for equipment, both cited by Silva Jr. (2008). The absence of contamination stresses an efficient implementation of washing and sanitation processes of equipment and utensils used in the FNU.

Oliveira *et al*. (2008) assessed the hygienic-sanitary conditions of meat grinders in a study conducted on five food establishments in the city of Lavras, Brazil. They found that the amount of coliforms at 113°F (45°C) detected enabled the formation of bacterial biofilms. According to Andrade *et al.* (1998), a biofilm comprises a minimum amount of 10^7 cells per cm^2. The results obtained by this study were satisfactory and differed from the research conducted by Sneed *et al.* (2004), which assessed the microbiological quality of equipment and utensils' surfaces after the sanitation of food establishments in the state of Iowa, in the United States. They detected a dissatisfactory amount of biofilms in 55% of the analyzed samples. As already mentioned, Marzano and Balzaretti (2013) noted a high hygiene level (n=139) on the surfaces of twenty-six Italian schools, which corroborates the results of this study.

Microbiological quality of food handlers' hands

The conducted microbiological assessments did not detect any contamination with coliforms at 113°F (45°C) on the food handlers' hands. As for the coagulase-positive Staphylococcus, only two of the employees (corresponding to 25%) presented hand contamination ($1.0x10^1$CFU/hand and $1.8x10^2$ CFU/hand) (Table 5). There are no specifications or standards that guide the microbial counting of coagulase-positive Staphylococcus on food handlers' hands.

However, Silva Junior (2008) highlight that satisfactory microbiological results mean the absence and thermotolerant coliform count of up to 100 CFU/cm^2 of *Staphylococcus* coagulase positive for collection with swab. The results obtained by this study show that the analyzed handlers' hands are in accordance with that author regarding coliforms. Since these are primary disease transmitting agents, Mesquita *et al.* (2006) observe that the handlers' hands must be thoroughly washed with liquid soap (whether or not antiseptic) in order to be cleansed of potentially pathogenic microorganisms.

Lagaggio *et al.* (2002) analyzed the hygiene of food handlers' hands at a university restaurant in the city of Santa Maria, and asserted that 27% of them were contaminated with *Staphylococcus aureus* and thermotolerant coliforms. Campos *et al*. (2009) carried out microbiological analyses on the hands of employees of public schools in the city of Natal. Amongst the analyzed samples, they found a 55.6% contamination percentage. Such result could be explained by a possible lack of exclusive hand sinks and washing methods in the cafeterias.

Lastly Malhotra *et al*. (2006) noted inappropriate hand washing methods in an Indian teaching hospital. They detected a 73% contamination percentage amongst the analyzed samples. By comparing the present study's results to the aforementioned authors, the researchers were able to observe that the food handlers in the studied FNU sanitized their hands with the proper procedure; such finding is evidenced by the absence of Thermotolerant Colfirms in all of the subjects' hands – which shows that this antisepsis was carried out in an efficient manner.

Conclusion

Through the course of this study, the researchers could observe a substantial improvement in the hygienic-sanitary aspects of the FNU (since it moved from the "Defficient" group to the "Medium" group). The results of the handlers' knowledge assessment, both before and after the training course, showed that that is a reliable method of improving their skills. However, these food handlers will need constant knowledge recycling, as well as regular supervision by qualified specialists; these are the most efficient ways to ensure an effective learning and use of the primary concepts studied during the courses. Thus, they can begin acquiring satisfactory hygiene habits. Finally, this study evidenced the effectiveness of Good Practices Manufacturing Tools in the quality of the food prepared in the Food and Nutrition Unit. Nevertheless, its maintenance will depend on ongoing institutional management actions that seek to improve the handling of such foodstuffs and to properly train those who handle them, since these tools can be used to ensure the safety of the food.

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