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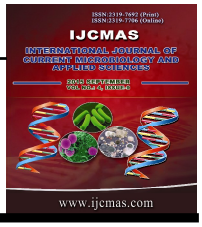

Original Research Article

A Survey of the Microbiological Quality of Food Served at a University Hospital in Egypt

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Food safety, food borne illnesses, temperature dangerous zone, microbiological quality

A B S T R A C T

The aim of this study was to investigate the microbial contamination of food served to patients at the Ain Shams University Hospital. Eighty food specimens were collected from the kitchens of the Internal Medicine (IM) and General Surgery(GS) Hospitals as well as eighty three environmental specimens (surface swabs and hands of food handlers swabs) .Sampling of food was done from the hospital kitchen (hot meals) as well as from the ward kitchen (cooled meals). Food samples were processed according to the protocol obtained from the Centre Hospitalier Universitaire Bicêtre (2001). Several tests were done: total colony count, total coliform count, *Staphylococcus aureus* and fungal detection. Audit on the hospital kitchen was done on the same day as food and environmental samples were taken. In the IM hospital kitchen: the percentage of unsatisfactory hot meals was 39% and became 72% in cooled meals. In the GS hospital kitchen: the percentage of unsatisfactory hot meals was 28% and became 64.7% in cooled meals. The most commonly isolated pathogens were the Bacillus spp. It was concluded that the process of cooling and packaging of food was not efficient and food was kept in the temperature dangerous zone for a long time.

Introduction

Despite the progress seen in recent times in medical care and food technology, food-borne diseases are still, and increasingly, of major concern for human health, both in developing and developed countries. Everyone is susceptible to food-borne diseases but the immune compromised patients are particularly at risk of contracting food-borne illnesses and suffer more serious complications as a result of infection. Food-borne illnesses can be caused by microorganisms and/or their toxins, fungi and their related toxins, and chemical contaminants (Khamis and Hafez, 2011).

The International Commission on Microbiological Specifications for Food *(ICMSF)* introduced the concept of 'Food Safety Objectives' (FSOs) as 'the maximum frequency and/or concentration of a microbial hazard (micro-organisms or toxins) in a food considered tolerable for

consumer protection' *(ICMSF, 2002).*The FSO concept relates also to the use of the Hazard Analysis and Critical Control Point (HACCP) concept for controlling the effectiveness of food processing operations *(ICMSF, 2005).*

HACCP is an ideal, proactive approach and a management system. It is applied to the food chain from purchase to consumption. This program was first developed for the National Aeronautic and Space Administration (NASA) food space program**.** HACCP is interested seriously in keeping the potentially hazardous foods (PHFs) safe. PHFs are food items that require temperature control because they are capable of supporting the rapid and progressive growth of infectious or toxin-producing microbes (Hanekom et al, 2010)

If PHFs are held in the temperature danger zone between (5˚C) and (57˚C) for 4 hours or more, infectious and toxin-producing microbes can grow to dangerous levels. PHFs have been associated with most food-borne disease outbreaks. It is critical to control the handling and storage of PHFs to prevent bacterial growth *(Leistner and Gould, 2001).*

Many hospitals advise Low Microbial Diets (LMDs) for patients with a low neutrophil count and these diets are termed "neutropenic diets". LMDs reduce ingestion of bacterial and fungal contaminants by exclusion of uncooked fruits, vegetables, cold cuts, undercooked eggs and meat, unsterilized water, unpasteurized milk products and soft cheeses. LMDs and general HACCP guidelines can ensure that all sick patients in hospitals get the advantage of receiving safe food (Lund, 2014).

The aim of this study was to investigate the microbial contamination of food served at the Ain Shams University Hospital; also to correlate it with the contamination of the food preparation surfaces taking into consideration the food handling practices.

Materials and Methods

The present study is a cross-sectional descriptive study that was conducted at the Central Microbiological Laboratory, Clinical Pathology Department, Ain Shams University Hospital, a tertiary referral university hospital in Cairo, Egypt over the period from June 2013 and January 2014.

Sampling

The study included 80 food specimens collected from Internal Medicine and General Surgery hospital kitchens as well as 83 environmental samples (surface swabs and hand swabs).

Food included processed food stuffs (rice, poultry, vegetables, and meat) as well as non-processed food-stuffs (green salad).

Sampling of food was done from the hospital kitchen (hot meals) as well as from the ward kitchen (cooled meals).

