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Analysis of Food Safety Programs in Three University Restaurants at Some Central-Delta Region Universities, Egypt Based on HACCP Principles

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Abstract: HACCP programs have been designed to ensure food safety. The concept of food safety knowledge refers to the education and expertise acquired, whereas food safety practices involve the practical application of this knowledge. This research aims to evaluate how university restaurants apply HACCP principles for their food safety programs. Most of the standard operating procedures for HACCP were followed, but only a few records of corrective actions were found. A university restaurant health inspection score (UNR-1) was high, suggesting that food safety practices were generally well-implemented. Observations of restaurant facilities were positive overall. However, approximately 53.91% of the employees did not adhere to proper handwashing protocols, as outlined in the 2022 Food Code. While most employees washed their hands before handling food, many did not adhere to the proper handwashing procedure. Despite the strong performance of university restaurant employees of UNR-1, there are still possible risks of food contamination. Restaurant directors and managers can use this information to evaluate their food safety programs and practices, ensuring they effectively provide safe and healthy food to their university students.

Keywords: HACCP, food safety, university restaurants, employee behaviors, facility

1. Introduction

The primary aim of nutrition programs in universities / educational institutions is to provide safe and nutritious meals; however, certain practices during food preparation and service can compromise food safety (Roberts *et al*., 2014). Hwang *et al*. (2001) Hwang *et al*. (2001) examined the elements affecting the likelihood of school foodservice managers in Indiana to adopt a HACCP system., finding that only 13.7% were aware of and intended to implement such a program, while 33% were unfamiliar with HACCP. Similarly, Roberts (2002) highlighted that only about 8% of restaurant managers in Iowa had a complete HACCP plan in place, although most lacked the prerequisite programs (PRPs). Giampaoli *et al*. (2002) showed that 30% of restaurant managers reported developing and implementing HACCP system in their school foodservice. In another study, Youn and Sneed (2003) reported that 22% of restaurant managers had implemented the HACCP system in school food services. Moreover, about 6% of schools had established protocols to assess microbial quality for food contact surfaces, while nearly 70% had procedures in place for monitoring and recording the temperatures of hazardous foods as they flowed through the production process.

Henroid and Sneed (2004) investigated how prepared restaurant managers implement HACCP systems in school food service. Their on-site observations revealed that several prerequisite programs

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(PRPs) were largely compliant, with items such as cooking practices, ware washing facilities, lighting, and dry storage meeting over 90% compliance. However, there were significant shortcomings, as only 30% of the schools checked food temperatures before service, and only 27.5% used calibrated

thermometers for temperature checks. Despite these issues, federal law mandates that school food service programs follow HACCP principles.

Stinson *et al.* (2011) and Roberts *et al*. (2014) examined the implementation of HACCP system in nutrition programs at school through a survey of 2,716 school nutrition directors and managers. They discovered that only 63.5% of district directors put HACCP system into practice within their food service operations, while 70.3% of school managers reported having completed the implementation process. However, it was also found that the implemented HACCP programs lacked some of the required programs, as specified in the USDA guidance document (USDA Food and Nutrition Service, 2005).

The effectiveness of implementing a food safety management system in the food services relies heavily on having prerequisite programs (PRPs) of HACCP system in place. These programs are essential, as they activate the food safety management system and address the core components essential for its foundation (Mortimore and Warren, 2014). Without these prerequisites, system implementation can become extremely challenging, rendering it ineffective and potentially costly (Jackowska-Tracz *et al*., 2018). This study aimed to evaluate how three university restaurants in the Central Delta region in Egypt have implemented food safety programs based on HACCP principles.

2. Materials and Methods

2.1. Study samples

The study sample included three university restaurants in some Central Delta region universities, Egypt.

2.2. Data Collection Instruments

We developed three different forms for collecting data, one of which is the HACCP Verification Checklist. This checklist evaluated how restaurants were applying their food safety program and collecting information on training, standard operating procedures, and various HACCP principles.

