

Assessment of food safety knowledge, attitude, practices of food handlers and microbial contamination in foods at the canteens of a University in Pakistan

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Abstract

Developing nations are striving to assure food safety that rely mainly upon handling procedures. The current study focused upon the understanding level and practices of food handlers working at various canteens of University of the Punjab, Quid-i-Azam campus, Lahore. Different canteens were selected where 300 different food handlers were judged for their approach towards food safety through a closed ended questionnaire. Samples of different food products were also taken randomly for their microbiological safety evaluation. The whole data was analyzed using chi-square to assess the proportion of correct and incorrect responses among various parameters. The non-significant variation was observed among the knowledge, attitude and practices scores of university and its hostels' canteens food handlers. Overall, 60% of the responses were correct from the university and hostel canteens food handlers. Similarly, 50-60% of the responses regarding attitude and practices were correct from the university and hostel canteen food handlers. With many technical flaws, these food handlers showed moderate level of knowledge. Not only apprentices but the supervisors too, lacked the basic knowledge of temperature as major factor creating potential food safety threats. Lack of knowledge about personal hygiene and workplace sanitation were few contributing factors towards heedless behavior. Incidence of *Salmonella* and *Staphylococcus aureus* contamination in food samples was found 29% and 57%, respectively, while 35% food samples were

found contaminated with *E. coli*. It further exposed the negligence, emphasizing proper training of employees as part and parcel of food safety procedures. It was concluded that more training programs along with periodic validation of food manufacturing standards are required to ensure food safety. Furthermore, strict surveillance and implementation of GMPs by the administrative authorities are needed to safeguard the consumers' health.

Introduction

Developing world is suffering from foodborne diseases for years with the estimated cases of 600 million including 420,000 deaths, annually. The major contributors of foodborne diseases include unhygienic food handling techniques and lack of cleanliness. Food safety knowledge is the learned skills or education, while food safety attitude is the belief about food safety. Food safety practices are the on-ground act or application of food safety. The food safety knowledge, attitude, and practices (KAP) play a crucial role to overcome the incidence of food poisoning among consumers. On the other hand, the lack of food safety knowledge, inappropriate attitude and wrong handling practices can cause severe food safety threats to the consumers. Hence the food safety KAP are critical to make food free from any kind of hazards during preparation, processing and serving as well (Tuglo *et al.*, 2021).

Food handlers plays a significant role in ensuring food safety and preventing food contamination throughout the food supply chain (Lee *et al.*, 2017). The precise attitude of food workers can decline the outbreak of food borne disease and further the sufficient knowledge as well as rigorous administration can also play an important role. The suggested reasons behind food poisoning are substandard cooking and cooling, long duration between preparation and consumption, inappropriate heat treatment, infectious staff, application of contaminated materials, lack of equipment cleaning, cross contamination, low quality food materials and residual food materials. The pathogenic microbial transmission from food handlers to consumer can be reduced by applying the principle of good hygienic practices and correct food handling. Food handlers must follow the proper food safety measures and hygiene practices to reduce the incidence of pathogenic microorganism in foods (Bou-Mitri *et al.*, 2018).

Microbes have evolved into threatening creatures posing real threats to human beings with acquired resistance over the

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passage of time. These microbes have mastered a skill of existence under toughest conditions and food processing procedures. Foods containing potential pathogenic microbes could be source of food borne illness. Various studies have confirmed that the training of food handlers could be effective in this regard. The success of training programs with consequent of reduction in prevalence of pathogenic microorganism in prepared foods has been established through research (Elobeid *et al.*, 2019). In developing world, food safety is indicator of economic growth that is why both government and private sector recognize the significance of safety in food supply chains (Akhtar *et al.*, 2014). The public sector universities of Pakistan are contributing a lot towards education and well-being of society. In this domain, University of the Punjab is one of the oldest, established in 1882 and the highest site of learning which accommodates more than 40,000 students out of which >10,000 students are residing in its

hostels. In addition, almost every department and hostel have its own canteen. Food business in university premises is mainly run by local vendors who are un-professional and lack background knowledge of food safety. The workers involved in food operations mostly belong to rural backgrounds. As, most of the recorded outbreaks have been reported from educational organizations (Soon *et al.*, 2020), this urged us to conduct a food safety study based on knowledge, attitude and practices of food handlers working at different canteens of University of the Punjab. Moreover, the microbiological analysis of different food products being sold at various canteens was also performed to conclude the relationship between KAP of workers and microbial safety of the products being sold.

