APPLICATION OF HACCP SYSTEM IN CATERING SYSTEM AND MICROBIOLOGICAL QUALITY OF ROASTED CHICKEN MEALS

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ABSTRACT

This study aimed to work out the microbiological quality of roasted chicken ready to eat meals (n=240), swabs of labor surfaces in contact with food (n=390), and the food handlers hands (n=90) in catering services within the university dormitory females to assure a secure supply of food for colleges students. The results obtained appeared no contamination with L. monocytogenes, Salmonella spp., Shigella spp., and Clostridium perfringens before the applying of the HACCP framework. While the fluctuation within the microbial numerous total viable bacteria, total molds and yeasts, B. cereus, Staph. aureus, spore-formers, and coliforms in served meals ascribed to inadequate handling or processing procedures, multiplication of microorganisms during thawing and cutting of chicken, poor hygiene of utensils, and equipment as well as the survival of microorganisms to the cooking process. The examined chicken samples from receiving to serving were 1.12×10^5, 7.4×10^3, 2.8×10^4, and 1.6×10^3 in washing chicken, thawing, and washing steps respectively. The lowest value was 3.98×10^3, 3.2×10^2, 1.2×10^3, and 6.1×10^2 in serving, dressing, washing, and receiving steps, respectively. Swabs samples analysis which taken before and after HACCP application from handlers, utensils, equipment and work surfaces observed different levels of significance in the reduction of microbial load in one or more of selected examination. Application of the HACCP framework shows a low rate of examined microorganism with a decreasing percentage reached 100% of 1 or more microbial groups in the statistically serving step (p<0.05) which demonstrates a critical impact of HACCP application. HACCP framework can be moreover utilize to control the safety and quality of prepared ready to eat meals, based on microbiological specifications to improve the microbiological and healthy quality of foods to reduces the reliance on the end product inspection that ultimately resulted in improving food safety, reducing costs associated with food hazards.

Keywords: Microbiological food quality; HACCP; catering; roasted chicken meals.

INTRODUCTION

Globally, food safety problems in the most food-serving establishments arise from bad holding (44%), inadequate cooking or reheating (9%), unsafe sources (18%), cross-contamination from infected persons and contaminated equipment (27%) in addition to toxic chemicals (2%) as reported by (WHO, 1999).

To ensure the safety of foods prepared by catering systems the microbiological contamination that depends on the quality of the raw materials and the application of good manufacturing practices (GMPs) by the staff must be assessed. Total mesophilic aerobes, spoilage and pathogens such as: Salmonella spp., Listeria monocytogenes, Escherichia coli, and Staphylococcus aureus are main contaminants of food supplied by a catering service. So that foods can be considered as a source of many foodborne outbreaks (Osimani et al 2016a). Salmonellae, S. aureus, E. coli, and Cl. perfringens are important bacteria causing food poisoning leading to gastroenteritis and other health complications (CDC, 2015).
Mass catering is classified as commercial, non-commercial segment which includes colleges and university establishment, schools business and industry and public food services. Conditions that allow the proliferation and transmission of disease-causing organisms such as bacteria, viruses and other food-borne pathogens is result of Unsanitary practices during food preparation, handling and storage (Akabanda et al 2017).

Cross-contamination is the main reason of existence of pathogens in foods due to many factors mainly unsatisfactory cleanliness surrounding environment and staff, in addition to inadequate conditions such as temperature abuse or inadequate cooking. These factors facilitate microbial growth or survival. Contamination ensues at any point from food chain either during food preparation or during serving. A wide range of illnesses are involved under foodborne diseases which caused by ingesting foods contaminated with microorganism. A significant number of foodborne diseases cases are lethal, although most of the cases are trivial, thus a lot of money is lost as a result of recurrent recalls and medical expenses (Davis, 2018).

Therefore the aim of this study was to determine the microbiological quality, apply HACCP system through the catering services within the university dormitory females to assure a secure supply of food for college’s students and roasted chicken ready to eat.