About 50 grams of different foods were collected in sterile containers labeled with the type of sample, date, time of collection and name of the kitchen. Samples were transported immediately in an ice box to the microbiology laboratory for processing. Unless immediately processed, foods were kept at 2-4°C for a maximum of 24 hours.

Swabs were taken on the same day of food sampling from the hands of food handlers as well as from the surfaces to which the food is exposed (the kitchen pans, meat cutting boards, salad cutting boards, ovens, vacuums, foam plates where the food is served).

Processing

Samples were processed according to the protocol obtained from the Centre Hospitalier Universitaire, CHU Bicêtre (2001).Several testes were done total colony count on nutrient agar, total coliform count on Mac Conkey agar medium, *S.aureus* on Baird Parker medium and fungal detection on Sabouraud Dextrose agar medium.

Determination of the total bacterial count

Plates were examined after 48 hours, each individual colony was counted, and the total number of colonies was multiplied by the dilution shown on the plate to get the total number of bacteria per gram product. Example: if 10 colonies were found in the plate containing 1mL of the dilution 1:10, then the total bacterial count will be 100cfu/gm.

Determination of the total Coliform count

Plates were examined after 48 hours, each individual colony was counted, and the total number of colonies was multiplied by the dilution shown on the plate to get the total number of Coliforms per gram product.
Values obtained were compared to the values cited in the guidelines for the microbiological quality of various foods *(Gilbert et al., 2000)*.

Each type of colony was further identified to the species level by routine biochemical tests used at the microbiology laboratory.

Determination of *Staphylococcus aureus*

Colonies of *Staphylococcus aureus* appear as black colonies surrounded by clear halo on the BP medium. They were further tested by coagulase test to confirm their identity.

Determination of fungal contamination

Any growth on SDA was considered significant and was further identified by culture morphology and microscopic examination.

Culture of environmental samples

Hand and surface swabs were inoculated on conventional Blood agar medium supplemented with 7%human blood. The plates were incubated aerobically at 37^0 C for 48 hours. The growing colonies were identified by culture morphology, morphology in Gram stain, conventional biochemical tests routinely done at the microbiology laboratory. Typing of organisms was done by an antibiogram. Antimicrobial susceptibility tests were done to all identified organisms according to the recommendations of the clinical and laboratory standards institute ***(CLSI, 2010).***

Auditing on Hospital Kitchens

Audit on the hospital kitchen was done on the same day as food and environmental samples were taken. A checklist was developed taking into account some important points related to the food preparation process including the foodhandlers, the kitchen environment and the surfaces.

Results and Discussion

Results of Internal Medicine hospital:

Food samples

All the eighteen food specimens obtained as hot samples from the hospital kitchen, (100%) contained microorganisms. However,

the counts were considered satisfactory in 7 specimens (39%), unsatisfactory in 7 specimens (39%), acceptable in 4 specimens (22%) as shown in Table (1)
Bacillus species was the most common organism isolated from all types of contaminated hot food specimens (100%). This was followed by *Stenetrophomonas* (20%) and *Enterobacter vulneris* (16.7%) as shown in Table(2).

Also, all of the eighteen food specimens obtained as cooled samples from the hospital ward kitchen,(100%) contained microorganisms. However, the counts were considered satisfactory in 2 specimens (11%), unsatisfactory in 13 specimens (72%), acceptable in 3 specimens (17%) as shown in Table (3).

Bacillus species was the most common organism isolated from all types of contaminated cooled food specimens (100%) as shown in Table (4).

Environmental samples

The 20 swabs obtained from the hands of the food-handlers were all positive for microorganisms (100%).The most frequent organism identified was the *Coagulase Negative Staphylococci (CoNS)* as it was recovered from (11/20,55%) of samples. This was followed by *methicillin resistant Staphylococcus aueus* (*MRSA)* (5/20,25%) , *Bacillus* spp. (4/20,20%), *Candida* (3/20,15%), *Serratia* species (2/20,10%), *Enterobacter* species (2/20,10%), *Proteus* species (1/20,5%), *Acinetobacter* species (1/20,5%), *Micrococci* (1/20,5%) and *Corynebacterium* species (1/20,5%) .

