Integrating hazard analysis and critical control point (HACCP) systems in Cairo University dormitory restaurant

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ABSTRACT

Hazard analysis was implemented in Cairo University dormitory restaurant during the period of 2005-2008. The study shows the efficiency of HACCP system throughout meat and poultry entire production chain. A total of 1482 natural random samples through the production chain was microbiologically, chemically and physically monitored. Total bacteria, molds and yeasts, Bacillus cereus, Staphylococcus aureus, coliforms, Escherichia coli, Listeria monocytogenes, Salmonella spp., Shigella spp., spore-forming bacteria and Clostridium perfringens were enumerated. Results of implementation of the HACCP system show a low incidence of studied microorganisms, with $P<0.05$ which indicates significant effect of HACCP application. No detectable levels of total aflatoxins or ochratoxins A in raw materials, as well as, pesticide residues in the final products were found. On the same line, a documented training in personal hygiene, good manufacturing practices (GMPs), cleaning and sanitation procedures and personal safety in addition to the rearrangement in the infrastructure of these establishments could improve yet more the microbiological quality of the served meals.

***Key words**: HACCP, meat, poultry, microbiology, dormitory restaurant.*

INTRODUCTION

Dormitory, a building at a College or University where students live, provides three free and/or low price meal offered to indoor and outdoor students. Therefore, quality of meals is a primary objective of dormitory food service systems. Cairo University dormitory restaurant (the male students' department) has several restaurants on the campus that serves the needs of more than 10000 residential dormitory students, who have semester-long food contracts, i.e., commuter students and staff. This study was fulfilling HACCP requirements in Cairo University dormitory for male students' which serves complete hot meal for ca. 6000 students.

Food service is responsible for about 58% of outbreaks of food borne illness because of modern processing methods, handling and distribution, takes longer for food to reach the table and it is more likely to be contaminated with microorganisms. Centralized kitchens and mass feeding operations mean that more people are affected by a contaminated food. Protecting food service customers from food borne illness is complicated but important. So, prepared food should be kept wholesale and safe by good sanitation during preparation and storage (Kassem *et al.*, 2004). Food safety is dependant on good hygiene practices meeting the guidelines stipulated by Hazard Analysis Critical Control Points (HACCP) food safety management

system. Implementation of HACCP system is emphasized by US Food and Drug Administration (FDA). In order to the HACCP plan to be effective, prerequisite programs should be implemented including: good manufacturing practices (GMP) and standard operating procedures (SOP), programs aimed at improving employee hygiene practices, cleaning and sanitation programs, proper facility-design practices, equipment-maintenance, supplier selection and specification programs (cross-contamination control) (Santana *et al.*, 2009). Meat and poultry products are sensitive to contamination with bacteria, viruses and parasites. After being contaminated, meat and poultry provide an excellent environment for growth of bacteria. To improve product safety, the meat and poultry industries are adopting the process controling system "Hazard Analysis Critical Control Point (HACCP)" which improves product safety by anticipating and preventing in advance the possible health hazards (Northcutt and Russell, 2003).

The aim of this study was to determine food safety procedures and practices related to HACCP program implementation in Cairo University- Student's hostel food service through: 1) Monitoring microbial contamination and Critical Control Points (CCPs) in the preparation and handling of catering foods.
2) The correction of CCPs for each step will be applied and evaluated based on the obtained results; and then 3) verification of the whole running system.

MATERIALS AND METHODS

Hygienic sanitation self-monitoring was conducted in Cairo University Dormitory Restaurant (the male students' department) for the catering industry during a period extended from 2005 to 2008. Implementation of hygiene measurements was done to evaluate the potential hazards associated with foods prepared in its current restaurant, i.e., to determine the possible Critical Control Points (CCPs). Monitoring was the scheduled measurement and observation of a CCP related to its critical limits. It was categorized into 3 general hazards: biological, chemical and physical. Due to the diversity of meals produced by the restaurant, a total of 1482 random samples were studied through the food production chain (Table 1).

Table (1): Samples collected throughout the study.

Type of sample	Number of samples	
	Before HACCP	After HACCP
Meat * (9)	135	135
Chicken * (8)	120	120
Food additives **	195	195
Handlers' swabs [1]	45	45
Surfaces' swabs [2]	75	75
Instruments' swabs [3]	81	81
Utensils' swabs [4]	90	90

* *Number of processing steps.*

** *Include ghee, oil, raw onions, trimming onions, mincing onions, tomato paste, tomato juice, stewed tomato juice, garlic, salt, water, cumin and black pepper.*

1. From workers, cookers and serving chefs.

2. From preparation, elevator, kitchen, board and serving areas.

3. From steam pots, mincer, tin opener and civies.

4. From trays, roasting trays, pots, scoops, skimmers and spoons.

Samples were taken randomly in plastic bags and transferred as soon as possible in refrigerated and insolated container. Almost every week over the period of the current study, visits were done for collecting mentioned samples and swabs. For each examined food stuff, five samples were taken at each processing step before and after HACCP application. Similarly, swabs were taken from handlers, instruments, surfaces and utensils for microbiological analysis. In addition, 12 swab samples were taken from steam pots.

Microbiological examinations

Twenty-five grams of the sample were aseptically weighed in sterile stomacher bags, diluted with 225 ml peptone water, homogenized in a stomacher for 2 min (10^{-1} dilution) and serially diluted in 9 ml of peptone water (Soriano *et al.*, 2002). Microbiological analysis was performed according to the procedures recommended by the International Commission on Microbiological Specification for Foods (ICMSF, 1978 and 1996) and (Harrigan, 1998). Samples were subjected to the following microbial examinations: total count, molds and yeasts count, *B. cereus, Staph. aureus,* coliforms, *E. coli, L. monocytogenes, Salmonella* spp., *Shigella* spp., spore-forming bacterial count and *Cl. perfringens*. The respective media were used in dehydrated forms (Oxoid, Difco and LAB-M): Plate Count Agar; Sabouraud Dextrose Agar; MacConkey Broth; Brilliant Green Lactose Broth 2%; Lactose Broth, EMB, Tryptone Water, MRVP Medium and Simmon Citrate Agar; PPEMBA; Baired-Parker's Medium and Brain Heart Infusion; Selenite Cystine Broth, Tetrathionate Brilliant Green Broth, Bismuth Sulphate Agar, Brilliant Green Agar, TSI, LIA, SS Agar and XLD Agar; Listeria Enrichment Broth and Oxford Medium, in addition to the serological kits of Bacto Salmonella O antiserum.