MATERIALS AND METHODS

Sampling plan

A complete of 720 samples of natural random chicken and swab samples throughout the food production chain were studied from 2017 to 2019 (Table 1).

Sample collection

A total of 240 samples of chicken were collected from the university dormitory meals including different stages of preparation till serving (raw, defrosted, marinated, and cooked) of roasted chicken. It kept in separate sterile plastic bags and transferred on to the laboratory in an icebox under the entire aseptic condition to be bacteriologically examined.

The Samples of surfaces were classified and listed in Table 1. Swab samples were stored and transported inside an ice box. The samples collected along the preparation were examined 5 times also as swabs whereas steam pots were estimated in 12 replicates.

Preparation and dilution of samples

The ten grams of every sample was aseptically weighed during a sterile Petri dish, diluted with 90 ml saline, and homogenized using a stomacher for two minutes. A Serial dilution in saline was prepared for every sample (ICMSF, 1986).

Swabs preparation

Type of Samples from Handlers swabs, Surfaces swabs, Utensils swabs and equipment swabs were swabbed by an undefined limit of approximately 100 cm$^2$ with moistened medical gauze (Bryant et al 2003).

The prepared samples were subjected to examinations cleared in Table 2.

Method

Food preparation and distribution

The product consisted of frozen chicken only no abnormal appearance Storage ≤ -18 $^\circ$C which after being boiled, dressed in stewed tomato juice, roasted inside the oven, and finally cut into four portions during the serving step (Fig. 1).

Process flow chart

Raw materials, processing and packaging steps were described in Fig. 1, where data needed for microbiological hazard analyses, applied time and temperature throughout the process and distribution are explained (ILSI, 2004).

Hazard analysis

An analysis of hazard was implemented in Cairo University dormitory restaurant (the female student departments) which is classified as industrial catering and cook/hot holds systems. During hazard analysis all procedures concerned with production, distribution and use of materials for potential problems that could occur were evaluated.
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Table 1. Samples collected from different sources during 2017 and 2019

| Type of samples                                                                 | Number of processing steps | Number of samples * |
|--------------------------------------------------------------------------------|----------------------------|---------------------|
| Chicken                                                                         | 8                          | 240                 |
| Handlers swabs                                                                 | -                          | 90                  |
| Surfaces swabs                                                                 | -                          | 120                 |
| Instruments and equipment swabs (steam pots, mincer, and tin opener)           | -                          | 90                  |
| Utensils swabs (roasting trays, pots, mobile tanks, trolley tanks, colanders, and skimmers) | -                          | 180                 |

* Some samples before HACCP application = number of samples after HACCP application.

Table 2. Media and incubation conditions applied in microbiological analysis.

| Microbiological determination          | Methods                          | Medium used                | Incubation conditions | References |
|----------------------------------------|----------------------------------|----------------------------|-----------------------|------------|
|                                        | Total viable bacteria count      | Pour plate count/Nutrient agar medium | 37°C 24-48           | ICMSF,1978 |
|                                        | Spore-former count               | Pour plate count/Nutrient agar medium | 35°C 24-48           | Sneath,1986 |
|                                        | Bacillus cereus count            | Pour plate count/Polymyxin Pyruvate Egg-yolk Mannitol Bromothymol Blue agar | 30°C 24 - 48         | Harrigan,1998 |
|                                        | Staphylococcus aureus count      | Pour plate count/Baird-Parkers medium | 37°C 24              | Harrigan,1998 |
|                                        | Coliforms count                  | Most Probable count/MacConkeys broth medium | 37°C 48             | ICMSF,1978 |
|                                        | Faecal Coliforms count           | Most Probable count/Brilliant Green Lactose Bile Broth | 44.5°C 24 - 48       | ICMSF,1978 |
|                                        | Total Molds and Yeasts           | Pour plate count/Sabouraud Dextrose Agar | 20-25°C 72 - 120     | Bridson,1998 |
|                                        | Detection of Salmonella spp.     | Most Probable count/Bismuth Sulphite Agar | 37°C 24 – 48        | ICMSF,1978 |
|                                        | Detection of Shigella spp.       | Pour plate/Salmonella-Shigella Agar | 37°C 14              | ICMSF,1978 |
|                                        | Detection of Listeria monocytogenes | Pour plate/Listeria Selective medium | 35°C 18-24         | Bridson,1998 |
|                                        | Clostridium perfringens          | Pour plate/Perfringens agar | 35°C 18-24          | Bridson,1998 |
The (CCPs) were studied throughout the entire production chain started with the receiving of the raw chicken and ended with serving the final roasted chicken meals.