Out of the 21swabs obtained from the surfaces, 15 (71.4%) were positive for microorganisms. The most frequent organisms identified were the *CoNS* (3/15,20%) , *Bacillus* species (3/15,20%) and *Enterobacter* species (3/15,20%) followed by *Corynebacterium* species (2/15,13.3%), *Serratia* (2/15,13.3%), *Stenetrophomonas* (2/15,13.3%), *MRSA* (2/15,13.3%), *Methicillin Resistant Coagulase Negative Staphylococci* (2/15,13.3%), *Pseudomonas* species (1/15,6.7%), *Salmonella* (1/15,6.7%), *Listeria* (1/15, 6.7%), *Micrococci* (1/15,6.7%), *Enterobacter agglomerans* (1/15,6.7%), *Candida* (1/15,6.7%), *Shigella sonnei* (1/15,6.7%) and *Aspergillus niger* (1/15,6.7%).

Results of General Surgery hospital

Food samples

Out of the 15 food specimens obtained as hot samples from the hospital kitchen, 14 (95%) contained microorganisms. The counts were considered satisfactory in 8 specimens (58%), unsatisfactory in 4 specimens (28%), acceptable in 2 specimens (14%) as shown in Table (5).

The Bacillus species was the most common organism recovered from all the types of positive food specimens as shown in Table (6).

All of the 17 food specimens obtained as cooled samples from the hospital ward kitchen contained microorganisms (100%). However, the counts were considered satisfactory in 4 specimens (23.5%), unsatisfactory in 11 specimens (64.7%), acceptable in 2 specimens (11.8%) as shown in Table (7).

The *Bacillus* species was the most common organism isolated from all types of contaminated cooled food specimens except in the salad samples where the most common organism isolated was the Candida species as shown in Table (8).

Environmental samples

Out of the 19 swabs obtained from the hands of the foodhandlers, 17 (90%) were positive for microorganisms. The most frequent organism isolated was the *CoNS* (13/17, 76.5%), followed by *Streptococci* (1/17, 5.9%), *Bacillus* species (1/17,5.9%), *Enterobacter* species (1/17,5.9%), *MRSA* (1/17,5.9%), *Stenetrophomonas*(1/17,5.9%), and *Corynebacterium* spp.(1/17,5.9%).

Out of the 23swabs obtained from the surfaces, 7 (30%) were positive for microorganisms. The most frequent organisms isolated were the *CoNS* (3/7,42.9%), and *Enterobacter* species (3/7,42.9%),followed by *Acinetobacter* (2/7,28.6%) and *Micrococci* (2/7, 28.6%), then *Serratia* species (1/7,14.3%), *Corynebacterium* spp. (1/7,14.3%),*Bacillus* species (1/7,14.3%), *Klebsiella* (1/7,14.3%) and *MRSA* (1/7,14.3%).

Using the antibiogram, no correlation was found between the organisms recovered from the environmental samples obtained at the Internal Medicine and the General Surgery hospitals kitchens and the microorganisms recovered from the different types of specimens obtained from food.

Our findings goes with *Reglier-Poupet et al. (2005)* who compared between the microbiological quality of meals on leaving the central kitchen and at the time the last patient was served. The authors found that although the microbiological results on leaving the central kitchen were: 37 good meals (72%),12 acceptable meals (24%) and 2 unsatisfactory meals (4%), the results at the time the last patient was served were:36 good meals (71%), 7 acceptable meals (14%) and 8 unsatisfactory meals (15%).

This could be due to the fact that in the present study ,the prepared food was left to cool then some workers start to package food inside the foam plates by a cellophane covering, waiting to be distributed to the patients after 30-45 minutes.
For this reason the European Food Safety Authority recommended that effective cooling is required after cooking to prevent growth from bacterial spores, which survive cooking. Food should be cooled rapidly and kept below 7-8^0 C (ideally below 4^0 C) to control Clostridia and other bacteria, and reheated to at least 72^{0}C before consumption *(Juneja et al., 2006).* Also, *Barbara and Sarah (2009)* recommended that food should be served within 15 minutes.

Bacillus spp. was the most common organism identified in all types of food. This finding goes in agreement with *Barbara and Sarah (2009)* and *Khamis and Hafez (2011)* studies which stated that *Bacillus* spp. can survive cooking in almost all types of food such as cooked rice, vegetable samples, cooked meat and poultry.