Preparation of swabs

Samples from workers, equipment, surfaces and utensils were collected by swabbing an undefined limit of approximately 100 cm^2 with moistended medical gauze. Each swab was pummeled for 2 min with 10 ml of 0.1% (w/v) peptone water. Then, 1 ml of the pummeled fluid was diluted in 9 ml of peptone water (Bryant *et al.*, 2003).

Physical analysis

Clinical examination of the carcass was carried out by a veterinary doctor, in addition to visual inspections during the production process.

Chemical analysis

Mycotoxin residues

Raw material samples were examined for the presence of the total aflatoxins and ochratoxins A referred to AOAC (2003) and Harrigan (1998), which was implemented by following the Veratox kit's individual instructions. The mycotoxin's test kits are a direct competitive ELISA in a microwell format which allows the user to obtain the exact concentrations in parts per billion (ppb).

Pesticide residues

Gas chromatographic multiresidue quantitative determination of organochlorine and organophosphorous residues was determined according to AOAC (2003) in Central Agricultural Pesticides Laboratory, Agricultural Research Centre.

Application of HACCP plan

HACCP program was established for each food product preparation following the flow chart outlined in Figs. (1 and 2) as well as the standard operation procedures that needed to be accomplished started from the receiving and ended with serving, i.e., type of hazards (physical, chemical or biological), control methods, control

limits, monitoring frequency and documentation, corrective actions when limits are exceeded, and the personnel who is responsible. According to the menu served, the types of food prepared in the restaurant; roasted meat and chicken; the storage conditions; after chilling or hot-holding before serving; all of these needed to be considered and recorded on worksheets which is the basic procedures that need to be considered before implementation of HACCP in food service (Tables 2 and 3). FDA emphasized the role of Pre-Requisite Program (PRP) for the implementation (Sun and Ockerman, 2005). Meat and poultry hot meals production chains were exposed to a 12-part HACCP plan according to the program summarized by Taylor (2007) as follow:

1-HACCP team

A team of individuals from different areas of production and processing was involved in developing the HACCP plan. HACCP team was appointed to guide the discussion: 1) manager responsible for the current study, 2) veterinary, 3) catering engineer (process flow: supervisor and serving engineer), 4) senior chef, 5) cooking and roasting chef, 6) serving chef, 7) consultant of food hygiene and sanitation, 8) consultant of food microbiology, and 9) a secretary to record the decision of a HACCP data sheet.

2-Describing the food and its distribution

Roasted meat and chickens

Fresh meat is received in quarters in the same day of cooking, whereas chicken were delivered in a frozen phase. Both were processed in different steps until served (Figs .1 and 2).

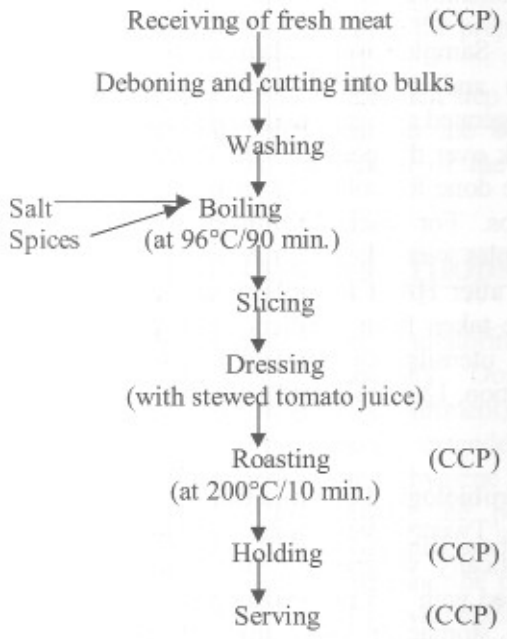

Fig. (1): Process flow diagram of roasted meat meal prepared and served at the kitchen.

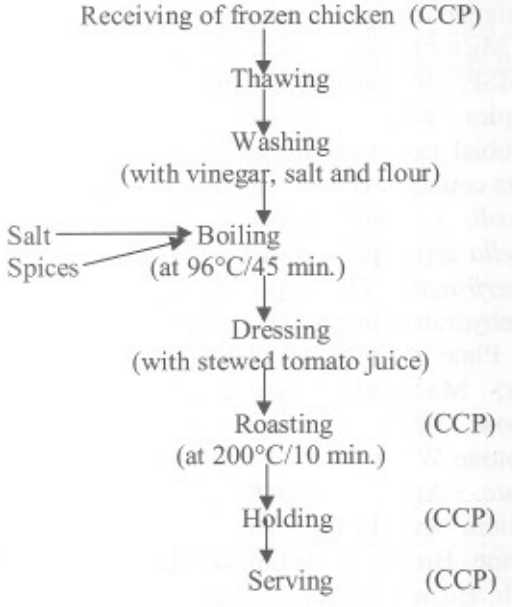

Fig. (2): Process flow diagram of roasted chicken meal prepared and served at the kitchen.

1. Intended consumers

The intended consumers of the complete hot meal in this study were male residential and commuter undergraduating students in addition to some faculty staff members.

2. Flow diagram of the process (Fig. 1 and 2).

3. Verifying the flow diagram

Principles of HACCP and implementation of a HACCP plan (NACMCF, 1998; Northcutt and Russell, 2003; ILSI, 2004)

Principle 1
conducting a hazard analysis (Table 2).

Principle 2
determination of Critical Control Points (CCPs).

Principle 3
establishing critical limits (Table 3).

Principle 4
establishing monitoring procedures.

Principle 5
establishing corrective actions.

Principle 6
establishing HACCP verification.

Principle 7
establishing record-keeping and documentation procedures.