The processing of roasted chicken was included in the application of the HACCP system. ILSI (2004).

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P = \frac{B-A}{A} \times 100
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**Monitoring procedures establishment**

All CCPs in process were monitored to ensure that the process remains within the critical limits and the method for determining the frequency of CCPs evaluation was established as well. Microbiological measurements and observation of a CCP related to its critical limits were nominated for product and CCP.

**Reduction percentages**

To calculate the percentage decrease of the mean value of Total viable bacteria, Molds & yeasts, Coliforms, and Spore-forms of roasted chicken meal vs. the application of HACCP throughout the production process percentage reduction formula reported by (Benham et al 2011) was used.

Where: \( P \) is the percentage of reduction, \( B \) is the number of viable microorganisms before treatment, \( A \) is the number of viable microorganisms after treatment.

**Statistical analysis**

All statistical analyses of the microbiological results were performed using the SPSS (V. 21) program upon completion of data collection. Data were
Food analyses

The obtained results in Table 3, showed that the highest mean value of TVB, yeast and mold, spore-former and coliform (cfu/g) of examined chicken samples from receiving to serving were 1.12 X 10^6, 7.4 X 10^5, 2.8 X 10^5, and 1.6 X 10^3 in washing chicken, in thawing, in washing, and washing steps respectively, and the lowest was 3.98 X 10^3, 3.2 X 10^2, 1.2 X 10^3, and 6.1 X 10^2 in serving, dressing, receiving, and receiving steps, respectively.

Before the implementation of the HACCP system, the microbiological profiles are illustrated in Table (3). The analyzed chicken samples showed the presence of Salmonella spp., L. monocytogenes, B. cereus, Staph. aureus, Cl. perfringens, and Shigella spp. during the assembly steps.

The data shown a wide gap between the results before and after application of HACCP in the serving step translated in a highly significant comparison between the data, where p was < 0.0001 in the examination of total viable bacteria, molds and yeasts and spore-formers counts. Kassem et al. (2004), reported that the microbial count after GMP application was the lowest in 100% of investigated cooked chicken in the range 10^2 < 10^5 CFU/G. They also found that B. cereus was found in cooked chicken, while, Santos et al. (2003), the detection of Staph. aureus, Salmonella spp., faecal coliforms, and Cl. perfringens were negative in all samples before and after GMP application.

These trends are also in agreement with that reported by Santana et al. (2009) in the adoption of GMP on meals served to children in a public school in Brazil, and found that chicken with tomato sauce contained thermo-tolerant coliforms (23 cells/g) before GMP, while was not detected after implementation of GMP. They reported that Salmonella spp. was found in chicken samples after cooking.

Recently, Osimani and Clementi (2016 a and b) concluded that the spread of foodborne disease that may leads to hospitalization and death is the main reason for the contribution of mass catering systems in Europe. Application of HACCP system help in monitoring microbiological parameters and provides a timely assessment of sanitary conditions of food-producing plants where several factors such as: food temperature holding and transportation affect the final quality produced by catering system and may lower the quality of a dish. It worth to mention that microbiological evaluation of meals at the centralized facility and of meals collected at the satellite kitchens can provide further information on possible food contamination or inappropriate maintenance during transportation or just before serving.