Only 2 samples contained *Staphylococcus aureus* (one salad sample from the IM hospital and one hot rice sample from the GS hospital). *Rattanasena and Somboonwatthanakul (2010)* showed that *S.aureus* was the most common bacteria isolated in freshly made foods in hospital cafeteria, followed by *E.coli* and *Streptococcus faecalis.* The authors attributed their findings to the lack of hand hygiene since such infection occurs when cooked foods are handled by persons who carry the pathogen in their nails or their skin *(Protocarrero et al., 2002).*

In this study, there were multiple samples with high coliform count. The presence of coliforms indicates a substantially increased risk of the presence of pathogens and any cooked food should not have coliforms exceeding 100cfu/g *(KEBS, 2003). Aycicek et al. (2004)* reported that the presence of coliforms, *E.coli* and *CoNS* indicates either post-cooking or post-preparing contamination of the main dishes and salad studied. At the same time, these results indicate a long delay-time and inadequate temperature holding during the distribution processing of the hot meals. Alternatively, it can be said that management practices in agriculture, as part of growing, harvesting, washing, sorting, packing and transporting procedures for salad vegetables may also be improper.

In the present study, Yeast *(Candida)* was more prevalent than moulds in the food samples. It was detected in cooled rice, vegetables and salad in IM hospital. Also, it was detected in cooled rice, meat and salad in GS hospital. *Aspergillus niger* was detected in some samples but less frequently. *Penicillium* was detected in one sample of cooled vegetables. This was in disagreement with *Bouakline et al (2000)* who found that moulds contamination was more common than yeast. However, they examined different food types than us. They noted that different *Aspergillus* spp. were found in herbal teas, freeze-dried soup, all fruit types, except melons and grapefruit juice.

In the present work, *E. coli* was isolated from 16.7% of vegetable samples obtained at the IM kitchen but not from the samples obtained at the GS kitchen. *Marzano & Balzaretti (2011)* found that the cooked food ready for consumption was contaminated by E. coli in 2.7% of samples, by S. aureus in 2.2% of samples. As regard the green salad samples, in the present work, those obtained from the IM hospital were 100% contaminated by microorganisms. The organisms isolated were: *Bacillus* spp. (6/6,100%), *Candida* (4/6,66.6%), *Enterobacter* (2/6,33.3%) and *Klebsiella*, *Serratia*, *Stenetrophomonas, Candida tropicalis S.aureus* each (1/6,16.7%). However *Khamis and Hafez (2011)* found thatthe most commonly isolated bacteria from green salad samples were Pseudomonas aeroguinosa (*P. aeruginosa), Aeromonas and enterococci*.

As regard the hand swabs, the most frequent organism identified was *CoNS* (55%) in IM hospital and (76,5%) in GS hospital followed by *MRSA* (25%)in IM hospital, *Bacillus* spp. (20%) in IM hospital and (5.9%) in GS hospital and other species less frequently isolated. Similarly, *Aycicek et al (2004)* found that the most common bacteria isolated from the hands of the food handlers were *S.aureus* (70%) and *CoNS* (56.7%) followed by *Bacillus subtilis* (17.2%), *Bacillus* species (10.5%), *E.coli* (7.8%), *Klebsiella oxytoca* (3.9%), *Klebsiella pneumonia* (2.2%) and *P.aeruginosa* (0.6%). Also, *Cengiz et al. (2008)* found that *CoNS* (95%) and *S. aureus* (74%) were the most common organisms isolated from the hands of the kitchen staff. However, *Ekrami et al. (2011)* which found that *Enterobacteriaceae* (*K.pneumonia* and *Enterobacter* spp.) were the most common isolates in food service personnel followed by *CoNS* and *S.aureus.*

As regard the environmental surface swabs, the most frequent organisms identified were the *CoNS* (3/15, 20%), *Bacillus* species (3/15,20%) and *Enterobacter* species (3/15,20%) in IM hospital and the *CoNS* (3/7,42.9%), and *Enterobacter* species (3/7,42.9%) in GS hospital. *Ekrami et al. (2011)* found that *S.aureus, K. pneumoni* (31.5%) and *CoNS* (31%) are isolated from the surfaces, and there are some reports for

the production of enterotoxins by *CoNS* *(Pep et al., 2006).*

Table.1 Results of the Internal Medicine Hospital kitchen (hot meals)