Statistical analysis

Data were statistically analyzed according to a Statistical Package for the Social Sciences (Windows software version 11.5.0, 2002, SPSS, Inc, Chicago, IL). The descriptive statistics were carried out to characterize the distribution of the evaluation of the HACCP plans.

RESULTS AND DISCUSSION

Microbiological monitoring

Four CCPs were identified of HACCP models of the examined dormitory food service systems, i.e., receiving, roasting, holding and serving steps. For each control point, one or more of the four CCPs were identified (Table 3). The roasted meat had the highest microbial load with a mean value of $2.6x10^5 \pm 2.6x10^5$ CFU/g total count in washing step, while it was almost free from microorganisms in boiling and roasting steps, before HACCP application. *B. cereus* was isolated from the slicing step and its load was $1.8x10^2 \pm 1.4x10^2$ CFU/g. Also, faecal coliforms, *E. coli* and *L. monocytogenes* were detected before implementation of HACCP plan. Total bacteria after HACCP application reduced to $3.3x10^4 \pm 1.4x10^4$ CFU/g in the washing step. No microbial load was found in the steps starting from boiling to serving, therefore, no pathogens were detected in these steps. *Staph. aureus, Cl. perfringens, Salmonella* spp. or *Shigella* spp. were not found in any of the investigated samples neither before nor after HACCP application. The differences between results before and after subjecting the product to the HACCP system in the serving step were statistically significant throughout the microbial examinations. Microbial profile of roasted meat in the present study goes in the same line with those reported in Alexandria by Gomaa (1999), Cairo and Giza by El-Banna et al. (2002), Kassem *et al.* (2004) and Rashwan (2004), Egyptian railway by Malik (2003), Brazil by Pedroso *et al.* (1999), UK by Baker (2002), Taiwan by Sun and Ockerman (2005), and Iran by Tavakoli and Riazipour (2008).

These authors recorded the incidence of different microbiological profiles and pathogenic microorganisms; the ability of several bacteria to grow; as well, during the implementation of HACCP system in hot meat meal substrates. All these studies emphasized the improvement of food analysis as a guarantee of food safety. Although, *E. coli* indicates potential faecal contamination, the predominance of *B. cereus* and *L.*

monocytogenes indicates possible cross-contamination throughout the process of food preparation, handlers, surfaces and the food itself. For these microbiological hazards, there was a need for applying HACCP system. *B. cereus* population under normal circumstances was $1.8x10^2 \pm 1.4x10^2$ CFU/g in slicing step, which was lower than the minimal level required to cause food-borne illness ($>10^4$ CFU/g). However, the presence of enterotoxigenic strains of *Bacillus* spp. in minimal processed meat and poultry products is of public health significance because of the worse hygiene management which may be adopted during different preparation steps, uncontrolled storage conditions and method of heat treatments (El-Banna *et al.* 2002). Table (5) illustrates that before application of HACCP system in roasted chicken meal production, the mean counts of total bacteria, molds and yeasts, coliforms and spore-forming bacteria were the highest in the washing step being $1.4x10^5 \pm 9.5x10^4$, $3.3x10^4 \pm 1.3x10^4$, $>1.1x10^3$ and $2.8x10^3 \pm 2.6x10^3$ CFU/g, respectively. In addition, *E. coli, Salmonella* spp, and *L. monocytogenes* were detected in receiving, thawing and washing steps. In washing step, counts of total bacteria, molds and yeasts, coliforms and spore-forming bacteria were $1.5x10^4 \pm 1.2x10^4$, $9.2x10^3 \pm 1.0x10^3$, $1.0x10 \pm 2.6$ and $4.4x10^2 \pm 8.9x10$ CFU/g, respectively after HACCP implementation. A finding refers to the high significant differences among the microbiological traits of samples before and after integration of HACCP. *B. cereus, Staph. aureus, Cl. perfringens* or *Shigella* spp were absent in all of the examined chicken samples. Regarding to the serving step, the total bacteria, molds and yeasts and spore-forming bacteria were decreased in highly significant action ($p = 0$), where coliforms decreased significantly ($p = 0.029$).

These results are in agreement with Cogan *et al.* (1999), Gomaa (1999), Kassem *et al.* (2004), Rashwan (2004) and Tsola *et al.* (2008). Figure (3) shows the microbiological profile of the food additives used in these products before and after application of HACCP. Significant reduction in the microbiological load was found only in raw, trimming and mincing onions in addition to tomato juice. In this regard, raw materials were not anticipated as the source of serving step contamination. An assessment was conducted on 4 groups of swab samples taken from handlers (workers, cookers and serving chefs), surfaces (preparation area, kitchen, serving area, elevators and boards), utensils (trays, roasting trays, pots, scoops, skimmers and spoons) and instruments (steam pots, mincer, tin opener and civies) before and after the HACCP application (Fig. 4). All swab samples before HACCP were contaminated with total bacteria, molds and yeasts, coliforms, *B. cereus, Staph. aureus* and spore-formers. *E. coli, Salmonella* spp and *L. monocytogenes* were detected; meanwhile, the swab samples were free from *Cl. perfringens* and *Shigella* spp. On the contrary and after HACCP application, the microbiological load was significantly reduced (i.e., the p varied between the different groups but in general was< 0.05 for total counts).

Table (2): Hazard analysis chart of roasted meat and chicken throughout the production line.