The Food Safety Observation Form was developed to assess how employees handle food, focusing on hand washing, food handling, and cleaning and sanitizing. These practices were classified as either compliant or non-compliant with the 2022 FDA Food Code (Food Code) (USFDA, 2022).

The Facility Observation Form was used to document various food safety practices, including hand washing, temperature control (such as cooling and cooking), and measures to prevent contamination.

Food Safety Observation and Facility Observation Forms were used to record both employee actions and operational features of each operation.

2.3. Data Analysis

Descriptive statistics, including means and percentages, were calculated using IBM SPSS (Version 29.0) (SPSS Inc., Chicago, Illinois, USA). Researchers compiled qualitative data recorded during observations. Following data collection, they convened to discuss their general observations findings.

3. Results and Discussion

Three university restaurants were visited, of which one utilized traditional HACCP system and two followed the Egyptian health guidelines document (MOHP, 2005), which classifies food into three categories (no cook, same day, and complex). Two restaurants (UNR-2 and UNR-3) did not have a food safety program. UNR-1 was supervised by the National Service Project Agency (Egypt Highest) Company, and in July 2024 had a Food Safety Management Certificate; UNR-2 had a private company, and UNR-3 had nutrition sector supervision at the university (Table 1).

According to Roberts *et al*. (2014), we classified the examined university restaurants where UNR-1 and UNR-3 restaurants were small, with those served fewer than 2500 students/meals, while UNR-2 had served more than 2500 students/meals, which classifies a medium restaurant.

When asked about training provided to employees, only one restaurant manager indicated he provided training in personal hygiene, good manufacturing practices and cleaning and sanitizing procedures. Two managers (n = 2) indicated that they did not offer any training sessions. Three restaurants had product and traffic flows of operation, including movement of personnel and material, that were designed to minimize cross-contamination.

Only one restaurant (UNR-1) followed a master sanitation schedule and had documented procedures for cleaning and disinfecting equipment.

Table 1. Characteristics of university restaurants examined (n=3)

Characteristics	UNR- 1	UNR- 2	UNR- 3
	No	No	No
Number of meals served daily	750	5000	2000
Operating system	External company	Private company	Self-operated
Number of food service staff	22	31	26
Classification of restaurants	small	medium	small

Table 2. Standard operating Procedures (SOPs) included in examined university restaurant Food Safety Programs (n=3)

Standard operating Procedure	Number		
	Yes	No	Not Applicable
Calibration thermometer.	1	2	
Personal hygiene.	1	2	
Cleaning & Sanitizing.	1	2	
Holding hot and cold potentially hazardous foods.	1	2	
Hair restraints.	1	2	
Washing hand.	1	2	
Cooking potentially hazardous foods.	1	2	
Receiving deliveries.	3		
Using suitable utensils when handling ready to-eat foods.	1	2	
Serving food.	1	2	
Reheating potentially hazardous foods.	1	2	
Storing and using poisonous or toxic chemicals.	3		
Cooling potentially hazardous foods.			3
Employee health and illness.	3		
Date marking ready to eat, potentially hazardous foods.			3
Preventing cross-contamination during storage and preparation.	1	2	
Controlling time and temperature preparation.	1	2	
Washing fresh fruits and vegetables.	1	2	
Handling a food recall.	1	2	
Using time as a control.	1	2	

3.1. HACCP programs

Most of the standard operating procedures (SOPs) outlined in the USFDA Guidance Document (US Food Code, 2022) were implemented in the university restaurants observed (Table 2). SOPs related to thermometer calibration, personal hygiene, cleaning and sanitizing, hair restraints, and handwashing were only found in one (33.3%) out of the three restaurants (UNR-1). The remaining two restaurants (66.7%) lacked proper knowledge about personal hygiene and workplace sanitation. Additionally, SOPs for holding hot and cold potentially hazardous foods, washing fruits and

vegetables, and avoiding cross-contamination throughout storage and preparation were frequently observed in UNR-1, and the other two restaurants should consider adopting these practices.