Fig. 2, illustrate the reduction percentage of total viable bacteria, Molds & yeasts, Coliforms, and Spore-forms in the receiving, thawing, and washing steps which varied between 17 and 100% while the reduction in the boiling and roasting steps is zero because these steps were from any detectable levels of microorganisms before and after HACCP application in roasted chicken. The highly significant reduction of Total viable bacteria, Molds & yeasts, and Coliforms were recorded in the Holding step. The highest reduction percentage of the mean value of Total viable bacteria, Molds & yeasts, Coliforms, and Spore-forms in serving step of roasted chicken meal after application of the HACCP system recorded 96 to 100%.

Kassem et al (2004), reported that the microbial count after GMP application was the lowest in 100% of investigated cooked chicken in the range 10^2 < 10^5 CFU/G. They also found that B.cereus was found in cooked chicken, while, Santos et al (2003), the detection of Staph. aureus, Salmonella spp., faecal coliforms, and Cl. perfringens were negative in all samples before and after GMP application.

Microbial analysis of Swabs

Handlers swab analysis

Four groups of swabs were taken before and after HACCP application it taken from handlers, surfaces, utensils (roasting trays, pots, mobile tanks, trolley tanks, colander, scoop, and skimmer) and equipment (steam pots, mincer and tin opener) before and after HACCP had been fulfilled.

None of the swab samples were found to be positive to Cl. perfringens, Salmonella spp., and Shigella spp. within the three sorts of handlers’ swab samples also as L. monocytogenes, faecal coliforms and E. coli in cooks’ and serving chefs’ swab samples, neither before nor after application of HACCP. After application of HACCP, the microbial loads, i.e. total viable bacteria, molds and yeasts, coliforms, faecal coliforms, E. coli, B. cereus, Staph. aureus, spore-formers, and L. monocytogenes, in hands, had, 100% dipped vs. before application of HACCP that’s thanks to using sterile gloves (Table 4).

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Table 3. The microbiological profiles of roasted chicken meal throughout the production line before and after the HACCP application

| Process steps          | Statistics | TVB X 10^3 | Molds & yeasts \( \times 10^2 \) | Spore-formers \( \times 10^3 \) | Coliforms \( \times 10^2 \) |
|------------------------|------------|------------|---------------------------------|-------------------------------|-----------------------------|
| Receiving of frozen chicken | b          | 42.0       | 17.1                            | 1.2                           | 6.1                         |
|                        | a          | 12.0       | 4.0                             | 1.0                           | 5.0                         |
|                        | p          | 0.201      | 0.014*                          | 0.23                          | 0.75                        |
| Thawing                | b          | 26.0       | 74.0                            | 15.2                          | 9.4                         |
|                        | a          | 38.0       | 9.0                             | 7.1                           | 6.0                         |
|                        | p          | 0.003**    | 0.013*                          | 0.178                         | 0.32                        |
| Washing                | b          | 112.0      | 21.6                            | 28.0                          | 16.4                        |
|                        | a          | 12.1       | 5.6                             | 2.6                           | <10                         |
|                        | p          | 0.013*     | 0.014*                          | 0.110                         | 0.001***                    |
| Boiling                | b          | <10        | <10                             | <10                           | <10                         |
|                        | a          | <10        | <10                             | <10                           | 0                           |
|                        | p          | -          | -                               | -                             | -                           |
| Dressing               | b          | 6.62       | 3.2                             | 0.34                          | 0.14                        |
|                        | a          | <10        | <10                             | <10                           | -                           |
|                        | p          | 0.001***   | 0.001***                        | 0.001***                      | 0.005**                     |
| Roasting               | b          | <10        | <10                             | <10                           | 0                           |
|                        | a          | <10        | <10                             | <10                           | 0                           |
|                        | p          | -          | -                               | -                             | -                           |
| Holding                | b          | 8.78       | 0.37                            | 0.39                          | 0                           |
|                        | a          | <10        | <10                             | <10                           | 0                           |
|                        | p          | 0.001***   | 0.001***                        | 0.001***                      | -                           |
| Serving                | b          | 3.98       | 0.21                            | 0.33                          | 0.21                        |
|                        | a          | < 10       | < 10                            | < 10                          | 0                           |
|                        | p          | 0.001***   | 0.001***                        | 0.001***                      | 0.012*                      |