Process step	Hazards	Preventive measures
1- Receiving of fresh meat *	- Contamination from the car trunk and from workers' hands. - Contamination from the environment. - Presence of foreign materials. - Presence of mycotoxins. - Presence of pathogens.	- Receiving in special car refrigerator. - Cover the meat with a clean cloth. - Series visual inspections. - No preventive measures. - Veterinary inspections and hygienic conditions.
Receiving of frozen chicken **	- Growth and multiplication of pathogens. - Contamination from the environment and containers. - Presence of mycotoxins. - Appearance of fungal or bacterial growth and their secretions.	- Receive frozen product only. - No abnormal appearance or smell. - Storage at ≤ -18°C. - Expiry date should not exceed 9 months. - Well packaging.
2- Thawing**	- Cross contamination from the environment, handlers, water and utensils.	- Well packaging. - Thawing for adequate time. - Avoid refreezing.
Deboning and cutting into bulks*	- Microbial load. - Microbial contamination. - Cross contamination from other stored raw food.	- Appling GMP. - Clean and sanitize hands and surfaces. - Avoid contact between meat and other raw food.
3- Washing	- Distribution and spreading of bacteria. - Cross contamination from the environment, handlers, water and utensils.	- Avoid soaking - Using vinegar, salt and pepper in washing (in chicken). - Using healthy handling procedures.
4- Boiling	- Microbial cross contamination from hands and from raw materials pieces sometimes added to already cooked or slightly cooked products. - Inadequate cooking.	- Avoid using bare hands and use a clean utensil instead. - Avoid adding any raw meat while cooking. - Time and temperature control (internal temperature > 71°C).
5- Slicing*	- Microbial cross-contamination from inadequately washed and sanitized surface (cutting board used also with raw meat), from hands and from wiping cloths.	- Adequate cleaning and sanitizing of cutting board or use a separate board for slicing cooked meat. - Personal hygiene and training of staff.
6- Dressing	- Growth and multiplication of microorganisms. - Germination of spores. - Cross contamination.	- Mix promptly after cooking without delay. - Personal hygiene.
7- Roasting	- Microbial cross contamination from workers' hands (inadequately washed) and from animals and insects found in the kitchen. - Growth and multiplication of microorganisms. - Survival of vegetative cells and spores.	- Personal hygiene of workers and control the animals and insects. - Time and temperature control.
8- Holding	- Spores germination. - Microbial cross contamination from workers' hands (inadequately washed) and from animals and insects found in the kitchen. - Growth and multiplication of microorganisms as time of holding increase.	- Hot hold at ≥ 60°C. - Avoid touching cooked meat with bar hands. - Minimize using wiping cloths. - Personal hygiene of workers and control the animals and insects. - Reduce time of holding.
9- Serving	- Contamination from workers' hands (inadequately washed) and utensils in addition to animals and insects found in the kitchen. - Germination and multiplication of surviving spores and other existing organisms.	- Serve hot, or hold at or above 60°C till serving. - Personal hygiene.

** In the meat meal production line.*

*** In the chicken meal production line.*

Table (3): HACCP control chart of roasted meat and chicken throughout the production line.

Process step	CCP	Hazard	Preventive measures	Critical limits	Monitoring		Corrective action	Personal responsible
					Procedure	Frequency		
Receiving of fresh meat and frozen chicken	1.1.	- Contamination from the environment and containers.	- Receiving meat at ≤ 5°C. - No preventive measures.	- TBC ≤ 10^6 - No pathogens	-Temperature -Detection of mycotoxin.	- At every receiving step.	- Reject the received meat if contains mycotoxin residues exceeds the critical limits	- Veterinary doctor
	1.2.	- Presence of mycotoxins	- Adequate veterinary examination.	- Aflatoxin ≤ 20 ppb.	-Visual inspections			
	1.3.	- Presence of foreign materials	- Receive frozen product only.	- No ochratoxins	-Microbiological profile.			
	1.4.	- Growth and multiplication of pathogens. - Appearance of fungal or bacterial growth	- No abnormal appearance or smell. - Storage chicken at ≤ -18°C.	- No foreign materials found				
	1.5.	and their secretions.	- Expiry date should not exceed 9 months. - Well packaging.					
Roasting	2.1.	- Microbial cross contamination from workers' hands (inadequately washed) and from animals and insects found in the kitchen.	- Personal hygiene of workers and control the animals and insects. - Time and temperature control.	- Microbial load within acceptable levels. - No pathogens found	- Microbiological examination	- At every roasting step.	- Time and temperature control.	- Process flow supervisor and chief of roasting.
	2.2.	- Growth and multiplication of microorganisms.						
	2.3.	- Survival of vegetative cells and spores.						
Holding	3.1.	- Spores germination.	- Hot hold at ≥ 60°C.	- Microbial load within acceptable levels. - No pathogens found	- Microbiological examination	- At every storing step.	- Apply GMP. - Ashore the hot holding at ≥ 60°C.	- Serving engineer and chief of serving.
	3.2.	- Microbial cross contamination from workers' hands (inadequately washed) and from animals and insects found in the kitchen.	- Avoid touching cooked meat with bar hands. - Minimize using wiping cloths. - Personal hygiene of workers and control the animals and insects.					
	3.3.	- Growth and multiplication of microorganisms as time of holding increase.	- Reduce time of holding.					
Serving	4.1.	- Contamination from workers' hands (inadequately washed) and utensils in addition to animals and insects found in the kitchen.	- Serve hot, or hold at or above 60°C till serving. - Personal hygiene.	- Microbial load within acceptable levels. - No pathogens found	- Microbiological examination	- At every serving step.	- Apply GMP. - Ashore the hot holding at ≥ 60°C.	- Serving engineer and chief of serving.
	4.2.	- Germination and multiplication of surviving spores and other existing organisms.						

Tale (4): The microbiological profiles[I] of roasted meat meal throughout the production line before and after HACCP application.

