Perception of Food Safety and Prevalence of *Staphylococcus aureus* and *Salmonella* species Carriers among Fayoum University Food handlers

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Abstract: Foodborne diseases encompass a wide spectrum of illnesses especially in developing countries. **Aims:** This study aimed to investigate food handlers' knowledge, attitude and practices about food safety in four restaurants in Fayoum University and to assess the carrier rate of *S aureus* and *Salmonella* spp. also determination of the total viable count, and level of hand contamination with *E. coli*, other members of Enterobacteriaceae as well as other aerobic Gram-negative bacteria**. Methods:** A cross- sectional, descriptive, observational study was conducted among 209 Fayoum University food handlers serving four main kitchens at the University. The food handlers' interviewed using a pre-tested questionnaire included three main topics regarding knowledge, attitude and practices of food safety. Data collectors observed food handlers' to collect information on food preparation, handling and the sanitary condition of the facilities. Microbiological samples were collected from 158 healthy food handlers including swabs from throat, each nostril, stool and urine samples followed by culturing on proper media, also determine of the total bacterial count and hand contamination by fingerprint culture technique. **Results:** About 90% of food handlers have good knowledge, between 30.1% and 55% found to have good practice. Carrier rate of *S. aureus* was 17.1%. The total viable bacterial count exceeds 300 CFU)/hand in 37.3%. Out of 158 food handlers, 57 (36.1%) of them had contaminated hand with *S. aureus*, 26 (16.5%) with Enterobacteriaceae and 6 (3.8%)with *Pseudomonas* Spp.. All stool and urine samples were negative for *Salmonella* spp. **Conclusion:** To achieve a good level of food safety, pre Employement investigations and training as well as continuous monitoring of food handlers should be implemented.

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1. Introduction

Foodborne diseases encompass a wide spectrum of illnesses especially in developing countries. They are growing public health problem, costly yet preventable worldwide. They are the result from ingesting contaminated foodstuffs, by many different microbes or pathogens, chemical hazards or other harmful toxins that present in food for example, poisonous mushrooms **(Kibret and Abera, 2012)**. Occurrence of foodborne illness is a clinical health problem causing economic losses related to lower work productivity, hospitalization, and other health care expenses **(Dharod *et al.*, 2009).**

Food safety is a scientific discipline describing handling, preparation and storage of food in ways that prevent foodborne illness. This includes a number of routines that should be followed to avoid potentially severe health hazards. Food service establishments are sources of food borne illnesses and food handlers contribute to food borne illness **(Teferi *et al.*, 2012).**

The World Health Organization (WHO) estimated that in developed countries, up to 30% of the population suffers from food borne diseases each year, whereas in developing countries up to 2 million deaths are estimated per year **(WHO, 2007 a&b)**. Unsafe, disregard hygienic measures of food and faulty food handling practices may enable pathogenic bacteria to come into contact with food, multiply in sufficient numbers to cause many acute and life-long diseases, ranging from diarrheal diseases to various forms of cancer **(Clayton *et al.*, 2002).** Lacking personal hygiene among food handlers is one of the most commonly reported practices contributing to food-borne illness with poor hand and surface hygiene **(Cogan *et al.*, 2002; Collins, 2001).** Hand-washing, a simple and effective way to cut down on cross-contamination, is all too often forgotten **(Rippel, 2002).**

The transmission of enteric-related pathogenic microorganisms via the hands of food handlers continues to be a problem in the food industry **(Barza, 2004).** *Staphylococcus aureus, Escherichia coli* and *Salmonella* spp. survive on hands and surfaces for hours or even days after initial contact with the microorganisms **(Kusumaningrum *et al.*, 2002).** These microbes have been associated with food-borne illness for decades and there is no doubt

that they, together with members of amongst others the genera *Listeria, Campylobacter, Bacillus* and *Clostridium* are the cause of illness and even death to many people each year, at immeasurable economic cost and human suffering **(Borch & Arinder, 2002).**