Some Standard Operating Procedures (SOPs) might not be necessary for all operations, such as data management or cooling potentially hazardous foods, which could account for their absence. Additionally, none of the SOPs provided space for signatures indicating when they were developed, reviewed, or updates. Only one of the three restaurants had a SOP to handle food recalls, while the others lacked procedures, documentation, or records related to managing recalled food products.

All food safety plans included monitoring procedures, but only one university restaurant (UNR-1) offered training to its employees on monitoring critical limits and had established procedures for keeping monitoring records, which managers confirmed they maintain. In contrast, UNR-2 and UNR-3 lacked documented procedures, programs, or plans for assessing training needs and providing staff training.

There were virtually no records of corrective actions for the UNR-2 and UNR-3 restaurants. The managers of these university restaurants were unaware about whether their food safety program followed HACCP principles.

3.2. Facility and Employee Observations

In the majority of university dining establishments observed (2 out of 3), there was no pest control plan or program in place for addressing pest infestations. Additionally, the majority of employees' handwashing facilities (7 of 10) were not conveniently situated or easily accessible (Table 3). Moreover, only a few facilities (4 out of 10 observations) had water at the correct temperature, and some restaurants did not have dedicated sinks for handwashing.

Several facility-related issues were observed, including hand washing facilities being often inadequately supplied with hand cleaners, disposable towels, or hand drying devices, with only 3 out of 10 observations meeting compliance. Additionally, only 3 out of 10 observations facilities had handwashing stations that were conveniently located and accessible for employees. The water temperature at these stations was comfortable in just 3 out of 10 observations. Food safety risks were also noted, with only 3 out of 9 observations showing food was protected from environmental contamination or cross-contamination. Hot food holding was problematic, with only 5 out of 14 observations in compliance, and cold food holding was also an issue, with only 2 out of 6 observations meeting compliance standards.

Temperature control is essential for ensuring food quality, so regulation is essential. In refrigerated storage units (15 of 15 observations) were full compliance and also with food consistently kept below 5 °C (7 of 7 observations). However, temperature compliance in dry storage was less consistent, with only 2 of 3 observations meeting the standards. Although not a food safety concern, it's recommended that dry storage areas be maintained within a temperature range of 10 – 21°C. Only 1 of 3 university restaurants met this standard.

All five activities that were observed adhered to the compliance standards perfectly, achieving 100% adherence. We consistently saw that food was covered during transport from the restaurant (3 of 3 observations); refrigerated storage was at or below 5 °C (15 of 15 observations); frozen storage was at or below -18 °C (7 of 7 observations); milk was stored at or below 5 °C (3 of 3 observations); and food was properly covered, labeled, and stored before holding or storing (3 of 3 observations).

Overall, employee performance was generally strong. Notably, 100% of the observations were compliant in two areas (Table 3): no employees showing symptoms of illness or had unprotected wounds in the food production area, and raw animal products were properly cooked. However, there were some issues with sanitizing work surfaces. Approximately 66.7% of observations revealed that solution in sanitizer buckets was not changed as required, and (58.3%) food contact surfaces and utensils were not cleaned and sanitized before use. This lack of proper sanitation could potentially result in cross-contamination.

Table 3. Facility and Employee Observations in university restaurants examined.