Process steps	Statistics	Total bacteria	Molds & Yeasts [II]	Coliforms	Faecal coliforms	*E. coli*	*B. cereus*	Spore-formers	*L.monocytogenes*
Receiving of fresh meat	b	$1.1x10^5 \pm 9.2x10^4$	$5.3x10^4 \pm 1.9x10^4$	$2.2x10^2 \pm 1.6x10^2$	+ ve	+ ve	- ve	$1.1x10^3 \pm 8.0x10^2$	- ve
	a	$5.6x10^4 \pm 1.6x10^4$	$4.2x10^4 \pm 1.4x10^4$	$1.9x10^2 \pm 3.9x10$	- ve	- ve	- ve	$4.2x10^2 \pm 1.1x10^2$	- ve
	p	0.169	0.203	0.689	-	-	-	0.094	-
Deboning and cutting into bulks	b	$2.0x10^5 \pm 1.9x10^5$	$6.3x10^4 \pm 1.9x10^4$	$6.2x10^2 \pm 4.5x10^2$	+ ve	+ ve	- ve	$2.2x10^3 \pm 1.9x10^3$	+ ve
	a	$4.7x10^4 \pm 1.7x10^4$	$3.4x10^4 \pm 1.4x10^4$	$1.2x10^2 \pm 4.9x10$	- ve	- ve	- ve	$3.7x10^2 \pm 7.5x10$	- ve
	p	0.140	0.030*	0.066	-	-	-	0.089	-
Washing	b	$2.6x10^5 \pm 2.6x10^5$	$9.7x10^4 \pm 6.3x10^4$	$> 1.1x10^3$	+ ve	+ ve	- ve	$3.2x10^3 \pm 2.6x10^3$	+ ve
	a	$3.3x10^4 \pm 1.4x10^4$	$2.1x10^4 \pm 1.9x10^4$	$6.2x10 \pm 4.9x10$	- ve	- ve	- ve	$3.4x10^2 \pm 5.2x10$	- ve
	p	0.130	0.035*	0***	-	-	-	0.073	-
Boiling	b	< 10	< 10	- ve	- ve	- ve	- ve	< 10	- ve
	a	< 10	< 10	- ve	- ve	- ve	- ve	< 10	- ve
	p	-	-	-	-	-	-	-	-
Slicing	b	$4.4x10^3 \pm 2.4x10^3$	$2.6x10^3 \pm 2.1x10^3$	$7.4x10^2 \pm 3.2x10^2$	+ ve	+ ve	$1.8x10^2 \pm 1.4x10^2$	$1.2x10^3 \pm 1.1x10^3$	- ve
	a	< 10	< 10	- ve	- ve	- ve	- ve	< 10	- ve
	p	0.016*	0.049*	0.007**	-	-	0.053	0.076	-
Dressing	b	$5.9x10^3 \pm 2.5x10^3$	$3.8x10^3 \pm 3.4x10^3$	$8.6x10^2 \pm 3.2x10^2$	+ ve	+ ve	- ve	$1.0x10^3 \pm 8.5x10^2$	- ve
	a	< 10	< 10	- ve	- ve	- ve	- ve	< 10	- ve
	p	0.007**	0.067	0.004**	-	-	-	0.048*	-
Roasting	b	< 10	< 10	- ve	- ve	- ve	- ve	< 10	- ve
	a	< 10	< 10	- ve	- ve	- ve	- ve	< 10	- ve
	p	-	-	-	-	-	-	-	-
Holding	b	$3.9x10^3 \pm 2.7x10^3$	$1.8x10^3 \pm 1.5x10^3$	$1.7x10 \pm 3.0$	+ ve	+ ve	- ve	$3.7x10^2 \pm 6.5x10$	- ve
	a	< 10	< 10	- ve	- ve	- ve	- ve	< 10	- ve
	p	0.032*	0.058	0***	-	-	-	0***	-
Serving	b	$7.5x10^3 \pm 5.9x10^3$	$2.0x10^3 \pm 1.5x10^3$	$2.5x10 \pm 8.3$	+ ve	+ ve	- ve	$4.3x10^2 \pm 6.7x10$	- ve
	a	< 10	< 10	- ve	- ve	- ve	- ve	< 10	- ve
	p	0.047*	0.041*	0.002**	-	-	-	0***	-

I: No detectable levels of Staph. aureus, Cl. perfringens, Salmonella spp. *and Shigella* spp.
b: Mean ± SD before the application of HACCP.
a: Mean ± SD after the application of HACCP.
p: Significant (2-tailed).
- : t cannot be computed because the standard error of the difference is 0.

II: Molds & yeasts as a group.
**: Significant at $p < 0.05$.*
***: Moderate significant at $p < 0.01$.*
****: Highly significant at $p < 0.001$.*
– ve: negative.

Table (5): The microbiological profiles[I] of roasted chicken meal throughout the production line before and after HACCP application.

Process steps	Statistics	Total bacteria	Molds & Yeasts[II]	Coliforms	Faecal coliforms	*E. coli*	Spore-formers	*Salmonella spp.*	*L.monocytogenes*
Receiving of frozen chicken	b	$4.5x10^4 \pm 2.6x10^4$	$5.6x10^4 \pm 2.8x10^4$	$5.6x10^2 \pm 3.2x10^2$	+ ve	+ ve	$7.5x10^2 \pm 3.3x10^2$	+ ve	+ ve
	a	$1.6x10^4 \pm 1.1x10^4$	$6.0x10^3 \pm 2.6x10^3$	$5.0x10^2 \pm 3.6x10^2$	+ ve	+ ve	$6.3x10^2 \pm 1.9x10^2$	+ ve	+ ve
	p	0.105	0.017*	0.831	-	-	0.237	0.178	-
Thawing	b	$1.7x10^5 \pm 3.4x10^4$	$6.3x10^4 \pm 2.9x10^4$	$8.6x10^2 \pm 3.2x10^2$	+ ve	+ ve	$1.5x10^3 \pm 1.0x10^3$	+ ve	+ ve
	a	$4.9x10^4 \pm 3.0x10^4$	$1.0x10^4 \pm 6.0x10^3$	$5.0x10^2 \pm 3.6x10^2$	+ ve	+ ve	$7.1x10^2 \pm 1.9x10^2$	+ ve	+ ve
	p	0.002**	0.015*	0.236	-	-	0.196	0.178	-
Washing	b	$1.4x10^5 \pm 9.5x10^4$	$3.3x10^4 \pm 1.3x10^4$	$> 1.1x10^3$	+ ve	+ ve	$2.8x10^3 \pm 2.6x10^3$	+ ve	+ ve
	a	$1.5x10^4 \pm 1.2x10^4$	$9.2x10^3 \pm 1.0x10^3$	$1.0x10 \pm 2.6$	- ve	- ve	$4.4x10^2 \pm 8.9x10$	- ve	- ve
	p	0.029*	0.014*	0***	-	-	0.120	-	-
Boiling	b	< 10	< 10	- ve	- ve	- ve	< 10	- ve	- ve
	a	< 10	< 10	- ve	- ve	- ve	< 10	- ve	- ve
	p	-	-	-	-	-	-	-	-
Dressing	b	$4.7x10^2 \pm 7.0x10$	$3.1x10^2 \pm 4.0x10$	$1.8x10 \pm 1.5x10$	- ve	- ve	$3.6x10^2 \pm 3.4x10$	- ve	- ve
	a	< 10	< 10	- ve	- ve	- ve	< 10	- ve	- ve
	p	0***	0***	0.053	-	-	0***	-	-
Roasting	b	< 10	< 10	- ve	- ve	- ve	< 10	- ve	- ve
	a	< 10	< 10	- ve	- ve	- ve	< 10	- ve	- ve
	p	-	-	-	-	-	-	-	-
Holding	b	$6.8x10^2 \pm 9.7x10$	$3.8x10^2 \pm 2.3x10$	- ve	- ve	- ve	$4.7x10^2 \pm 9.4x10$	- ve	- ve
	a	< 10	< 10	- ve	- ve	- ve	< 10	- ve	- ve
	p	0***	0***	-	-	-	0***	-	-
Serving	b	$7.4x10^2 \pm 1.2x10^2$	$4.6x10^2 \pm 3.1x10$	$2.4x10 \pm 1.6x10$	- ve	- ve	$4.8x10^2 \pm 3.3x10$	- ve	- ve
	a	< 10	< 10	- ve	- ve	- ve	< 10	- ve	- ve
	p	0***	0***	0.029*	-	-	0***	-	-