A microbial indicator is a microorganism or group of microorganisms that is indicative of the possible presence of pathogens and the detection and enumeration of indicator organisms are widely used to assess the efficacy of sanitation programs **(Brown *et al.*, 2000; Ingham *et al.*, 2000; Moore & Griffth, 2002).** Indicator organisms associated with hygiene practices include, total viable counts, total coliforms, *E. coli*, members of the family Enterobacteriaceae and *S. aureus* **(Department of Health, 2000).** The presence of *S. aureus* in food indicates flaws during food manipulations. For this reason most sanitary norms require the detection of *S aureus* carriers **(Figueroa *et al.*, 2002).**

This study aimed to investigate food handlers' knowledge, attitude and practices about food safety and explore the sanitary conditions of food service establishments in four restaurants in Fayoum University. The most important aim of the present study was to assess the carrier rate of *S aureus* and *Salmonella* spp. among food handlers and determine the total viable count, and level of hand contamination with *E. coli*, other members of Enterobacteriaceae as well as other aerobic Gram-negative bacteria**.**

2. Subjects and Methods:

A cross- sectional, descriptive, observational study was conducted among 209 Fayoum University food handlers' serving four main kitchens at the University campus selected by purposive sampling. Data collectors and supervisor were oriented about the purpose of the study.

The food handlers' interviewed using a pre-tested, Arabic structured closed questionnaire with an inclusion criterion of being a staff in Fayoum University kitchens. While the exclusion criteria were refusal to participate in the study. The questionnaire included three main topics regarding knowledge, attitude and practices of food safety containing thirty questions, ten about personal hygiene, nine related to kitchen equipment's hygiene and eleven considered with the usage of proper healthy food items. Data collectors observed food handlers' while they were performing their jobs to collect information on food preparation, handling and the sanitary condition of the facilities.

Microbiological sampling and processing

Microbiological samples were collected from 158 healthy food handlers; after given written consent for samples collection; 89 were males (56.3 %) and 69 were females 43.7%).

Determination of S. aureus carrier rate:

To determine *S. aureus* carriers, swabs from throat and each nostril from each subject were cultured onto Columbia blood agar as well as manitol salt agar (Oxoid LTD, Basingstoke, England), Plates were incubated for 24h at 37°C under aerobic conditions. *S.aureus* was identified using standard microbiological procedures.

Determination of total bacterial count and hand contamination

Fingerprint technique was used to determine the total bacterial count and hand contamination onto a Columbia blood agar plate (one plate / 5 fingers) (Oxoid LTD, Basingstoke, England). Total bacterial count was recorded as the number of colony forming units (CFU)/hand. Plates were incubated at 37°C under aerobic conditions, and colony-forming units (CFUs) were counted after 48 hrs. The maximum count was 300 CFUs; beyond this figure, it was considered that there was a confluence **(Lucet *et al.*, 2002)**. Potential pathogenic bacteria from transient flora (i.e. *Staphylococcus aureus*, Enterobacteriaceae, aerobic Gram-negative bacteria) were identified using standard microbiological techniques.

Determination of Salmonella spp. carrier rate:

To determine *Salmonella* carriers as well as presence of *Shigella* spp. In stool, stool and urine samples were collected from each subject. Stool samples were cultured in selenite broth, incubated at 37°C then subcultured after 24hrs on MacConkey and Xylose deoxycholate (XLD) agar (Oxoid LTD, Basingstoke, England) while urine samples were cultured on MacConkey, XLD and CLED agar (Oxoid LTD, Basingstoke, England). Any non-lactose fermented Gram-negative Bacilli were tested for oxidase production. Oxidase-negative Gram-negative Bacilli were further identified by Microbact (12A) Gram-negative identification system (Oxoid, Basingstoke,UK) to identify *Salmonella* and *Shigella* spp.

Data entry and statistical analysis:

Data were collected, coded and analyzed using SPSS software version 15 under windows 7, simple descriptive analysis in the form of percentage distribution, were done.

Ethical Consideration:

This study was reviewed and approved by the Faculty of Medicine Research Ethical Committee, and a waiver of consent form was approved, as we used an anonymous self-administered questionnaire with no private or sensitive information.