b: Mean ± SD before the application of HACCP  
a: Mean ± SD after the application of HACCP  
p: Significant (2–tailed)  
TVB: total viable bacteria  
I: Molds and yeasts as a group  
*: Significant at p< 0.05  **: Moderately significant at p< 0.01  
***: Highly significant at p< 0.001  
- : t cannot be computed because the standard error of the difference is 0
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Reduction percentages of the mean value of Total viable bacteria, Molds & yeasts, Coliforms and Spore-formers of roasted chicken

Table 4. The microbiological profiles and detection of handlers throughout the production line before and after the HACCP application

| Swabs        | Statistics | TVB X10³ | Molds & yeasts X10³ | Coliforms X 10³ | B. cereus X10² | Staph. aureus X10² | Spore formers X10³ |
|--------------|------------|----------|---------------------|-----------------|-----------------|-------------------|-------------------|
| workers      | B          | 63       | 5                   | 0.01            | 6.2             | 4.1               | 1.4               |
|              | A          | 0.25     | 0.17                | 0               | 0               | 0                 | 0.1               |
|              | P          | 0.11     | 0.092               | 0.087           | 0.08            | 0.078             | 0.082             |
| Cookers      | B          | 87       | 32                  | 0.15            | 5.1             | 2.7               | 1.2               |
|              | A          | 0.22     | 0.16                | 0               | 0               | 0                 | 0.09              |
|              | p          | 0.051    | 0.042               | 0.054           | 0.07            | 0.056             | 0.061             |
| Serving chefs| b          | 3.6      | 28                  | 0.1             | 4.2             | 0                 | 1                 |
|              | a          | <10      | 0.12                | 0               | 0               | 0                 | 0.06              |
|              | p          | 0.021    | 0.016               | 0.065           | 0.084           | 0.039             | 0.072             |

Data in Table 4 show that the highest mean value of TVB, yeast, mold and coliform (cfu/g), of examined handlers samples (workers, cooks and serving chefs) 87×10³, 32×10³ 0.15×10³ cfu/g in cooks group while B. cereus, Staph. aureus and spore-former was 6.2×10², 4.1×10² 1.4×10² cfu/g respectively. The lowest was 3.6×10³, 5×10³ and 0.01×10³ cfu/g in serving chefs, workers respectively. The microbial loads in hands had, 100% dipped after HAACP application vs. before application of HACCP that is due to using sterile gloves.

In the order of practice personal hygiene, (Schid et al 2006) reported that due to unhygienic food handling procedures, Pathogenic microorganisms can enter food and can multiply in it due to inadequate food storage, chilling, thawing and processing parameters.
Utensils swab analysis

Table 5 shows the microbial load of utensils swabs and their reduction rate. It could be noticed that spoons had no detectable counts of any microorganisms. While, L. monocytogenes, Cl. perfringens, Salmonella spp. and Shigella spp., were not detectable in all utensils swab samples. Coliforms, B. cereus, and Staphy. aureus was not detectable only in Roasting trays swab samples.

In a comparison between the microbial results before vs. after application of HACCP. The highest result for total viable bacteria was recorded (124 X 10^3 vs. <10 CFU/100 cm^2), molds and yeasts (52 X 10^3 vs. <10 CFU/100 cm^2) in scoops and coliforms (0.82 X 10^3 vs. <10 CFU/100 cm^2).

While, for B. cereus (66 X 10^2 vs. 0 CFU/100 cm^2) in colanders, Staph. aureus (56 X 10^2 vs. 0 CFU/100 cm^2), and spore-formers (33 X 10^3 vs. <10 CFU/100 cm^2) in pots. Besides, a significant reduction was detected in a population of total bacteria in scoops, roasted trays, mobile tanks, colanders, and pots swabs; for molds and yeasts in pots, colanders, scoops and skimmers swabs; for coliforms in trolley tank.