I: No detectable levels of B. cereus, Staph. aureus, Cl. perfringens and Shigella spp.
b: Mean ± SD before the application of HACCP.
a: Mean ± SD after the application of HACCP.
p: Significant (2-tailed).
- : t cannot be computed because the standard error of the difference is 0.
II: Molds & yeasts as a group.
**: Significant at $p < 0.05$.*
***: Moderate significant at $p < 0.01$.*
****: Highly significant at $p < 0.001$.*
– ve: negative.

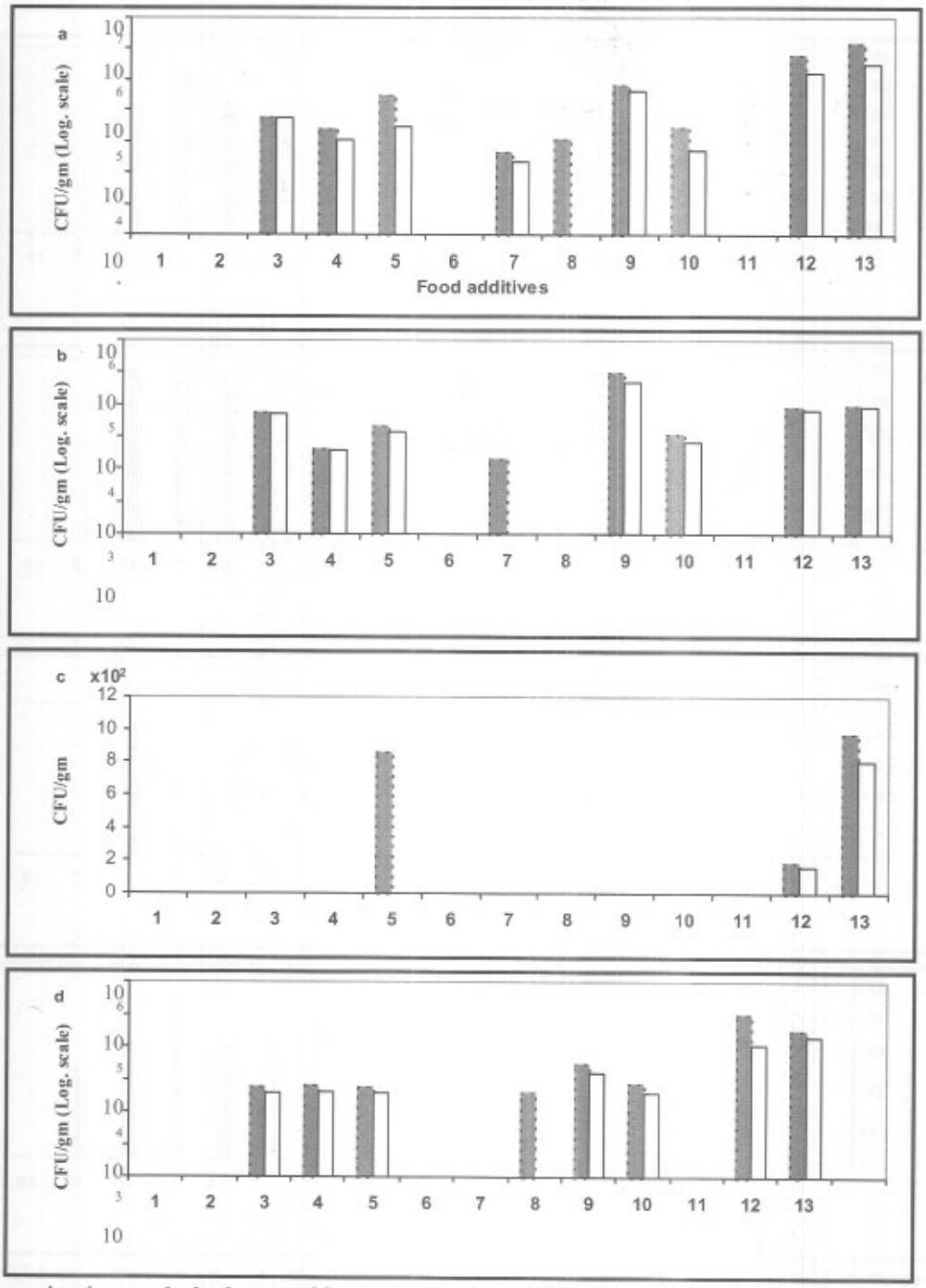

Fig. (3): Comparison between the development of the mean value of a) total bacteria, b) molds & yeasts, c) coliforms and d) spore-forming bacteria of food additives before and after the application of HACCP throughout the production process.