Materials and methods

The cross-sectional survey was conducted to collect the data from food handlers working at the canteens of hostels and the departments in University of the Punjab, Quaid-i-Azam Campus, Lahore. Total 300 food handlers, 180 from various departments of campus (G-I) and 120 from hostel canteens (G-II) were randomly selected and included in the study. In addition, microbiological quality of different food commodities was also assessed at Food Safety Research Lab in the Department of Food Sciences.

Questionnaire design

A comprehensive questionnaire was designed including four sections *i.e.*, demographic data (4 questions *i.e.*, gender, age, experience and education), second question regarding knowledge, attitude and practices related to personal hygiene (10 questions) whereas workplace cleanliness (22 questions) was part of third section and fourth section contained temperature supervision data (7 questions). Moreover, different questions were asked to assess the knowledge (10 questions), attitude (15 questions) and practice (15 questions) within the aforementioned sections of the questionnaire and the correct responses were analyzed (Luu *et al.*, 2017).

Microbiological assessment

Food samples were collected randomly from selected canteens and placed into sterile glass bottles and the bottles were kept in the ice cooler for transportation. The samples were labeled with date of sample collection, canteen number and name of food sample. All the samples were stored at freezing temperature and transferred to

refrigerator at 4°C for thawing before analysis. Types and number of collected food samples are as follows: Samosa 10; Bread 10; Patties 10; Milk Shake 20; Kebab 4; Chaat 12; Drinking Water 12; Yogurt 6; Salad 6; Juice 10.

Microbiological analysis

Enumeration of TPC was done by adopting standard ISO Method 483310. Presumptive test for the *Coliforms* followed by the detection and confirmation of *E. coli* was done by the described method (Herrera, 2001). Detection of *Staphylococcus aureus* and *Salmonella* from food samples was done via McLandsborough (2004) method.

Statistical analysis

All the data were analyzed using statistical package for social sciences (SPSS) version 26 and were expressed as frequencies and percentages. The chi-square was applied to assess the proportion of correct and incorrect responses among various parameters assessed in the knowledge, attitude, and practices with reference to personal hygiene, workplace cleanliness and temperature supervision.

Results and discussion

The present study was conducted with the aim to assess the knowledge, attitude and practices of food handlers with reference to their place of employment, in which they were asked about the personal hygiene, workplace cleanliness, temperature monitoring and supervision. Overall, 10 questions were asked in the personal hygiene section form which half of the questions were addressed more appropriately by the hostel canteens food handlers and vice versa. Personal hygiene parameters scores were comparable for both hostel and university canteens food handlers. On the contrary, the knowledge attitude and practices scores regarding workplace cleanliness were better in hostel canteen workers. Similarly hostel canteen workers were more accurate in responding to temperature supervision parameters. There was a huge percentage of workers from both placements, who were unable to answer correctly the questions based on simple food safety and food handling practices, depicted from the scoring of the data, as 42-51% of the food handlers from both settings were unable to address simple parameters related to food safety KAP.

Demographic attributes

The demographic information of food handlers included in this study is presented

in Figure 1. The food handlers of various age groups (ranging from less than 20 to more than 50 years) were categorized into various subgroups based upon the age range *i.e.*, 20-30 years (41.67%) and 30-40 years (35%) *etc.* The majority of food handlers were illiterate (48.3%), while only 20% and 16.7% had completed their primary and middle school education, respectively. Only one female employee had bachelor's degree with her name. This clearly defines how lack of education may directly or indirectly influence food safety situation. Majority of the participants were male with only one female out of 300. In Pakistan food business is dominated by males, however, in some countries, females have higher proportion in food business as reported by Samapundo *et al.*, (2015) in which 88.7% women were involved in food supply chain as food handlers. The information for work experience was also gathered and segmented into five groups. The 25% of food handlers had experience of less than one year where 33.3% had working experience of 1-3 years (Has *et al.*, 2018). It is worth mentioning that work experience of all the workers does not include any kind of training for their job.