Also, the comparison between the microbial load before vs after the application of HACCP, P = 0 for a total viable count (1.24 X 10^3 vs <10 CFU/100 cm^2) in Scoops samples. Moreover, a significant reduction was detected in a load of TVC and molds and yeasts in Roasting trays, Pots, Trolley tanks, and Skimmers swabs samples; for coliforms in Pots, Trolley tanks and Skimmers; and for B. cereus and Staph. aureus in Pots, Scoops, and Skimmers swabs; for spore former in Roasting trays, Pots, Trolley tanks, Scoops, and Skimmers.

Affifi and Kassem (2004) recorded that, after each working period all food utensils must be cleaned. Also, Tavakoli and Riazipour (2008) showed that contaminated dishes would transfer pathogenic bacteria to the cooked foods in restaurant.

Equipment swab analysis

Table 6 shows the microbial profiles of instruments or equipment used in the preparation of foods. It could be observed that the highest result for total viable bacteria, coliforms, and B. cereus was recorded (78 X 10^3 vs. <0.06 X 10^3 CFU/100 cm^2), (1.2 X 10^3 vs. 0 CFU/100 cm^2) and (8.4 X 10^2 vs. 0 CFU/100 cm^2) respectively in mincer while Staph. aureus and molds and yeasts were recorded (4.1 X 10^2 vs. 0 CFU/100 cm^2) and (28 X 10^3 vs. <0.018 X 10^3 CFU/100 cm^2) respectively in steam pots.

For B. cereus (66 X 10^2 vs. 0 CFU/100 cm^2) in colanders, Staph. aureus (56 X 10^2 vs. 0 CFU/100 cm^2), and spore-formers (33 X 10^3 vs. <10 CFU/100 cm^2) in pots. In addition, a significant reduction was detected in a population of total bacteria in scoops, roasted trays, mobile tanks, colanders, and pots swabs; for molds and yeasts in pots, colanders, scoops and skimmers swabs; for coliforms in trolley tank.

The results recorded by Kassem et al (2004) after the application of GMP, agreement with our results after the application of HACCP. Although microbial load in swabs of equipment before application of GMP was 1.5 X 10^4 CFU/100 cm^2 of the aerobic bacterial count. Detection of faecal coliforms, B. cereus, Salmonella spp, and Cl. perfringens were negative; while molds and yeasts were 4.2 X 10^5 CFU/20 cm^2. All swabs were free from microorganisms after the application of GMP.

Work surfaces swab analysis

Table 7 shows that microbial load in swabs of preparation area, kitchen area, serving area, and boards shows the microbial profiles could be observed that, The highest result for total viable bacteria, molds and yeasts and B. cereus was recorded (122 X 10^3 vs. <0.19 X 10^3 CFU/100 cm^2), (34 X 10^3 vs. 0.2 X 10^3 CFU/100 cm^2) and (7.1 X 10^2 vs. 0 CFU/100 cm^2) respectively in the kitchen where coliforms were (0.45 X 10^3 vs. 0 CFU/100 cm^2) in boards. For Staph. aureus was recorded (4.1 X 10^2 vs. 0 CFU/100 cm^2) in the serving area.

In a study on, Ismail et al (2013) reported that the use of microbiological analyses of surfaces as one of the tools to control the hygiene of products to control of microbial hazards to prevent food safety issues. This preventive approach used now widely used in The HACCP-based processes.