■ *Before HACCP* □ *After HACCP*

1. Ghee. *2. Oil.* *3. Raw onions.*
4. Trimming onions. *5. Mincing onions.* *6. Tomato paste.*
7. Tomato juice. *8. Stewed tomato juice.* *9. Garlic.*
10. Salt. *11. Water.* *12. Cumin.* *13 Black pepper*

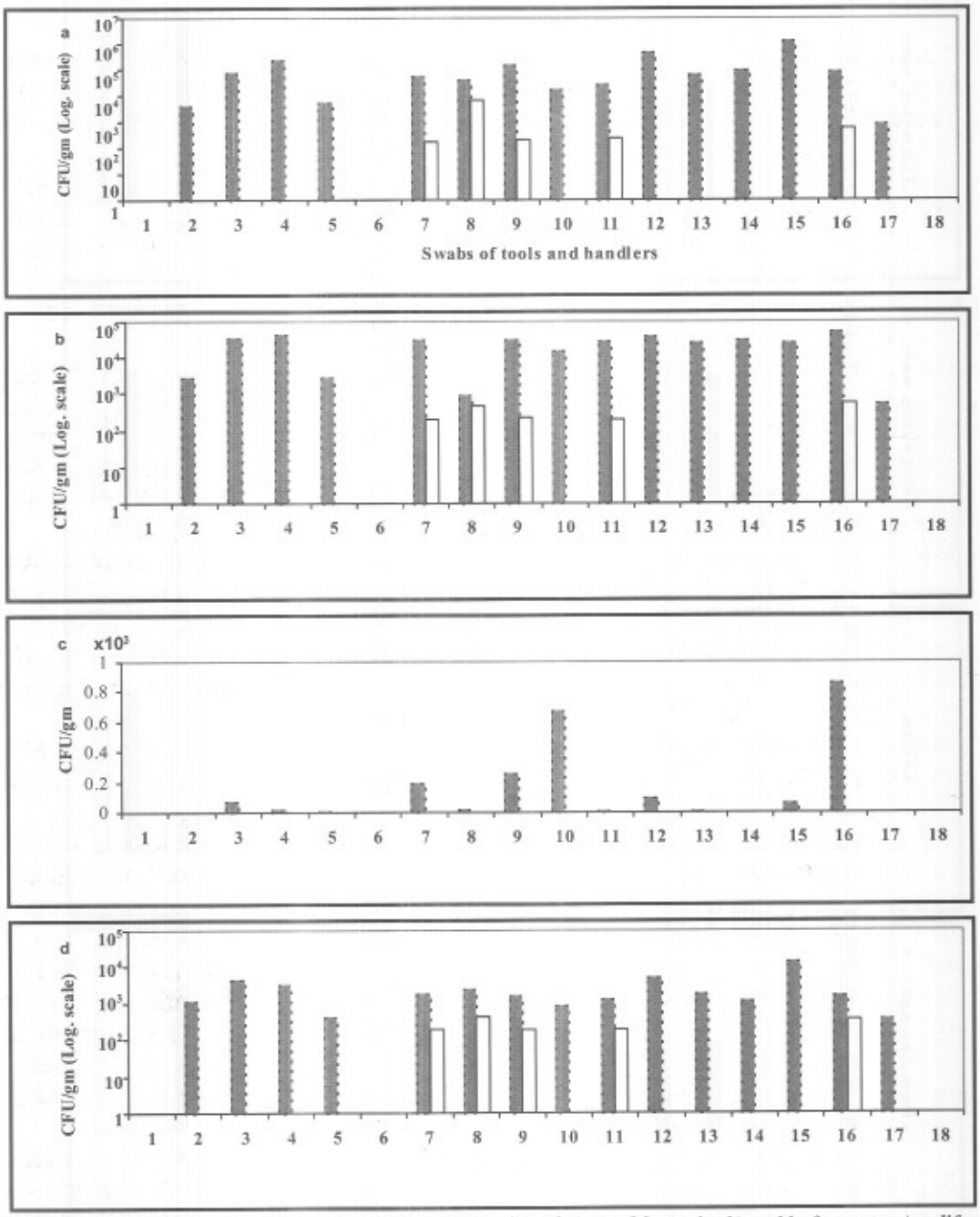

Fig. (4): Comparison between the development of the mean value of a) total bacteria, b) molds & yeasts, c) coliforms and d) spore-forming bacteria of the swabs before and after the application of HACCP throughout the production process.

■ *Before HACCP* □ *After HACCP*

1. Trays. 2. Roasting trays. 3. Pots. 4. Scoops.
5. Skimmers. 6. Spoons. 7. Preparation. 8. Elevator.
9. Kitchen. 10. Boards. 11. Serving. 12. Workers.
13. Cookers. 14. Serving chefs. 15. Steam pots. 16. Mincer.
17. Tin opener. 18. Civies.

Chemical monitoring

Neither total aflatoxins nor ochratoxins A were detected in raw materials, as well as, pesticide residues in the final products. Food may be contaminated by naturally occurring microorganisms or pathogens transferred to food during food preparation step. Measures to protect from contamination are fundamental to GMP. Natural or transferred contamination of infectious pathogens can be destroyed in food by adequate processing. Preventing growth of other pathogenic organisms in food is a third important step to prevent food-borne disease. Bacterial colonization and growth is limited by holding foods hot and by ensuring that hot food are cooled to appropriate storage temperatures before bacterial multiplication (Baker, 2002). Prior to HACCP system application, specific security provisions to help protect hot meal served through the restaurant were developed from deliberate contamination. Although HACCP provides insurance that meat and poultry are safe, there is no way to completely eliminate all hazards. HACCP is most effective when applied with other control systems. Total Quality Management programs and Standard Operating Procedures should be used with HACCP to improve product safety, product quality, and plant productivity by providing intimate knowledge of the production process, production environment and processing equipment.

REFERENCES

AOAC (2003). Official Methods of the Association of Official Analytical Chemists, 17th ed Arlington, Virginia, U.S.A.

Baker, D.A. (2002). Use of food safety objectives to satisfy the intent of food safety law. Food Control, 13: 371-376.

