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Research Article

Evaluation of Food Safety Management System in Hotel Restaurants in Khartoum State, Sudan

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Abstract: This descriptive and experimental study was conducted between September and November 2019 in in Khartoum State, Sudan with the objective of evaluating food safety management systems (FSMS) in hotels' restaurants using risk-based inspection. Cooked meat was taken as an example for the final products to evaluate the bacterial load in food. The risk factors encountered in the operational process steps for final meals preparation in the restaurants were investigated using a checklist, direct observations and microbial testing. The results of the study revealed that the evaluation of operational process steps showed that three quarters (3, 75%) of hotels' restaurants received raw meat from reliable sources and stored it at an appropriate temperature (adequate cooling). On the other hand, cooking, cold storage and reheating process steps were found adequate in only one quarter (1, 25%) in the investigated restaurants. The mean total bacteria count (TBC) in cooked meat was found to be 2.576 X 10^5, 2.866 X 10^5, 3.432 X 10^5 and 3.27210^5 in hotels A, B, C, and D, respectively with highly significant difference between the standard mean and the mean of TBC, with p≤0. 05. This mean TBC reported in this study was found higher than the permissible limits used in this study. The results of the total coliform counts (TCC) in the four restaurants were 2.5X10^3, 1.112X10^3, 2.3 X10^3 and 1.123X10^3 in hotels A, B, C, and D, respectively**.** While there was highly significant difference between the TCC in the four restaurants and the standard permissible limits of total bacteria count, also there was significant differences in the TCC between the four restaurants with p ≤0. 05. This mean TCC reported in this study was found higher than the permissible limits used in this study. The relative risk estimate of operational process steps such as unapproved source, improperly received and stored ingredients and inadequate preparation of food were estimated at almost five times more than when they were performed in proper ways with p≤ 0.05. Also the relative risk estimate of operational process steps such as improper cooling, inadequate cooking, and inadequate reheating and inadequate hot holding were estimated about two times more when there were adequate cooling, cooking, reheating, and hot holding with p ≤ 0.05. The study concluded that the food safety management systems in hotels' restaurants in Khartoum State were not properly implemented.

Keywords: Hotels' restaurants, food safety management system, relative risk estimate, HACCP approach

INTRODUCTION

FDA (2018) recommended developing and implementing food safety management system (FSMS) to prevent, eliminate, or reduce the occurrence of food borne illness risk factors to achieve active managerial control (AMC) in food serving establishments. Elements of an effective food safety management system may include practices such as standard operating procedures (SOPs) and specific goal-oriented plans that outline procedures for controlling food borne illness risk factors.

According Luning *et al.*, (2011) the concept behind food safety management system diagnosis is that companies operating in a high-risk context need an advanced food safety management system to achieve high levels of food safety.

On the other hand, food facilities can also be ranked according to relative risk, and in this case, multiple risk factors are evaluated (Sonoma County Environmental Management, 2001). Thus, risk factors can include food from unsafe sources, improper holding/improper time and temperature, inadequate cooking, poor hygiene, and contaminated equipment and prevention of contamination (FDA, 2004).

To this end, consumers shall be protected against such hazards. U. S. Public Health Service

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(2013) identified five key public health interventions to protect consumer health such as demonstration of knowledge, employee health controls, controlling hands as a vehicle of contamination, time and temperature parameters for controlling pathogens, and the consumer advisory.

To verify any FSMS in food services establishments, hazard analysis shall be conducted by using "process approach to hazard analysis and critical control points (HACCP)" following the approach of Hal King (2016).This approach comprised the determination of the operational process steps (OPS) food path in the restaurant and accordingly a flow diagram will be drawn and verified. The OPS to be determined are verifying the source of food ingredients, receiving and storage, preparation, cooking, cold storage, reheating, hot holding and serving.

In Sudan there is no food safety policy or a sole competent authority in charge of food control and the activities and responsibilities of FSMS and inspection are coordinated between several organizations (Mustafa *et al.,,* 2016). Therefore, this research study was designed to evaluate FSMS in hotels (2-3 stars) in Khartoum State by identifying risk factors encountered in operational process steps and their control measures and to evaluate the bacterial load on workers' hands and products.

MATERIAL AND METHODS

Study area and layout

This cross-sectional study was conducted between September and November 2019 in Khartoum State, Sudan in 4 hotels' restaurants (2 to 3 stars hotels) following the approach of Newsad *et al.,* (2016) in categorizing hotels restaurants as high risk establishment. This was based on extensive handling of raw ingredients, complex preparation, and hot or cold holding of foods needing temperature control.

A risk-based inspection was conducted to evaluate the FSMS in the hotel restaurants by using standardized checklist which comprised risk factors and risk control measures. Cooked meat as one of the final products was sampled to evaluate the bacterial load.