Personal hygiene

The participant's response about personal hygiene has been presented in the Table 1. The results indicated that food handlers had an average knowledge of food safety related personal hygiene. The majority of the food workers had a habit of washing their hands before performing any operation as more than 50% workers (from both groups) choose option "Yes" in this case. Handlers who chosen correct option for wearing proper uniform at the workplace were few in numbers and the data showed significant association. However, most of the food handlers were certain about washing their hands before operational work and timely trimming of their nails. Most of the food handlers have very poor level of awareness about other hygienic practices *i.e.* avoiding touching nose, mouth and hair *etc.* during operational work. Food handlers from G-I (72.22%) and from G-II (87.5%) had habit of doing such unhygienic activities with significant variation between both groups. The 61.11% of G-I food handlers claimed that they cover their head while working whereas, only 29.16% of G-II food handlers had habit of doing this. However, all the food handlers assured that they don't work when suffering from any disease. In another study conducted by Isoni Auad *et al.* (2019) in Brazil also reported that the food handlers answer correctly for hand-washing. Nevertheless, (95%) food han-

dlers were aware about the reduction of food contamination by the use of jewelry, accessories, adornments and (77.5%) food handlers affirmed that they never used adornment and jewelry. The results also revealed that 82% of food handlers wear cap and having no adornment during working. Previous studies reveal that 86.3% food handlers know that it is necessary to take

leave from work in case of skin infection and other associated diseases while 88.1% were aware of microbial presence on the nose, skin, and mouth of healthy handlers (Samapundo *et al.*, 2015). Food handlers of G-I (27.78%) and G-II (58.33%) had a positive response about need of having separate washing facility. A contemporary study describes best personal hygiene in which

96.6 % food worker follow safe practices during work. They wear proper uniform and hairnet/caps. More than 90 % food workers washed hands after sneezing, coughing or smoking and more than 70% were well aware of removing their personal belongings *i.e.*, jewelry, ring during their job (Al-Shabib *et al.*, 2016). In addition, Codex Alimentarius Commission (2003) ended