Observed activity	Number

	Total observation	In-Compliance	Out- of-Compliance
No evidence of pests.	3	1	2
Foods are covered during transport off facility.	3	3	0
Hand washing facilities equipped with hand sanitizer, disposable towels, and hand drying devices.	10	3	7
Hand washing facilities conveniently situated and easily accessible for employees.	10	3	7
Refrigerated storage at 5° C or less.	15	15	0
Foods are protected from environmental contamination and cross-contamination.	9	3	6
Dish washer achieves the suitable temperature	3	0	3
Water at the hand washing station is at a comfortable temperature	10	3	7
Hot foods held at 63° C or above.	14	5	9
Only foods and materials used in food production are stored in cold and dry storage areas (no personal belongings).	3	1	2
All food products are stored 6 inches above the floor.	3	1	2
Frozen storage at -18° C.	7	7	0
Milk stored at 5° C or less.	3	3	0
Dry storage areas kept at between 10 - 21° C.	3	1	2
Foods are properly covered and labeled before holding or stored.	3	3	0
Cold food held at 5° C or below like Salad pickles.	6	2	4
Employees avoid handling ready-to-eat foods with their bare hands.	79	28	51
No food employees displaying symptoms of illness or having unprotected wounds that would require exclusion or restriction were observed in the food preparation areas of the facility.	79	79	0
Food contact surfaces and utensils are thoroughly cleaned and sanitized prior to use.	60	25	35
Employees uncovered beverages and foods excluded outside the designated food production area	79	79	0
Check internal temperature of food by inserting the thermometer stem or probe into the thickest part of the product.	12	4	8
Sanitizing solutions are replaced as necessary.	3	1	2
Wiping cloths are designated separately for cleaning food surfaces and non-food surfaces.	48	14	34
Clean, rinse, sanitize, and let thermometers air-dry both before and after use.	3	1	2
Measure the food temperature after cooking has finished.	9	3	6
Utensils were cleaned and sanitized using the correct manual procedures.	3	1	2
Check the food temperature after reheating is complete.	3	1	2
Utensils are cleaned and sanitized using a properly functioning washing machine.	3	0	3
Raw animal products are cooked to the necessary temperatures.	3	3	0
Time / temperature control foods that in cooked and cooled on-site are quickly reheated to 73° C for 15 sec before hot holding.	3	0	3

Behaviors that consistently met the identified standards over 90% of the time included keeping uncovered food and beverages out of the production area, which was done 100% compliance. Conversely, behaviors that did not meet the standards more than 66.7% of the time included using a properly working dishwashing machine for washing and sanitizing dishes and utensils (100% non-compliance) and employees handling ready-to-eat foods by their bare hands (66.7% non-compliance).

Describes the actual observed practices and operational characteristics, which might be more than 3. For instance, employees washed their hands more than once or restaurants had several hand sinks.

3.3. Employee hand washing behaviors

Table 4 summarizes the findings on employee handwashing behaviors. In total, 319 handwashing instances were observed across three university restaurants. According to the Food Code (USFDA, 2022), Employees must wash their hands with water and soap for a minimum 20 seconds and then dry them completely using an approved method, such as disposable towels or heated air or high-velocity hand dryer.

Table 4. Employee Hand Washing Practices Observed in Three University Restaurants at some Central-Delta Region Universities.

Observed activity	Total Observations	Number (%) *		
		Employee observed washing hands properly and when required	Employee observed washing hands improperly	Employee observed failing to wash hand when required
Immediately before beginning in food Preparation.	48	12(25)	5(10.4)	31(64.5)
Before putting on new gloves or changing gloves.	79	17(21.5)	28(35.4)	34(43.0)
After contaminating hands while food preparation or service activities	48	10(20.8)	16((33.3)	22((45.8)
After dealing soiled equipment and utensils.	24	6(25)	2(8.3)	16(66.6)
After touching body parts, coughing or sneezing, blowing nose, eating, or drinking.	79	14(17.7)	23(29.1)	42(53.1)
Switching between handling raw animal foods and ready- to-eat foods.	16	3(18.8)	5(31.2)	8(50)
After using hot pads with your hands (or gloved hands) during handling ready-to-eat foods.	25	0	6(24)	19(76)
Total observations	**319**	**62(19.43)**	**85(26.64)**	**172(53.91)**

*Percentages may not add up to 100% due to rounding errors.

The Food Code stipulates that employees must wash their hands right before they start preparing food, before putting on or changing gloves, after their hands become dirty during food preparation or service, after handling dirty equipment or utensils, after touching their body or after activities such as coughing, sneezing, eating and drinking. Additionally, hands should be washed when moving between handling raw animal products and ready-to-eat foods.