For this respect, floor, wall, and work surfaces must be cleaned and sanitized at least once a day using sodium hypochlorite solution at 500 mg·l for 30 min. (Santana et al 2009).
Table 5. The microbiological profiles and detection of utensils throughout the production line before and after the HACCP application

| Swabs      | Statistics | TVB X10³ | Molds & yeasts X10³ | Coliforms X 10³ | B.cereus X10² | Staph.aureus X10² | Sporeformers X10³ |
|------------|------------|----------|---------------------|-----------------|---------------|-------------------|-------------------|
| Roasting trays | b          | 3.8      | 3.2                 | 0               | 0             | 0                 | 12                |
|             | a          | <10      | <10                 | 0               | 0             | 0                 | <10               |
|             | p          | 0.022    | 0.026               | 0               | -             | -                 | 0.016             |
| Pots       | b          | 60       | 42                  | 0.8             | 34            | 44                | 33                |
|             | a          | <10      | <10                 | 0               | 0             | 0                 | <10               |
|             | p          | 0.014    | 0.02                | 0.062           | 0.028         | 0.041             | 0.027             |
| Trolly tanks | b          | 44       | 22                  | 0.82            | 48            | 29                | 28                |
|             | a          | <10      | <10                 | 0               | 0             | 0                 | <10               |
|             | p          | 0.094    | 0.08                | 0.031           | 0.13          | 0.1               | 0.096             |
| Colanders  | b          | 62       | 42                  | 0.51            | 66            | 42                | 32                |
|             | a          | <10      | <10                 | 0               | 0             | 0                 | <10               |
|             | p          | 0.21     | 0.14                | 0.013           | 0.32          | 0.27              | 0.11              |
| Scoops     | b          | 124      | 52                  | 0.16            | 28            | 28                | 5.2               |
|             | a          | <10      | <10                 | 0               | 0             | 0                 | <10               |
|             | p          | 0.621    | 0.59                | 0.1             | 0.04          | 0.03              | 0.031             |
| Skimmers   | b          | 6.2      | 1.4                 | 0.11            | 19            | 56                | 4.1               |
|             | a          | <10      | <10                 | 0               | 0             | 0                 | <10               |
|             | p          | 0.022    | 0.011               | 0.01            | 0.042         | 0.084             | 0.024             |

Table 6. The microbiological profiles and detection of instruments and equipment throughout the production line before and after the HACCP application

| Swabs      | Statistics | TVB X10³ | Molds & yeasts X10³ | Coliforms X 10³ | B.cereus X10² | Staph.aureus X10² | Sporeformers X10³ |
|------------|------------|----------|---------------------|-----------------|---------------|-------------------|-------------------|
| Steam pots | b          | 32       | 28                  | 0.001           | 6.1           | 4.1               | 1.3               |
|             | a          | 0.3      | 0.18                | 0               | 0             | 0                 | 0.11              |
|             | p          | 0.082    | 0.14                | 0.01            | 0.42          | 0.34              | 0.21              |
| Mincer     | b          | 78       | 0.54                | 1.2             | 8.4           | 1.4               | 1.2               |
|             | a          | 0.06     | <10                 | 0               | 0             | 0                 | 0.2               |
|             | p          | 0.084    | 0.021               | 0.04            | 0.084         | 0.071             | 0.061             |
| Tin opner  | b          | 9.1      | 4.2                 | 0               | 0             | 0                 | 0.3               |
|             | a          | <10      | <10                 | 0               | 0             | 0                 | <10               |
|             | p          | 0.072    | 0.048               | 0               | 0             | 0                 | 0.018             |
Table 7. The microbiological profiles and detection of work surfaces throughout the production line before and after the HACCP application