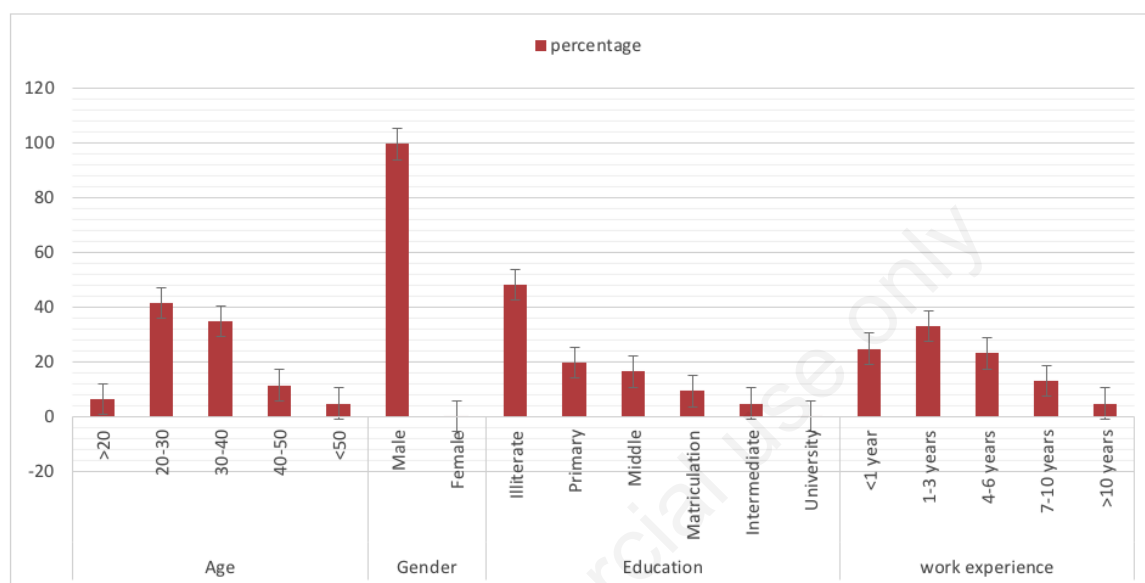


Figure 1. Demographics attributes of the participants.

Table 1. Assessment of personal hygiene knowledge, attitude and practices of food handlers.

Variables	Response	University Canteen, n (%)	Hostel Canteen, n (%)	X ²	P
Do you wash hands with soap	Correct	135 (75)	80 (66.7)	2.462	0.117
	Incorrect	45 (25)	40 (33.3)		
Do you wear proper uniform during work	Correct	80 (44.4)	35 (29.2)	7.109	0.005*
	Incorrect	100 (55.6)	85 (70.8)		
Do you cut your nails properly	Correct	125 (69.4)	90 (75)	1.094	0.296
	Incorrect	55 (30.6)	30 (25)		
Do you wash hands before making sandwich	Correct	120 (66.7)	90 (75)	2.381	0.123
	Incorrect	60 (33.3)	30 (25)		
Do you sneeze or touch your mouth and nose while working with food	Correct	50 (27.8)	15 (12.5)	9.902	0.002*
	Incorrect	130 (72.2)	105 (87)		
Do you cover head while working	Correct	110 (61.1)	35 (29.2)	29.422	0.000*
	Incorrect	70 (38.9)	85 (70.8)		
Do you work when you have diarrhea/sick or lesions on the hands	Correct	140 (77.8)	85 (70.8)	1.852	0.174
	Incorrect	40 (22.2)	35 (29.2)		
Do you wear gloves if they have a cut or sore on hands	Correct	70 (38.9)	50 (41.7)	0.231	0.630
	Incorrect	110 (61.1)	70 (58.3)		
Do you have separate basins for hands and utensils washing	Correct	50 (27.8)	70 (58.3)	28.009	0.000*
	Incorrect	130 (72.2)	50 (41.7)		
Do you use single use cloths or tea towels	Correct	55 (30.6)	70 (58.3)	22.857	0.000*
	Incorrect	125 (69.4)	50 (41.7)		

Chi-Square (α 0.05), data are presented as frequency (percentage).

with a conclusion that unscrupulous food handling is the key reason for food borne diseases and proper washed hands is the main risk factor to prevent cross contamination in the food. At every step, food workers must wash their hands during food manufacturing. The food workers suffering from any disease could be compensated at other places and must not be permitted to deal with food. Our finding reveals that few workers (less than 30 %) keep working when ill or infected and find it safe for consumers.

Workplace cleanliness

The approach of food handlers towards workplace cleanliness is presented in Table 2. In G-I, 49.22% participants had habit of smoking whereas all the G-II participants denied having this habit and significant variation was revealed statistically. However, all the smokers were unaware of contamination risks during indoor cooking. Almost half of the participants from both groups did not have any awareness about the importance of neat/clean working environmental conditions and structure of working areas *i.e.*, floors, ceilings *etc* as concluded from their response in this survey. Condition of food stalls was also pathetic in another study (Okojie & Isah, 2014). Approximately 44.44% participants in G-I and 66.66% participants in G-II, claimed that they wash utensils before use. Less than 40% participants from both groups had an idea of proper storage of food to avoid contamination and damage with significant variations between groups. In contrast, study conducted in South Africa and Ghana explained that 84.4% of food handlers were aware of the importance of storing cooked and raw foods separately in order to prevent food borne diseases (Donkor *et al.*, 2009). Fariba *et al.* (2018) reported that food handlers 90.5% know how to handle raw and cooked foods separately during storage and among them 80% were used separate utensils for raw and cooked foods. In contrast to a survey conducted by Al-Shabib *et al.* (2016) where 82.8% food handlers were using separate utensils for raw and cooked food, most of the handlers in current study did not have any such approach. Food handlers were unaware of using separate cutting boards for vegetables and chicken. As assessed in a previous study 30% of the individuals thought that the reheating of foods can contribute to food contamination while 60% answered that preparation of foods in advance can reduce the chances of contamination (Samapundo *et al.*, 2015).