In Table 4, only 19.43% of the observations (62 out of 319) showed employees washing their hands correctly and when as well as at the required times. In 26.64% of the observations (85 out of 319), employees washed their hands, but not according to the recommended procedures. About 53.91% (172 out of 319) of employees did not follow the handwashing guidelines as outlined by the Food Code (USFDA, 2022), even though the SOP aligned with the Food Code.

Employees generally did not perform well in hand washing when moving between handling raw animal products and ready-to-eat foods. In only three out of sixteen (3 of 16) observations (18.8%), employees properly washed their hands at the right time and used the correct method. Five employees (31.2%) washed their hands incorrectly, while eight employees (50%) did not wash their hands when required at all (Table 4).

The practice with the highest rate of non-compliance was hand washing after handling soiled equipment and utensils. Only 25% of employees were observed washing their hands correctly and when required, while 8.3% washed their hands improperly. Most food workers, 66.6%, didn't wash their hands at all. While 64.5% of employees did wash their hands before preparing food, many did so improperly—either by not using soap or washing for less than the recommended 20 seconds. Additionally, 76% of employees failed to wash their hands when needed. Observations in this area (19 out of 25) showed employees not washing hands after using hot pads over hands/gloves when handling

ready-to-eat food. Overall, most employees lacked essential knowledge of personal hygiene and workplace sanitation.

3.4. Health Department Inspection Reports

The most recent health inspection reports were collected for each university restaurant examined (Table 5).

Table 5. Violations Identified in university restaurants health inspection (n=3).

Violations*	Frequency	University restaurant code
Floors: Constructed properly, with effective drainage, maintained clean, in good repair, with appropriate coverings installed, and cleaned using dustless methods.	2	UNR-2 and UNR-3
Potentially hazardous food complies with temperature standards throughout storage, preparation, display, service, and transportation.	2	UNR-2 and UNR-3
Thermometers are provided, accurate, and properly calibrated within a margin of ±0.5° C.	2	UNR-2 and UNR-3
Hand washing stations should be numerous, conveniently located, easily accessible, and well-designed and installed.	1	UNR-2
Non-food contact surfaces of equipment and utensils are clean.	2	UNR-2 and UNR-3
Preventing food contamination during storage, preparation, handling, and display, other.	2	UNR-2 and UNR-3
Equipment and utensils' food contact surfaces should be cleaned, sanitized, and kept in good repair.	2	UNR-2 and UNR-3
Walls, ceilings, and attached equipment should be in good repair, with clean surfaces, and cleaned using dust-free methods.	1	UNR-2
Effective equipment design and proper maintenance	1	UNR-2
Kitchenware and food contact surfaces of equipment should be thoroughly washed, rinsed, sanitized, and air-dried. The sanitizer solution must be provided and maintained as necessary.	2	UNR-2 and UNR-3
Food kept safe from possible contamination by staff and students.	2	UNR-2 and UNR-3
Ware washing facilities should be appropriately designed, constructed, maintained, installed, located, and operated to ensure optimal performance and compliance with standards.	1	UNR-2
Accurate thermometers and chemical testing strips.	2	UNR-2 and UNR-3
"Approved receptacles for refuse, recyclables, and returnable are provided for both indoor and outdoor storage areas, and all are covered. Methods for refuse disposal are approved and in compliance with regulations."	2	UNR-2 and UNR-3
Manual ware washing and sanitizing procedures.	2	UNR-2 and UNR-3
Outer openings are protected from insects and rodents, and no birds, other animals.	2	UNR-2 and UNR-3
Certified food handler and manager.	2	UNR-2 and UNR-3
Design, construction, maintenance, installation, and located of non-food contact surfaces.	1	UNR-2
The lighting and ventilation are both adequate. The lights are shielded, and the ventilation system is clean and equipped with filters that are properly maintained and operated.	2	UNR-2 and UNR-3
Toilet rooms enclosed with self-closing doors, and all fixtures must be in good repair and clean. Hand cleaners, sanitary towels or hand drying devices should be provided, along with proper waste receptacles for tissues.	2	UNR-2 and UNR-3
Grease trap service record / food establishment permit food manager or handler cockboat.	3	UNR-1, UNR-2 and UNR-3

*According to MOHP guidelines (2005).