3. Results:

Socio-demographic data: more than half of the food handlers were males118 (56.4%) s and 91 (43.5%) were females with an age ranging between 18 and 55 years of age with Mean age ±SD was 27.43± 7.72 years. Regarding level of education 147 (70.3%) of the food handlers completed primary school, 39 (18.6%) were completed secondary school and 23 (11%) had high education.

Food hygiene knowledge and hand hygiene practices of food handlers: There was no frequent food hygiene training received by food handlers but they acquire knowledge of food preparation through observation of the senior's staff. The majority of the food handlers appear to have excellent knowledge of food hygiene regarding what to do as almost 97.6% were know that they must do frequent hand wash during food preparation also 95.2% cut their nail and 90% concerned about their personal cleanliness 88% were covered hair and 91.3% stay at home during illness also 69.7% knew that they must perform an annual examination.

Hand washing with soap is a practice that has long been recognized as a major barrier to the spread of disease in food preparation. As hand hygiene is not always carried out effectively, both enteric and respiratory diseases are easily spread in these environments. The observational results of the investigator showed that they had poor practice by wearing hand jewelries while preparing food 115 (55%), they don't wash their hand frequently only at the beginning of the food preparation with minimal personal variation 63 (30.1%), but they were washing their hand during different activities in the kitchen Figure (1).

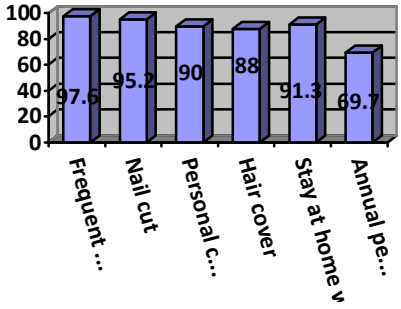

Figure (1) Food handlers knowledge & practice related to food safety

As regards the questions related to kitchen equipment's cleanliness practices: by using clean utensils, clean the utensils with hot water and detergent clean the sink to avoid contamination of the food and cover the garbage pot to prevent transmission of infection to the food are applied by more than 92%. These important finding were demonstrated in the Figure (2)

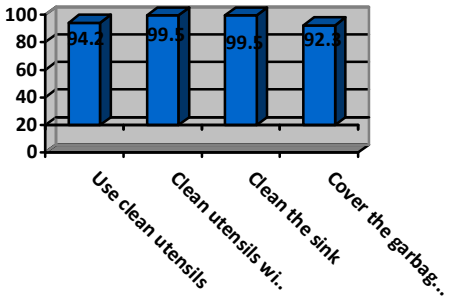

Figure (2) Kitchen cleanliness

One of the most important topics in the questionnaire was the proper use of fresh healthy food items as usage of (100%) fresh vegetables, fruits and intact food cans, (100%) apply proper temperature for cooking and (97.4%) check refrigerator temperature daily and lastly (99.1%) cover the pots after finishing cooking.

Microbiological results: Among the 158 healthy food handlers (89 males (56.3 %) and 69 females (43.7%)), the overall prevalence of nasal

carriage of *S. aureus* was 27(17.1%), 5 (3.2%) of them were also positive for throat swab (Figure 3).

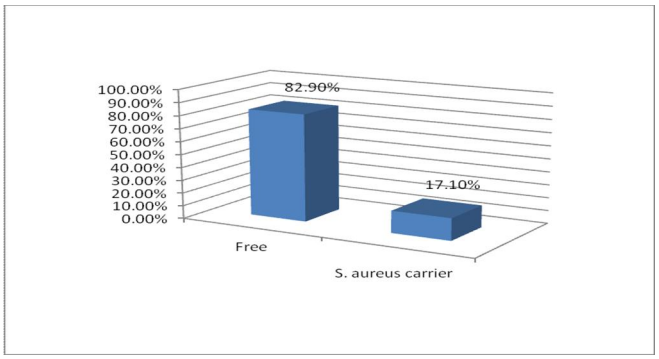

Figure (3): prevalence of nasal carriage of *S. aureus* among food handlers.