The food workers lack scientific or careful approach. They did not have any idea that dealing with the food and money at the same time may cause food contamina-

tion. As discussed in previous studies food safety relies over various factors including personal hygiene so dealing with the money and food at the same time should be avoided (Kaesboher, 2000). Insects and rodents may cause serious food safety issues and considered as a potential source of contamination. Most of the handlers from both groups (*i.e.* <35% answer correctly) did not have any idea about food safety issues associated with insects and rodents. A survey conducted in India revealed that food handlers did not cover food usually so chances of contamination from insects and rodents were high (Choudhury *et al.*, 2011). However, 94.44% participants from G-I and 58% from G-II agreed with the statement that training of staff may help in creating better food production circumstances. Majority of the participants were aware of checking expiry of the ingredients before usage. Less than 40% of them were reusing the leftover food without informing the customer, that was surprising and unethical. Consumers who pay for fresh food might get infested or spoiled food in such case. Due to better check and balance by hostel administration, workers at hostel canteens had better performance as compared to departmental canteens. Students at hostels have better ties with the workers, so this might be the other reason for relatively careful approach of the food handlers at hostel canteens.

Food temperature control

Temperature plays a key role in food quality management, so regulation is necessary. Majority of the food handlers were unaware of the basic knowledge and significance of temperature in controlling microbial population within the food. Poor handling results in escalation of microbial growth leading to food hazards subsequently food borne illness. Practices followed by food handlers regarding temperature were assessed and depicted in Table 3. In G-I, only 19.44%, whereas in G-II, approximately 33.33% considered temperature as important factor to be checked and regulated while others showed no concern. However, larger number of workers cooked the food at right temperature but failed to maintain it properly.

Food handlers of both groups did not have proper knowledge of high risks associated with food and cooking temperature. Merely 27.77% from G-I, and 28.88% from G-II had idea about the risks associated with the cooking temperature of high-risk food to avoid food borne diseases. Most of them were even unaware of temperature and techniques required for proper and safe storage. Despite all these mismanagements, majority of food handlers claimed that their

food was safe for consumers. When asked for the possible flaws in provision of unsafe food, most of the handlers failed to justify their opinion. These results match with the study of Baş *et al.* (2006), who suggested that many of participants lack the information of critical temperature for ready to eat food, refrigeration storage temperature range and cross contamination. However, Bou-Mitri *et al.* (2018) reported contrary that 97% respondents had the knowledge of temperature in refrigerator/freezer and its role in food spoilage while the 96% respondents check the temperature and thermometer of freezer/refrigerator at regular periods. In addition, knowledge is a key tool for behavioral improvement that will help in improving safety measures. To overcome such kind of behavioral problems, training courses should be incorporated within the food systems for the development of positive attitude in food handlers as a preventive measure for food contamination.

Scoring of food handlers from university and hostel canteens

Several questions were asked to the food handlers of university and hostel canteens and on the basis of knowledge, attitude and practices regarding personal hygiene, workplace cleanliness and temperature control. No differences were observed between the knowledge, attitude and practices scores of hostels and university canteen food handlers as mentioned in Table 4. Total 60% of the responses were correct from the university and hostel food handlers regarding knowledge of personal hygiene, workplace cleanliness and temperature monitoring. Similarly, 50-60% of the responses regarding attitude and practices were correct from hostel and university canteen food handlers.