Food	TCC	TC	*Staphylococcus aureus*%	Fungal Contamination%
Rice				
Satisfactory (n= 4)	1.3×10^3	0	0%	0%
Unsatisfactory (n=1)	4×10^5	0	0%	0%
Acceptable(n= 1)	2×10^4	0	0%	0%
Cooked vegetables				
Satisfactory (n= 1)	2×10^3	0	0%	0%
Unsatisfactory (n=4)	1.9×10^6	0	0%	0%
Acceptable (n= 1)	2×10^4	0	0%	0%
Cooked meat				
Satisfactory (n= 0)	0	0	0%	0%
Unsatisfactory (n= 1)	5×10^6	0	0%	0%
Acceptable (n= 0)	0	0	0%	0%
Cooked chicken				
Satisfactory (n= 2)	2.1×10^4	0	0%	0%
Unsatisfactory (n=1)	2×10^6	0	0%	0%
Acceptable (n= 2)	7×10^5	0	0%	0%

Table.2 Organisms isolated from hot food specimens of IM hospital

Food	Organisms	Number of positive samples (%)
Rice(n=6)	*Bacillus species* *Enterbactervulneris*	6 (100%) 1 (16.7%)
Vegetables(n=6)	*Bacillus species*	6 (100%)
Meat(n=1)	*Bacillus species*	1(100%)
Chicken(n=5)	*Bacillus species* *Stenetrophomonas*	5 (100%) 1 (20%)

Table.3 IM hospital ward kitchen (cooled meals)

Food	TCC	TC	*Staphylococcusaureus*%	FungalContamination%
Rice				
Satisfactory (n= 1)	4×10^3	0	0%	0%
Unsatisfactory (n=4)	4.5×10^6	58	0%	50%
Acceptable (n= 1)	5×10^4	0	0%	100%
Cooked vegetables				
Satisfactory (n= 0)	0	0	0%	0%
Unsatisfactory (n=5)	3.1×10^6	8×10^3	0%	20%
Acceptable (n= 1)	2×10^4	3×10^3	0%	0%
Cooked meat				
Satisfactory (n= 0)	0	0	0%	0%
Unsatisfactory (n= 1)	40×10^6	0	0%	0%
Acceptable (n= 0)	0	0	0%	0%
Cooked chicken				
Satisfactory (n= 1)	10^4	0	0%	100%

Unsatisfactory (n= 3)	2 x 10^6	0	0%	33.3%
Acceptable (n= 1)	7 x 10^5	0	0%	0%

Table.4 Organisms isolated from cooled food specimens of IM hospital

Food	Organisms	Number of positive samples (%)
Rice (n=6)	*Bacillus species*	6 (100%)
	Coagulase Negative	1 (16.7%)
	Staphylococci(CoNS)	1 (16.7%)
	Serratia	2 (33.3%)
	Enterobacterspecies	1 (16.7%)
	Candida	1 (16.7%)
	Aspergillus Niger	1 (16.7%)
	Penecillium	
Vegetables (n=6)	*Bacillus species*	6 (100%)
	Enterobacter species	1 (16.7%)
	Acinetobacter	1 (16.7%)
	Serratia	1 (16.7%)
	E.Coli	1 (16.7%)
	Candida	1 (16.7%)
Meat (n=1)	*Bacillus species*	1 (100%)
	Pseudomonas	1 (100%)
	Acinetobacter	1 (100%)
Chicken (n=5)	*Bacillus species*	5 (100%)
	Corynebacterium	2 (40%)
	Pseudomonas	1 (20%)
	Stenetrophomonas	1 (20%)
	Aspergillusniger	2 (40%)
Salad (n=6)	*Bacillusspecies*	6 (100%)
	Klebsiella	1 (16.7%)
	Serratia	1 (16.7%)
	Stenetrophomonas	1 (16.7%)
	Enterobacter	2 (33.3%)
	Candida	4 (66.6%)
	Candida tropicalis	1 (16.7%)
	Staphaureus	1 (16.7%)

Table.5 Results of the General Surgery hospital kitchen (hot meals)

Foods	TCC	TC	*Staphylococcus aureus*%	Fungal Contamination%
Rice				
Satisfactory (n= 2)	100	0	50%	0%
Unsatisfactory (n=2)	1.2 x 10^6	0	0%	0%
Acceptable (n= 0)	0	0	0%	0%
Cooked vegetables				
Satisfactory (n= 2)	2.5 x 10^3	0	0%	0%
Unsatisfactory (n= 1)	2 x 10^6	0	0%	0%
Acceptable (n= 2)	2.5 x 10^4	0	0%	0%
Cooked meat				
Satisfactory (n= 3)	3.7 x 10^3	0	0%	33.3%
Unsatisfactory (n=1)	20 x 10^5	0	0%	0%
Acceptable (n= 0)	0	0	0%	0%