Methods

Hazard analysis was conducted by using "process approach to HACCP" following the approach of Hal King (2016). The approach comprised the determination of the operational process steps (OPS) food path in the restaurants by drawing a flow diagram. The OPS determined were verifying the source of food ingredients, receiving and storage, preparation, cooking, cold storage, reheating, hot holding and serving as appeared in the diagram below:

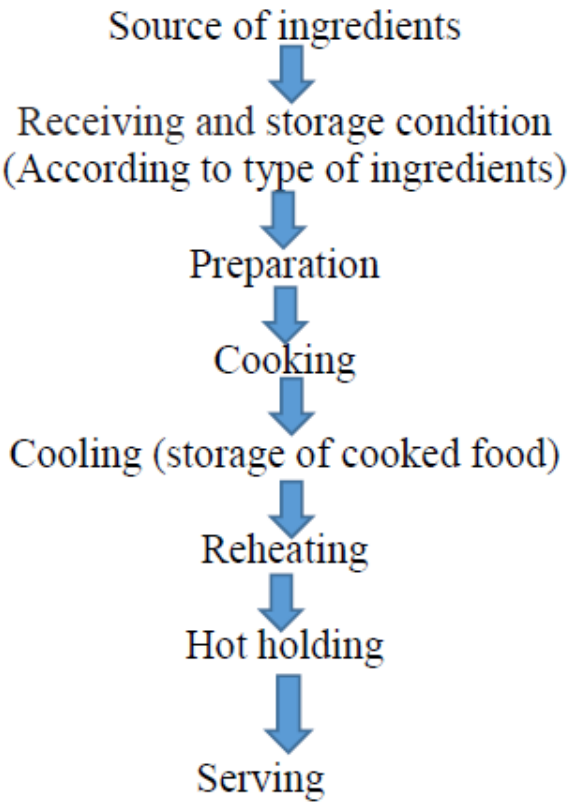

Figure 1: Risk Category
Source: Hal King, 2016

The risk factors investigated were food from unsafe sources, improper holding temperature (for both raw ingredients and cooked foods), inadequate cooking, contaminated equipment and poor personal hygiene. This was done by using a checklist as defined by FDA Food Code (2009). Direct observations were also used.

Cooked meat was taken as an example to evaluate the bacterial load in the food.

Total bacterial count (TBC) was used as described by FDA (2001), while total coliform count (TCC) was done by using most probable number according to Bartram and Pedley (1996).

Both TBC and TCC hotels restaurants were evaluated against the permissible limits mentioned in Food Administration Manual (1995) as a guide to indicate when food can be considered unacceptable or unsafe.

The standard permissible limits of TBC is $1X\ 10^5$, while that of TCC is $1X10^2$ as per Food Administration Manual (1995).

Sample Size

There were 30 hotels (2 and 3 stars hotels) in Khartoum State at the time of this research study. As most of the hotels' owners showed reluctance in accepting the idea of being investigated, the researcher succeeded in getting the acceptance of only 4 (15%) of them.

Sampling Method

Five samples (5 grams each) of cooked meat were taken from each hotel restaurant directly into a labeled sterile plastic container.

The samples were taken in an ice box and transported to the laboratory of the College of Veterinary Medicine, University of Bahri for microbiological analysis.

Procedure for Evaluation of Bacterial Load

TBC was calculated by using spread plate method. One gram was taken from the sample and then added to 9ml of normal saline for the first dilution. Then, 1ml was taken from the first dilution and added to 9ml for the second dilution. Then, 1ml of each dilution was prepared previously and added to labeled Petri dishes with a bout 15ml plate count agar. Then stirred to facilitate absorption. It was then incubated for 24 hours at 37 ˚C. Then bacterial colonies were counted.

TCC was calculated by using most probable number. 1g was taken from the sample and then added to 9ml of previously prepared Eosin Methylene Blue agar for the first dilution. Then 1ml was taken from the first dilution and added to 9ml for the second dilution and so on to 10^5 dilution. It was then incubated for 48 hours. Then changes to the media were observed and counted (Bartram and Pedley, 1996).

Statistical Analysis

The collected data were coded and analyzed to compare means, t-tests and crosstabs tests using Statistical Packaging for the Social Sciences (SPSS/PC version 16.0 for windows).

RESULTS

In this study there were some malpractices in the investigated hotels observed by the researcher. These were dirty food contact materials and no commitment by labors to wash hands or wear gloves.

Table (1) shows the relative risk estimate of washing hands in the 4 hotels' restaurants. As hands washing before cooking reduces the risk of contamination with TBC, the risk of getting higher TBC in cooked food with unwashed hands was found two times more than the TBC when performing hands washing.