Microbiological analysis

Microbial assessment done in the current study is presented in Table 5. Canteens usually serve food in polyethylene bags and uncovered utensils and workers do not use safety gloves. These factors collectively have major contribution in food contamination. The TPC of 30 plates was ignored because of overgrowth or too few colonies to count. The presumptive test for 35 food samples out of 100 was positive and *E. coli* was also found in the same samples. The prevalence of *Salmonella* and *Staphylococcus aureus* was found in 29 and 57 samples, respectively. The results unveiled milk shake as the most contaminated food followed by water and juice where contamination of *Coliform* and *E. coli* was found. The elevated level of microbes might be due to inappropriate

Table 2. Assessment of knowledge, attitude and practices of food handlers for workplace cleanliness.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	P
Smoking should be allowed in the area of canteen?						
University Canteen	40 (22)	50 (28)	15 (8%)	40 (22)	35 (19)	0.000*
Hostel Canteen	0 (0)	0 (0)	10 (8)	50 (42)	60 (50)	
Floors/ceilings of the canteens should be in good condition and repaired?						
University Canteen	50 (28)	40 (22)	10 (6)	50 (28)	30 (17)	0.012*
Hostel Canteen	50 (42)	30 (25)	10 (8)	20 (17)	10 (8)	
Layout should permit adequate cleaning and sanitation?						
University Canteen	60 (33)	50 (28)	20 (11)	35 (19)	15 (8)	0.009*
Hostel Canteen	30 (25)	50 (42)	20 (17)	10 (8)	10 (8)	
There should be adequate provision of washing utensils?						
University Canteen	15 (8)	20 (11)	50 (28)	60 (33)	35 (19)	0.000*
Hostel Canteen	30 (25)	40 (33)	10 (8)	20 (17)	20 (17)	
Do you think you should wash all the utensils regularly before use?						
University Canteen	40 (22)	40 (22)	15 (8)	45 (25)	40 (22)	0.000*
Hostel Canteen	40 (33)	40 (33)	10 (8)	30 (25)	0 (0)	
You should wash all the ingredients before use?						
University Canteen	40 (22)	40 (22)	15 (8)	45 (25)	40 (22)	0.000*
Hostel Canteen	20 (17)	50 (42)	20 (17)	20 (17)	10 (8)	
You should store raw and cooked food separately?						
University Canteen	50 (28)	60 (33)	10 (6)	30 (17)	30 (17)	0.000*
Hostel Canteen	20 (17)	40 (33)	30 (25)	15 (13)	15 (13)	
You should use separate utensils to store different ingredients?						
University Canteen	50 (28)	60 (33)	10 (6)	30 (17)	30 (17)	0.000*
Hostel Canteen	20 (17)	25 (21)	15 (13)	40 (33)	20 (17)	
Do you save your food from flies?						
University Canteen	60 (33)	60 (33)	20 (11)	30 (17)	10 (6)	0.235
Hostel Canteen	40 (33)	30 (25)	10 (8)	30 (25)	10 (8)	
Do you reheat the leftover until steaming hot?						
University Canteen	20 (11)	50 (28)	60 (33)	40 (22)	10 (6)	0.009*
Hostel Canteen	20 (17)	30 (25)	30 (25)	20 (17)	20 (17)	
Do you touch food and money at the same time?						
University Canteen	80 (44)	70 (39)	10 (6)	10 (6)	10 (6)	0.226
Hostel Canteen	40 (33)	60 (50)	5 (4)	5 (4)	10 (8)	
You should wash dishes in clean hot, soapy water?						
University Canteen	20 (11)	30 (17)	60 (33)	40 (22)	30 (17)	0.014*
Hostel Canteen	5 (4)	15 (13)	30 (25)	40 (33)	30 (25)	
You should follow a cleaning schedule?						
University Canteen	30 (17)	40 (22)	50 (28)	40 (22)	20 (11)	0.139
Hostel Canteen	30 (25)	20 (17)	25 (21)	35 (29)	10 (8)	
You should control cockroaches inside the kitchen?						
University Canteen	70 (39)	80 (44)	10 (6)	10 (6)	10 (6)	0.000*
Hostel Canteen	20 (17)	40 (33)	10 (8)	30 (25)	20 (17)	
Do you properly cover your food?						
University Canteen	60 (33)	60 (33)	10 (6)	40 (22)	10 (6)	0.010*
Hostel Canteen	30 (25)	30 (25)	10 (8)	30 (25)	20 (17)	
You should use separate cutting boards for raw chicken meat?						
University Canteen	10 (6)	20 (11)	60 (33)	50 (28)	40 (22)	0.000*
Hostel Canteen	20 (17)	30 (25)	50 (42)	20 (17)	0 (0)	
Unhygienic conditions can cause harmful diseases?						
University Canteen	70 (39)	80 (44)	20 (11)	5 (3)	5 (3)	0.054
Hostel Canteen	50 (42)	50 (42)	5 (4)	5 (4)	10 (8)	
You should report all pest sighting?						
University Canteen	60 (33)	70 (39)	20 (11)	20 (11)	10 (6)	0.000*
Hostel Canteen	30 (25)	20 (17)	30 (25)	30 (25)	10 (8)	
Do you dispose of the food waste properly?						
University Canteen	50 (28)	40 (22)	50 (28)	20 (11)	20 (11)	0.000*
Hostel Canteen	20 (17)	30 (25)	10 (8)	40 (33)	20 (17)	
Working staff should be trained for hygienic working in canteen?						
University Canteen	90 (50)	80 (44)	0 (0)	5 (3)	5 (3)	0.000*
Hostel Canteen	40 (33)	30 (25)	30 (25)	10 (8)	10 (8)	
Do you check the expiry date of products?						
University Canteen	70 (39)	60 (33)	10 (6)	30 (17)	10 (6)	0.010*
Hostel Canteen	40 (33)	60 (50)	0 (0)	15 (13)	5 (4)	
Do you reuse the food leftover?						
University Canteen	40 (22)	30 (17)	50 (28)	30 (17)	30 (17)	0.000*
Hostel Canteen	20 (17)	15 (13)	5 (4)	50 (42)	30 (25)	