The total viable bacterial count exceeds 300 CFU)/hand in 59 (37.3%) of them. Although 99/158 (62.7%) of food handlers have total viable count below 300 CFU)/hand which can be negligible in most cases **(Lucet *et al.*, 2002)**, 43 (27.2%) of them have contaminated hand with at least one type of pathogenic bacteria. Nineteen (12%) out of 158 food handlers showed mixed pattern of colonization by 2 or more pathogenic bacterial isolates, while 49/158 (31%) yielded a single isolate. Out of 158 food handlers, the hands of 57 (36.1%) of them were contaminated with *S. aureus*, 26 (16.5%) with Enterobacteriaceae and 6 (3.8%)with *Pseudomonas Spp*. Among Enterobacteriaceae, *E.coli* represent 6.3% (10/158), *Klebsilla Spp*. 5.7% (9/158) and *proteus Spp.* 4.4% (7/158) (Figure 4). All stool and urine samples were negative for *Salmonella* and *Shigella* spp.

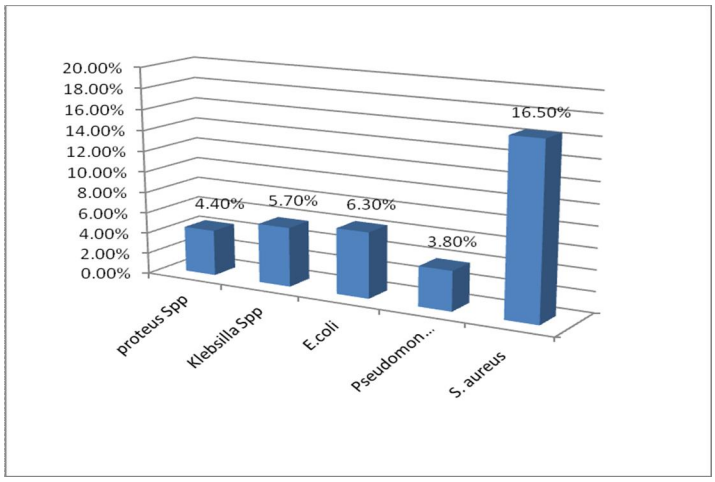

Figure (4): Prevalence of hand contamination of pathogenic organisms among food handlers.

4. Discussion:

The results of this study revealed that although there was no frequent training of food hygiene, yet they had an excellent knowledge related to food safety but they did not translate their knowledge into practice in spite of positive responding of food handlers for food safety related questions. Our results were in coincidence with **Kibret and Abera (2012)** results as they concluded that poor hygienic practices by food handlers coupled with poor sanitary conditions in food and drink establishments can contribute to foodborne illnesses**.**

Green *et al.* (2006) documented that improvement of food worker hand washing practices is critical to the reduction of foodborne illness and was dependent upon a clear understanding of current hand washing practices, hand washing and glove use were more likely to occur in conjunction with food preparation than with other activities. He also reported that only 32% of the workers were attempted to wash their hand frequently during food preparation this was agreement with our results as 30.1% washing their hand during different activities in the kitchen.

In this study, nasal and throat swab culture of 158 food handlers serving four restaurants at Fayoum University had been investigated for the presence of *S. aureus*. The rate of isolation of *S. aureus* from the nasal cultures in our study 27 (17.1%) was found to be similar to those reported by **Teferi** and his colleagues **(2012)** who conducted a cross sectional study among food handlers working in University of Gondar student's cafeterias and found that 20.5% food handlers were positive for nasal carriage of *S. aureus*. Also **Ahmed *et al.* (2010)** reported that the carriage rate of *S. aureus* among food handlers in the Omdurman area of Sudan was 21.6%. Other studies screened nasal carriage of *S. aureus* among restaurant workers in Kwit and Makkah cities and reported carrier rate of *S. aureus* to be 26.6% and 20.8% respectively **(Bustan *et al*,.1996; Asghar *et al.*, 2006).** However, our finding was found to be higher than the rate 69(0.77%) obtained from a study conducted in Turkey **Gunduz *et al.*, 2008)** and much lower than the findings reported in Brazil **(Souza and Santos, 2009; Acco *et al.*,2003)** and Botswana **(Loeto *et al.*,2007)** as 30%, and 44.6%; respectively. Nasal carriage rates reported by several workers vary and the variation has been attributed to the ecological differences of the study population.