Cooked chicken				
Satisfactory (n= 1)	2 x 10^4	0	0%	0%
Unsatisfactory (n=0)	0	0	0%	0%
Acceptable (n= 0)	0	0	0%	0%

Table.6 Organisms isolated from hot food specimens of GS hospital

Food	Organisms	Number of positive samples (%)
Rice (n=5)	*Bacillus species* *Staph.aureus*	4 (80%) 1 (20%)
Vegetables (n=5)	*Bacillus species* *Pseudomonas*	5 (100%) 1 (20%)
Meat (n=4)	*Bacillus species* *Aspergillusniger*	4 (100%) 1 (25%)
Chicken (n=1)	*Bacillus species*	1 (100%)

Table.7 The results of the General Surgery ward kitchen (cooled meals)

Food	TCC	TC	*Staphylococcus aureus*%	Fungal Contamination%
Rice				
Satisfactory (n= 2)	50	0	0%	100%
Unsatisfactory (n=4)	5.5 x 10^6	0	25%	0%
Acceptable (n= 0)	0	0	0%	0%
Cooked vegetables				
Satisfactory (n= 0)	0	0	0%	0%
Unsatisfactory (n= 5)	9.4 x 10^6	6 x 10^3	0%	40%
Acceptable (n= 1)	2 x 10^2	2 x 10^2	0%	0%
Cooked meat				
Satisfactory (n= 2)	5 x 10^3	10	0%	0%
Unsatisfactory (n=2)	1.3 x 10^7	0	0%	50%
Acceptable (n= 0)	0	0	0%	0%
Cooked chicken				
Satisfactory (n= 0)	0	0	0%	0%
Unsatisfactory (n=0)	0	0	0%	0%

Acceptable (n= 1)	4 x 10^5	0	0%	0%

Table.8 Organisms isolated from cooled food specimens of GS hospital

Food	Organisms	Number of positive samples (%)
Rice (n=6)	*Bacillus species*	5 (83.3%)
	Stenetrophomonas	1 (16.7%)
	Candida	1 (16.7%)
	Penecillium	1 (16.7%)
	CoNS	2 (33.3%)
	Staph.aureus	1 (16.7%)
Vegetables (n=6)	*Bacillus species*	6 (100%)
	Aeromonashydrophila	1 (16.7%)
	Serratia	1 (16.7%)
	Penecillium	1 (16.7%)
Meat (n=4)	*Bacillus species*	4 (100%)
	Candida	1 (25%)
	Serratia	1 (25%)
Chicken (n=1)	*Bacillus species*	1 (100%)
Salad (n=6)	*Klebsiella*	1 (16.7%)
	Enterobacter	1 (16.7%)
	Candida	4 (66%)

Contact surfaces analysis done by *Zbadi et al.*(2014) showed that the causative organisms were fecal coliforms (60%) and *S.aureus* (40%), that could make the warning signal in hospitals for the establishment of a global quality policy to ensure food safety and to prevent healthcare associated infections.

The surfaces and equipment were scored (45.8%) in the IM hospital kitchen and (51.4%) in the GS hospital kitchen because equipment, utensils, walls, floors and sinks were not always clean. The use of detergents and insecticides was neither adequate nor effective. Utensils were old and not easily cleanable. However, packaging materials were used to avoid contamination of food; also walls and floors were easily cleanable.

Also, personnel were scored (51.7%) in the IM hospital kitchen and (48.3%) in the GS hospital kitchen because wearing of masks, gloves, hair caps and overshoes was not usually implemented. Aprons were not adequately clean. The hands of the food handlers were not usually clean; rings and sores were sometimes seen. There is a specified person responsible for overall plant sanitation.

These findings are in agreement with the study of *Veiros et al (2009)*, who found that 76% of the attributes evaluated in checklist were classified as non- conforming.

We concluded from this study that the process of cooling and packaging of food was not efficient and food was kept in the temperature dangerous zone for a long time

which explains why the unsatisfactory meals were more at the time of serving. So it is recommended to follow the adequate temperature control regimen and to immediately cool the food after being prepared till being served. More training programs for the food handlers are needed to ensure strict adherence to hand and environmental hygiene.

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