Chi-Square (α 0.05), data are presented as frequency (percentage).

food handling practices and inadequate washing of utensils. The results of previous study conducted by Akhtar *et al.* (2013) for exploring the microbiological quality of various juices in Multan, Pakistan indicated

the prevalence of total viable count 2.48 ± 0.16 log CFU/ml, *coliform* 0.70-4.86 ± 0.29 log CFU/ml and *E.coli*. 0.6 -3.83 log CFU/ml. In addition, *salmonella spp.* was also detected from various samples. Various

type of *Arcobacter* species were detected in South Korea resulting more than 45 % food samples including chicken, meat, and leafy green were contaminated (Kim *et al.*, 2019). Total aerobic bacteria and *Coliform* that

Table 3. Assessment of knowledge, attitude and practices of food handlers regarding temperature monitoring and supervision.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	P
Do you check the temperature of incoming food items?						
University Canteen	15 (8)	20 (11)	115 (64)	20 (11)	10 (6)	0.001*
Hostel Canteen	10 (8)	30 (25)	50 (42)	15 (13)	15 (13)	
Do you cook food to the right temperature?						
University Canteen	80 (44)	70 (39)	5 (3)	15 (8)	10 (6)	0.000*
Hostel Canteen	40 (33)	25 (21)	10 (8)	35 (29)	10 (8)	
Do you keep hot food hot and cold food cold?						
University Canteen	35 (19)	45 (25)	25 (14)	35 (19)	40 (22)	0.281
Hostel Canteen	15 (13)	35 (29)	20 (17)	30 (25)	20 (17)	
Do you thoroughly cook high risk foods?						
University Canteen	20 (11)	30 (17)	40 (22)	50 (28)	40 (22)	0.960
Hostel Canteen	15 (13)	20 (17)	25 (21)	30 (25)	30 (25)	
Do you check temperature of fridges and freezers?						
University Canteen	20 (11)	30 (17)	50 (28)	70 (39)	30 (17)	0.003*
Hostel Canteen	30 (25)	20 (17)	30 (25)	30 (25)	10 (8)	
Do you keep hot food at 60c and cold food below 5c?						
University Canteen	10 (6)	20 (11)	90 (50)	40 (22)	20 (11)	0.175
Hostel Canteen	10 (8)	20 (17)	50 (42)	20 (17)	20 (17)	
Do you maintain the proper temperature needed for all the ingredients?						
University Canteen	60 (33)	50 (28)	20 (11)	30 (17)	20 (11)	0.023*
Hostel Canteen	30 (25)	20 (17)	20 (17)	30 (25)	20 (17)	