| Swabs       | Statistics | TVB X10³ | Molds & yeasts X10³ | Coliforms X10³ | B.cereus X10² | Staph.aureus X10² | Sporeformers X10³ |
|-------------|------------|----------|---------------------|----------------|----------------|-------------------|-------------------|
| Preparation | b          | 74       | 4.6                 | 0.03           | 6.2            | 3                 | 1.6               |
|             | a          | 22       | 0.14                | 0              | 0              | 0                 | 0.12              |
|             | p          | 0.01     | 0.07                | 0.01           | 0.091          | 0.051             | 0.052             |
| Kitchen     | b          | 122      | 34                  | 0.22           | 7.1            | 4                 | 1.3               |
|             | a          | 0.019    | 0.2                 | 0              | 0              | 0                 | 0.17              |
|             | p          | 0.02     | 0.04                | 0.06           | 0.01           | 0.012             | 0.061             |
| Serving area| b          | 32       | 28                  | 0.001          | 6.1            | 4.1               | 1.3               |
|             | a          | 0.3      | 0.18                | 0              | 0              | 0                 | 0.11              |
|             | p          | 0.082    | 0.14                | 0.01           | 0.42           | 0.42              | 0.21              |
| Boards      | b          | 0.27     | 17                  | 0.45           | 1.7            | 0                 | 0.81              |
|             | a          | <10      | <10                 | 0              | 0              | 0                 | <10               |
|             | p          | 0.29     | 0.2                 | 0.08           | 0.06           | 0                 | 0.01              |

CONCLUSION

The principles of HACCP should be applied to commercial and domestic catering and food preparation of a wide variety of raw materials processes and combinations of ingredients used. Qualitative risk assessments are also often done for the prevention of food poisoning in both domestic and commercial settings.

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تطبيق نظام تحليل المخاطر ونقاط التحكم الحرجة في نظام التموين والجودة الميكروبيولوجية لوجبات الدجاج المشوي

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تهدف الدراسة إلى تقييم الجودة الميكروبيولوجية لوجبات الدجاج المشوي (ن=212) ومسحات من أسطح العمل و mensajes من أسطح العمل للغذاء (ن=092) وأيدي المشغلين (ن=92) المستخدمة في خدمات إعداد وتجهيز وجبات التغذية المقدمة لطالبات المدن الجامعية لضمان تأمين إمدادات الغذاء لطالبات الكليات. لم تظهر النتائج التي تم الحصول عليها أي تلوث بكميات L. monocytogenes، Salmonella spp., Shigella spp., and Clostridium perfringens في حين أن التنبؤ في الحالة الميكروبي أو أعداد البكتيريا B. cereus, Staph. aureus, spore-formers، والحية الكلية والحيد الكلي للفطريات والخمائر وcoliforms في الوجبات المقدمة بحسب دعم كفاءة إجراءات المراقبة أو المعالجة وتكاثر الكائنات الحية المقدرة أثناء إنسحاب وقطع الطبقات وتنقيط النفايات الطهي. كانت عينات الدجاج تحت الاختبار من مرحلة الاستلام حتى مرحلة التغذية مسجلة أعلى قيم للعينات ذات حمل ميكروبي 1.12 × 10⁵ في خطوات غسل الدجاج والإنسحاب والغسيل على التوالي. وكان أقلها 0.96 × 10⁻ⁱ و 0.2 × 10⁻⁵ و 1.2 × 10⁻¹ و 8.1 × 10⁻² في خطوات الاستلام والغسيل وإضافة صلصة الطماطم للدجاج و إضافة صلصة الطماطم على التوالي. أظهرت النتائج المسحات التي تم أخذها قبل وبعد تطبيق نظام تحليل المخاطر ونقاط التحكم الحرجة من مستويات مختلفة من تقليل الحمل الميكروبي في واحد أو أكثر من الاختبارات التي تم إجراؤها. يظهر تطبيق نظام تحليل المخاطر ونقاط التحكم الحرجة إخفاق في معدل الإصابة بالكائنات الحية المقدرة مع إخفاق في النسبة التي وصلت إلى 100% من واحد أو أكثر من الاختبارات الميكروبي في خطوة التقييم إحصائياً. (p<0.05). مما يعني موترك إلى التأثير الواضح لتطبيق نظام (HACCP) الهاسب. يمكن أيضا استخدام نظام تحليل المخاطر ونقاط التحكم الحرجة (HACCP) للتحكم في السلامة وجودة وجبات النفايات، طبقاً للمواصفات الميكروبيولوجية والصحية للغذاء لتطبيق الإعتماد على فحص المنتج النهائي بما يحقق حسب سلامة الغذاء وخفض التكافل المرتبط بمخاطر الغذاء.