Table 1: Relative risk estimate of washing hands in the 4 hotels' restaurants

Source	Risk value	95% Confidence Interval	
		Lower	Upper
hands washing / not washing hands	2.11	1.314	3.391

The results of the evaluation of operational process steps in this study showed that three quarters (75%) of hotels' restaurants received raw meat from reliable sources and stored it at appropriate temperature (adequate cooling), while one quarter (25%) received it from unreliable source. Cooking, cold storage and reheating operation steps were found adequate in only one quarter (25%) in the investigated hotels (Table 2).

Table 2: The evaluation of operational process steps in the 4 hotels' restaurants

Operational process steps	Status	Frequency	Per cent
Source of ingredients	Approved	15	75.0
	Unapproved	5	25.0
	Total	20	100.0
Receiving and storage of ingredients(for raw ingredients)	Proper	15	75.0
	Improper	5	25.0
	Total	20	100.0
Cooling storage conditions(cooked food)	Proper	15	75.0
	Improper	5	25.0
	Total	20	100.0
Cooking	Proper	5	25.0
	Improper	15	75.0
	Total	20	100.0
Reheating	Proper	5	25.0
	Improper	15	75.0
	Total	20	100.0
Hot holding	Proper	5	25.0
	Improper	15	75.0
	Total	20	100.0

The mean total bacteria count (TBC) was found to be 2.576 X 10^5, 2.866 X 10^5, 3.432 X10^5 and 3.27210^5 in hotels A, B, C, and D, respectively. There was no statistical significant differences in the TBC between the four restaurants with p≤0. 05. Statistically there was highly significant difference between the TBC in the four restaurants and the standard permissible limits of total bacteria count which is 1X 10^5 (Table 3).

Table 3: The evaluation of TBC in the 4 hotels' restaurants

Hotel	Mean TBC	N	Std. Deviation
A	257600.0000	5	11,5787
B	286600.0000	5	52,084
C	343200.0000	5	23,509
D	327200.0000	5	34,967
Level of significance compared to the standard		19 df	0.000*
Level of ANOVA between the four restaurants		18df	0.532

The results of the total coliform count (TCC) in the four restaurants was 2.5X10^3, 1.112X10^3, 2.3 X10^3 and 1.123X10^{3}in hotels A, B, C, and D, respectively**.**

Table 4: The mean of TCC in the investigated hotels' restaurants

Hotel	Mean TCC	N	Std. Deviation
A	254,0000	5	6.65582
B	1112.0000	5	12.34909
C	230.6000	5	80.88139
D	1123.0000	5	31.28098
Level of significance compared to the standard		19 df	0.000*
Level of ANOVA between the four restaurants		18df	0.000*

While there was highly significant difference between the TCC in the four restaurants and the standard permissible limits which is 1X10^2 of total coliform count, also there was significant differences in the TCC between the four restaurants with p ≤0. 05 (Table 4).

Confidence Interval 95%

High counts in total bacteria not necessarily produce high count in coliform when applying Pearson Correlation, there was insignificant correlation (0.118) between the TCC and TBC with p ±0. 05 as shown in Table (5).

Table 5: the correlation between TBC and TCC in the 4 hotels' restaurants

		TBC	TCC
TBC	**Pearson Correlation**	**1**	**.118**
	Sig. (2-tailed)		.621

Table (6) demonstrates the values of the relative risk estimate of operational process steps (source of ingredients, receiving and storage, cooling of cooked food, cooking and reheating) in the 4 hotels' restaurants.

Relative risk of unapproved source, was estimated at 4.75 times more than when ingredients were provided by approved source, the odds of getting higher bacterial count when food was improperly received was 4.75 times compared to receiving food properly. The odds of getting higher bacteria count was also 4.75 times higher than when food was prepared adequately with $p \leq 0.05$.

Table (6) also shows the odds of getting high bacteria count in the case of improper cooling, inadequate cooking, reheating and hot holding was estimated at 1.3 times more when there were adequate cooling, cooking, reheating, and hot holding with p ±0.05.

Table 6: The relative risk estimate of operational process steps in the 4 hotels' restaurants

Operational process steps risk factors	**Risk value**	**95% Confidence Interval**	
		Lower	**Upper**
Approved sources / unapproved source	4.75	1.989	11.346
proper receiving/ improper receiving	4.75	2.001	11.346
proper preparation/ improper preparation	4.75	1.989	11.346
proper cold storage//improper cold storage	1.357	1.037	1.776
proper cooking/improper cooking	1.357	1.037	1.776
proper reheating/ improper reheating	1.357	1.037	1.776
proper hot holding/ improper hot holding	1.357	1.037	1.776

DISCUSSION

The aim of this study was to evaluate the FSMS in hotels' restaurants using checklist, direct observations, and microbial testing. This methodology was in line with that reported by Swanson and Anderson (2000) who considered that when adequate process controls and periodic verification were performed, these will be more effective than control of only final products. Added to this, the laborious process of testing final products, particularly in food service establishments where several final products are produced (Swanson and Anderson, 2000).