Chi-Square (α 0.05), data are presented as frequency (percentage)

Table 4. Knowledge, attitude and practices scoring of food handlers from university and hostel area.

	Food handlers	Correct	Incorrect	P
Knowledge	University	108 (60)	72 (40)	1.000
	Hostel	72 (60)	48 (40)	
Attitude	University	88 (49)	92 (51)	0.903
	Hostel	60 (50)	60 (50)	
Practices	University	104 (58)	76 (42)	0.962
	Hostel	69 (57)	51 (42)	

Chi-Square (α 0.05), data are presented as frequency (percentage).

Table 5. Total plate count, and detection of *E.coli*, *Salmonella*, *S. aureus* from various food samples.

Samples	Total plate count, CFU/ml ($\times 10^7$)	Coliform	<i>E. coli</i>	Detection of <i>Salmonella</i> , (10^{-2})	Detection of <i>Staphylococcus Aureus</i>
Water	$3.6-8.6 \times 10^7$	5	5	1	3
Salad	$4.6-8.6 \times 10^7$	3	3		2
Milk Shake	$3.0-8.5 \times 10^7$	16	16	14	19
Samosa	$3.0-7.6 \times 10^7$			2	7
Chaat	$3.6-7.7 \times 10^7$			4	11
Juice	$3.0-9.8 \times 10^7$	7	7	4	7
Kebab	$3.7-6.4 \times 10^7$	1	1		2
Yogurt	$3.8-7.2 \times 10^7$	2	2		1
Bread	$3.4-7.2 \times 10^7$	1	1	3	3
Patties	$3.2-6.5 \times 10^7$	—	—	1	2
Total	$3.0-9.8 \times 10^7$	35	35	29	57

were found in different types of salads were 3.2x10⁶ and 1.9x10⁴ CFU/g respectively and 23.2% samples were contaminated with *S. aureus* (Adjrah *et al.*, 2013). A study in Namibia unveiled the presence of *Escherichia coli* (42%), *Listeria monocytogenes* (15%), *Shigella* (6%) and *Staphylococcus aureus* (52%) in ready to eat food samples. Moreover, *Enterobacteriaceae* were found in 83 % food samples (Shiningeni *et al.*, 2019). The high microbial load and prevalence of pathogenic microorganisms in food samples under study, endorsed the above results that the participants did not have basic food safety knowledge, attitude and practices mandatory to reduce the contamination.

Conclusions

The study explored that the knowledge, attitude and practices followed by food handlers need to be improved as these do not comply with standard hygienic procedure for food handling. Moreover, microbiological quality of food commodities requires improvement as many samples were contaminated and may contribute a human health hazard. Proper training of employees and strict monitoring of food industries or chains, *i.e.*, hotels, restaurants and canteens may assure better food safety. Raw material suppliers and all the entities directly or indirectly involved in the food business should be considered for monitoring as these may play a critical role in food borne illness. Food handlers lack a scientific approach towards food commodities that needs to be developed via training sessions. Overall, 60% of the responses were answered correctly from the university and hostel food handlers about the knowledge of personal hygiene, workplace cleanliness and temperature control. Likewise, 50-60% of the responses regarding attitude and practices were correct from both groups. Legislative authorities are there, for the implementation of food safety laws but they need to work smartly. Little changes and little efforts give big rewards and that is what required for overall improvement that may in turn reward safety to the consumers and well prestige to the handlers.

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