It is very important to note that although *S. aureus* can cause severe infections it may also be as a member of the normal flora of the nasal cavity **(William, 1993).** If by chance, a food handler carries, an enterotoxin producer *S. aureus* he/she may contaminate the food and causes staphylococcal food poisoning outbreak in the population.

Microorganisms can be transferred to the hands in the process of handling food and through poor personal hygiene resulting in the hands being heavily contaminated with enteric pathogens **(Lues and Tonder, 2007).** Fecal coliforms can be easily removed by hand washing **(Jumaa, 2005)** and their presence indicates fecal contamination and food handlers are not taking enough care in hand hygiene **(Aycicek *et al.*, 2004).** Also staphylococci distributed in the environment and strains present in the nose often contaminate the back of hands, fingers and face, and nasal carriers could therefore easily become skin carriers **(Lues and Tonder, 2007).** In our study the total viable bacterial count exceeds 300 CFU)/hand in 59 (37.3%) of tested food handlers. Moreover 43 (27.2%) of the 99 (62.7%) food handlers who have acceptable count their hands were contaminated with at least one type of pathogenic bacteria. Nineteen (12%) out of 158 food handlers showed mixed pattern of colonization by 2 or more pathogenic bacterial isolates, while 49/158 (31%) yielded a single isolate. Out of 158 food handlers, the hands of 57 (36.1%) of them were contaminated with *S. aureus*, 26 (16.5%) with Enterobacteriaceae and 6 (3.8%) with *Pseudomonas Spp.* Among Enterobacteriaceae, *E.coli* represent 6.3% (10/158), *Klebsilla Spp*. 5.7% (9/158) and *proteus Spp.* 4.4% (7/158). Our results are similar to that previously reported in Brazil for *E. coli* (6.8%) and *Pseudomonas aeruginosa* (2.3%) isolated from the hands of food handlers (**Souza and Santos, 2009)** and South Africa which reported that *E. coli* was isolated from 7.8% of food handlers hands **(Lues, 2006).**

Our results were much lower than that reported by **Lues and Tonder (2007)** in South African as they found Enterobacteriaceae were present on hands of 44% of food handlers and *S. aureus* was 88%. Also **Mudey *et al.* (2010)** conducted a cross-sectional study on food handler in a rural area of Wardha district of Central India and reported that the frequency of pathogenic organisms in their hands were 56.87% for Staphylococci, 17.50% for *E.coli* and 21.87% for *Klebsilla Spp.* The different degrees of hand contamination between studies could be explained by the degree of adherence of food handlers to food safety measures and hand washing in different geographic regions. **Shojaei *et al.* (2006)** reported that the hands of 72.7% of Iranian food handlers were found to be contaminated with pathogenic flora of faeces or nose before simple hand-washing with significant decline to 32% after hand-washing.

Chronic asymptomatic *Salmonella* carrier food handlers may be a potential source of *Salmonella* spp. transmission also *Shigella* spp can be transmitted from food handlers by contaminated hands. So this study has also attempted to isolate *Salmonella* and *Shigella* spp. From stools of food handler participate in this study also urine samples were collected to diagnose *Salmonella* carrier. Our results revealed that all stool and urine samples were negative for *Salmonella* and *Shigella* spp.these finding were in agreement with **Andargie *et al.* (2008)** who reported that no *Salmonella* species were isolated from food handlers. Although *Salmonella* carrier rate among food handlers range between 0.1% to 3 % in many studies conducted in different geographic regions **(Yousefi-Mashouf *et al.*, 2003, Feglo *et al.*, 2004, Asghar *et al.*, 2006, Ahmed and Hassa, 2010),** it should be continuously surveyed because of high infectivity of this organism**.**

It is obvious that hand contamination indicates the non compliance of most food handlers to hand washing regulation. Also the carrier rates of different organisms may indicate the importance of pre-employment laboratory investigations and the continuous monitoring of food handlers. Pre employment training is important and continuous

observation of workers by an assigned senior staff is very important to ensure high degree of food safety.

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