This study revealed that 75% of the restaurants had approved suppliers for raw ingredients. This finding is supported by Luning *et al.,* (2011) who reported that food safety services establishments having approved supplier, will reduce risks associated with raw material using current raw material specifications and auditing of the safety management system of the supplier. It is also recorded that high-quality raw materials yielded low-risk environment as they are less likely to have undesirably high initial contamination levels (Luning *et al.,,* 2011). These scientific statements were also confirmed by another result in this study which revealed that risk factor in the case of unsafe source was estimated at 4 times more than the safe source with a mean value of 4.750 $p \leq 0.05$.

The current study revealed that three quarters of the investigated restaurants had good cold storage conditions. This result is in compliance with the scientific norms that most microorganisms grow at temperatures danger zone (between 5°C and 60°C), therefore, maintaining both cold and hot food chain temperatures at appropriate levels is the most important factor that control microbial growth (Valero *et al.,,* 2016).

This is also confirmed by another result in this study which revealed that risk factor in the case of improper cold storage was estimated at 4 times more than the proper cold storage with a mean value of 4.750 with p value ≤ 0.05).

Furthermore, internal temperature high enough to destroy harmful bacteria or a holding temperature of food temperature is considered a critical component of health inspections (Dundes and Swann, 2008).

The result of cooking and reheating in this study disclosed that 75% of the establishments were thought to have improper cooking and reheating temperatures. This finding is supported by Leocadio and Corazon (1998) who suggested that in order to ensure safety, a limit holding time of cooked food at controlled temperature is very crucial. The finding was also confirmed by another result in this study which revealed that risk factor in the case of inadequate cooking and inadequate reheating were each estimated at 1.357 times more than adequate cooking or reheating with p value ≤0.0.05. The researcher observed that there were no temperature recording system in some of the investigated establishments. This may be because there was no monitoring system in these establishments. This finding is also supported by Dundes and Swann (2008) who reported that employees responsible for recording temperature in the designated log sheets if not supervised, will feel bored having doing this many times a day.

TBC and TCC are used as microbial indicators for the hygienic and sanitary food quality and may pose health hazards when present at high levels and may include pathogenic microorganisms that may lead to a short shelf life of food products (International Commission on Microbiological Specifications for Foods (ICMSF) (Silva, 2007).

This study revealed highly significant differences between the standard mean $1x10^2$ and the mean of TCC, with p value ≤0.05. No significant differences were found in the mean TBC of the four restaurants which may mean that a similar food safety culture was adopted within these operations. The difference between the TBC in the four restaurants in this study was significantly higher than the permissible TBC $1X10^5$. Similar results were obtained by Ali (2008) who found that the TBC revealed high contamination levels in meat (3.3×10^5cfu/cm²) in some restaurants of Sultanate of Oman.

Coliforms as a reliable indicator of fecal contamination can sometimes be present in contaminated equipment and utensils, as well as in foods (Valero *et al.,,* 2016). The four hotels' restaurants in this study showed statistically significant differences in the TCC. This may be attributed to differences in general sanitation conditions and personal hygiene measures applied by some operations while neglected by others.

The high level of TCC in this study may be due to the weakness in the application of good hygiene practices required in these hotel restaurants. This finding is also supported by Guzewich and Ross (1999) who recorded that food handlers can act as vectors for food by transmitting enteric and respiratory pathogens through using dirty hands and aerosol droplets near the processing line.

In this study there were some malpractices observed by the researcher such as dirty food contact materials and no commitment by labors to wash hands or wear gloves. This finding was consolidated by the findings of several studies (Hertzman and Barrash, 2007; Jones *et al.,,* 2008; Ka¨ferstein, 2003; World Health Organization, 2007) that related the main causes of microbiological contamination and growth in food operations with the lack of a well-functioning food safety management system such as contaminated raw material, dirty food contact surfaces, poor personnel hygiene practices, inappropriate storage temperatures, and adequate cooking.

STUDY LIMITATIONS

In this study the validity of our data was limited considerably by reliance on only 4 different hotels' restaurants out of 30 which statistically was considered small number. The reason behind this was that most of the hotels' owners showed reluctance in accepting the idea of being investigated though the researcher tried to convince them that the sample analysis was meant to provide verification of the preventive measures taken in their operations. Therefore, the authors of this study recommended that further studies should include systematically collected data from a greater number of hotels' restaurants and more persons in charge at different levels of responsibility in order to gain a more thorough assessment of food safety management systems adopted in these operations.

CONCLUSION

The main finding of this evaluation was that food safety management system in hotels' restaurants in Khartoum State were not properly implemented. While poor personnel hygiene practices were detected in some restaurants, others had improper cooking and reheating temperatures.

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