One university restaurant (UNR-1) in the Central-Delta region of Egypt consistently excelled in routine inspections, achieving scores of 95% or higher. However, two other restaurants (UNR-2 and

UNR-3) had multiple violations, though no overall inspection scores were provided for them. The most common violations (n = 2) were associated with floor construction, food contamination, maintenance and cleanliness, cold food storage, and food contact surfaces. Because there was a few health inspection reports available and the scores were generally high, it was difficult to pinpoint any clear patterns in violations among the university restaurants visited. The study also highlighted that it did not conduct regulatory inspections but focused instead on evaluating the food safety program, facility resources, and employee behaviors, which revealed more issues than the official reports indicated.

4. Applications and conclusion

This study aimed to evaluate the implementation of food safety programs based on HACCP principles in three university restaurants at Central-Delta region in Egypt.

University restaurants have many food production and serving systems, making a single, standard food safety program ineffective, but rather every operation needs to create a special food safety program that caters to its specific requirements. University restaurants should be encouraged to develop and implement these customized food safety programs that suit their specific operations. Additionally, these programs must include documentation that is practical and applicable for their specific needs.

Moreover, programs require usable documentation for effective operation. Since developing these programs takes time, a proposed system could utilize a series of questions to generate SOPs based on the responses. Additionally, this system could produce logs, reminder signs, interactions for common tasks, and basic training materials. In the sample studied, out of the three university restaurants, only UNR-1 had SOP available.

A study designed to develop a university restaurant food safety program using HACCP principles (USDA, 2005) found that most needed improvements in university food safety programs are linked to employee behavior rather than the condition of facilities or operational practices. For example, while mistakes like improper food covering and labeling, as well as cold foods not being maintained at or below 5°C, were not common violations, they could be entirely prevented with effective application of the HACCP program. In university restaurants, there was a significant absence of documentation, particularly concerning corrective actions. While maintaining refrigerated storage at 5°C or lower is achievable, it relies on consistently implementing appropriate corrective measures whenever refrigeration units do not meet the critical control points set in the food safety plan. The concerns also encompass maintaining hot food temperatures, restricting non-food items from entering food production zones, and keeping frozen storage at or below -18°C. These issues are different from those highlighted in other studies, which have mainly pointed to facility-related problems as the most frequent issue in university restaurants (Donkor et al., 2009; Kwon et al., 2013 & 2014; Roberts et al., 2014).

Most university restaurants had consistently high health inspection scores, indicating robust food safety practices. However, some food managers and employees were concerned about the frequent turnover of health inspectors. They found that varying inspectors often focused on different aspects, leading to inconsistencies in inspections and making it difficult to interpret the results and decide on the necessary actions.

Food handling inspections identified problems like inadequate sanitizing of work surfaces, insufficient hand washing, and improper glove use. University dining facilities should have dedicated sinks for hand washing. Additionally, employees need to be informed about the risks of using the same sink for both hand washing and cleaning ready-to-eat items such as fresh produce. Emphasis should be placed on hand washing education for university restaurant staff, as proper hand washing is often overlooked or performed incorrectly, increasing the risk of cross-contamination.

Maintaining food safety at every level is essential. This study indicates that although university dining is executing effectively in different areas, there remain potential risks for food contamination during preparation and serving. Strengthening food safety initiatives based on HACCP (Hazard Analysis Critical Control Points) principles is essential. Some staff, managers, and directors might believe they have met legal obligations simply by having a documented food safety plan, while others might mistakenly think that a seemingly "clean" kitchen, like UNR 1, is free of food safety risks. Therefore, it's vital to emphasize the significance of HACCP programs.

It was concluded that increased training programs and regular evaluations of food manufacturing standards are essential to guarantee food safety.

Competing Interests

The authors state that they have no conflicts of interests in relation to this study, whether financial, personal, authorship or otherwise, that could affect the study and its results presented in this document.

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