Bryant, J.; Brereton, D.A. and Gill, C.O. (2003). Implementation of a validated HACCP system for the control of microbiological contamination of pig carcasses at a small abattoir. Can. Vet. J., 44(1):51-55.

Cogan, T.A.; Bloomfield, S.F. and Humphrey, T.J. (1999). The effectiveness of hygiene procedures for prevention of cross-contamination from chicken carcasses in the domestic kitchen. Lett. Appl. Microbiol., 29(5):354-358.

El-Banna, N.H.; Saddik, M.F.; Abou El-Makarem, W.M. and Zaid,H.A. (2002). Chemical and microbiological studies on meat and poultry products served in fast food establishments in Cairo and Giza. Bull. Nutr. Inst., Cairo, Egypt, 22(2): 52-77.

Gomaa, N. F. (1999). Hazard Analysis Critical Control Point (HACCP) system to food processing and manufacturing. Ph.D. Thesis, Food Hygiene and Food Control Dept., High Institute of Public Health, Alex. Univ., Alex., Egypt.

Harrigan, W.F. (1998). Laboratory Methods in Food Microbiology. 3rd ed. Academic Press Ltd., pp: 164-210.

ICMSF (1978). Microorganisms in Food 1. Their significance and Methods of Enumeration (2nd ed.), Toronto, University of Toronto Press, pp: 107-273.

ICMSF (1996). Microorganisms in Food 5. Application of the Hazard Analysis Critical Control Point (HACCP) system to ensure Microbiological Safety and Quality (in Portuguesee) Livraria Varela Ltda, Sao Paulo, pp: 20-299.

ILSI (2004). A simple guide to understanding and applying the Hazard Analysis Critical Control Point. ILSI Europe Risk Analysis in Microbiology Task Force, pp: 1-23.

Kassem, M.M.; El-Syaed, A.H.; Afifi, E.A. and Abo Elmakarem, W. (2004). Effect of good manufacturing practices "GMP" on food safety. Bull. of the National Nutrition

Institute of the Arab Republic of Egypt., 3:210-227.

Malik, Y.Z.M. (2003). Application of Hazard Analysis Critical Control Point system in a food serving establishment. Ph. D. Thesis, Fac. Vet. Med., Cairo University, Egypt.

NACMCF (1998). Hazard Analysis and Critical Control Point Principles and Application Guidelines. J. Food Prot., 61(6):762-775.

Northcutt, Julie K. and Russell, S.M. (2003). General Guidelines for Implementation of HACCP in a Poultry Processing Plant. Cooperative Extension Service, Poultry Science Dept., Fac. of Agric. and Envi. Sci., Georgia Univ., USA.

Pedroso, Débora M.M.; Iaria, S.T.; Gamba, Rosa C.; Heidtmann, Sandra and Rall, Vera L.M. (1999). Critical Control Points for meat bulls and kibbe preparations in a hospital kitchen. Rev. Microbiol., 30(4):1-12.

Rashwan, O.A.M. (2004). Application of (HACCP) system in hospital kitchens and the nutritive value of served meals. Ph.D. Thesis, Food Science and Techn. Dept., Faculty of Agric., Cairo Univ., Egypt.

Santana, N.G.; Almeida, R.C.C.; Ferreira, J.S. and Almeida, P.F. (2009). Microbiological quality and safety of meals served to children and adoption of good manufacturing practices in public school catering in Brazil. Food Control, 20: 255-261.

Soriano, J.M.; Rico, H.; Moltó, J.C. and Mañes, J. (2002). Effect of introduction of HACCP on the microbiological quality of some restaurant meals. Food control, 13: 253-261.

Sun, Y.M. and Ockerman, H.W. (2005). A review of the needs and current applications of Hazard Analysis and Critical Control Point (HACCP) system in the service areas. Food Control, 16: 325-332.

Tavakoli, H.R. and Riazipour, M. (2008). Microbial quality of cooked meat foods in Tehran University's restaurants. Pak. J. Med. Sci.,24(4):595-599.

Taylor, E. (2007). A new method of HACCP for the catering and food service industry. Food Cont., 1-9.

Tsola, E.; Drosinos, E.H. and Zoiopoulos, P. (2008). Impact of poultry slaughter house modernisation and updating of food safety management systems on the microbiological quality and safety of products. Food Cont., 19:423–431.

الملخص العربي

تطبيق نظام تحليل مصادر الخطر و نقاط التحكم الحرجة (الهاسب) فى مطعم مدينة الطلبة بجامعة القاهرة

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تم تحليل مصادر الخطر في مطعم مدينة الطلبة بجامعة القاهرة خلال الفترة من 2005- 2008. هذه الدراسة أظهرت كفاءة تطبيق نظام الهاسب على خطى إنتاج أغذية اللحم و الدجاج. و قد درست 1482 عينة من الناحية الميكروبيولوجية و الكيميائية و الفيزيائية. تم تقدير العدد الكلى للبكتريا، الفطريات و الخمائر، *B. cereus* ،*Staph. aureus* ميكروبات القولون، *L. monocytogenes* ،*Salmonella* spp. ،*Shigella* spp. البكتريا المتجرثمة، *Cl. perfringens* ،*E. coli*. تم الكشف عن وجود بعض السموم الفطرية و متبقيات المبيدات الحشرية. و قد أظهرت نتائج تطبيق نظام الهاسب انخفاضا ملحوظا فى الحمل الميكروبى($p < 0.05$) و التى تدل على وجود فروق معنوية قبل و بعد تطبيقه. أما العينات الخام فكانت خالية من السموم الفطرية (الأفلاتوكسينات الكلية و الأوكراتوكسينات A) و كذلك بالنسبة لمتبقيات المبيدات فى العينات عند مرحلة التوزيع. و قد أثبتت النتائج أن تدريب العاملين على النظافة الشخصية، الممارسات الصحية الجيدة، إجراءات النظافة و الإجراءات الصحية و الوقاية الشخصية، لها دور فاعل فى رفع جودة اللحوم و الدجاج فى الوجبة الغذائية من الناحية الميكروبيولوجيه.