Evaluation of Environmental Hygiene and Microbiological Status of Selected Primary School Canteens

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ABSTRACT: X Primary School canteens in Kota Bharu, Kelantan were investigated on the hygiene level under which these premise operated and the microbiological status of the environmental hygiene. A simple random sampling was applied to select the school. The environmental samples collected included swab from food handles' hand, apron, chopping board, wipe clothes, spoon containers and knives. A structured checklist known as Food Premise Assessment Format was used for inspection and assessment of premise hygiene. Fisher's Exact Test was conducted to investigate the difference in microbiological status with environmental parameters. Thirty-two (32.7%) primary school canteens included in this study out of 98 listed school canteens. Majority of premises did not comply with pest control treatment (68.8%), management of refuse (50.0%), proper clothing of food handlers (46.9%), and proper personal hygiene (28.1%). Nine out of 32 (28.1%) primary school canteens selected randomly for microbiological study. Of 171 swabs taken from 9 schools, 90 (52.6%) were from food handles' hand, 45 (26.3%) from apron and 9 (5.3%) from chopping board, wipe clothes, spoon containers and knives each. Microbiological analysis showed the highest unsatisfactory results accounted for total plate count (62.0%) followed by total coliform (55.0%). Less than 5% of samples showed the presence of *Bacillus Cereus* and *E. Coli*. This study suggested that there is a need to have more effective training program of food handlers in school canteen in order to bring into positive behaviour toward good hygienic practices.

Keywords: environmental hygiene, microbiological analysis, school canteen, total plate counts, hygienic practices

Introduction

Food safety is a main concern for human health. The history of food safety is as old as human history ever since they started to recognise the food. Food is reported to be the major vehicle for food borne diseases and is the cause of up to 70% of the cases (Motarjemi and Käferstein, 1999). The most susceptible population groups for food borne diseases are children because they are more likely to become ill when exposed to food borne agents (Rodríguez-Caturla *et al*., 2011). Many reports showed that, current food borne disease outbreak in Malaysia mostly occurred in school and institution rather than in community (Meftahuddin, 2002; MOH, 2006; Soon *et al*., 2011) although mandatory food hygiene training has been given to all food handlers. In general, half of the food borne diseases from the early 1990s until today was associated with outbreaks in institutions and schools with 62% of the episodes in schools, followed by academic institutions (17%) while community gatherings accounted for 8% (Soon *et al*., 2011).

A comparison of data from the Centers for Disease Control (CDC) showed very little change in the incidence of food borne illness caused by common pathogens between 2008 and the three preceding years (2005–2007). Thus, food borne illness remains a persistent problem in the United States despite of intensified prevention efforts (Nyachuba, 2010). In 1991, over 250,000 cases of cholera epidemic swept over the Latin American continent, resulting about 2,700 deaths within one year. A few years later, a newly recognised type of disease, the enterohaemorrhagic *Escherichia coli* (EHEC) infection, seized Japan and affected more than 9,500 people in only one single outbreak. Main victims were school children and 11 people died (Motarjemi and Käferstein, 1999). More than 59% of food borne disease outbreaks between 1993 and 1998 in Europe and 55% in Spain during 2004–2007 were attributed to catering businesses consecutively (Rodríguez-Caturla *et al.*, 2011).

Based on National Health and Morbidity Survey III (NCHMS III), the overall incidence of self-reported acute diarrheal illness within a two weeks period in Malaysian population was 5.0% (95% CI: 4.8 – 5.2) or 1,036,518 episodes. The reported highest incidence was among teenagers aged 15-19 years old and 25.6% of the diarrheal cases sought time off either time off from work, school or carrying out normal activities (MOH, 2006). Food poisoning cases was on the rise as evident by the incidence rate of 62.47 cases per 100,000 population in 2008 and 36.17 in 2009 (*Soon et al*., 2010). Most of raw foods, including raw meats and vegetables have been contaminated by potential food borne pathogens such as *Salmonella, Listeria spp.* and *E. coli O157:H7*. *Salmonella* were detected from 35% of the vegetables samples examined in Selangor, Malaysia (Awang Salleh et al., 2003), and they were also found in 32% of the raw foods (chicken pieces, liver and gizzard) and 17% of the ready-to-eat cooked foods (including cooked chicken meat, beef, prawns and satay) (Arumugaswamy *et al.,* 1995).

Food borne disease occurs whenever a person consumes food that contains enough live germs (bacteria, viruses, or parasites) or their toxins that can affect human health. The most common known bacterial agents accountable for food borne diseases are *Salmonella* spp, *E. coli*, *Campylobacter*, *Shigella, Listeria* and *Vibrio* (CDC, 2009; Olsen et al., 2000). Once infected by any enteric pathogen, a person can continue to carry the bacteria/virus in the intestinal tracks and stool for a long period without showing symptoms. Therefore, fecal-oral transmissions can become a major route of infection if good personal hygiene is not practiced (Rodríguez-Caturla *et al.*, 2011; Simonne *et al.,* 2010).

Hence, the role of food handlers is truly significant in the prevention of food borne diseases by maintaining and improving the food handling practices and personal hygiene since they could be the mechanical agents which contaminate food (Campos *et al.,* 2009). However, direct inspection of personal hygiene and premise sanitation are still unsatisfactory and underlines the need to improve (Legnani *et al.,* 2004). Food handlers tend to self-evaluated their food safety practices and premise sanitation as higher than their actual practices deserved (Park *et al.,* 2010). As reported by Veiros *et al.* (2009), there were lack of hand washing facilities, unavailability of detergent for hand washing that will compromise the quality, and safety of food served.

Personal hygiene especially in regards to those handling food is very crucial. Human bodies carry a variety of microorganisms some of which are non-pathogenic (not disease causing), while others are pathogenic (disease causing). The most common potentially pathogenic bacteria isolated from hands of food handlers were *Bacillus* spp. (28.6%), *E. coli* (22%), *Enterobacter* spp. (14.6%), *Klebsiella* spp. (13.3%) and *S. aureus* (12.6%) (Shojaei *et al*., 2006). Meanwhile, most of ready to eat food were unsatisfactory in term of being highly contaminated with anaerobic colony counts, total coliform, *E. coli*, *S. aureus* and *Bacillus spp* (Edema and Omemu, 2004). Various bacteria including *S. aureus* and *E. coli* can survive on hands and surfaces for hours or even days after initial contact with the microorganisms (Lues and Van Tonder, 2007).

Therefore, the indicator organisms commonly being associated with hygiene practices include, amongst others, total viable counts, total coliforms, *E. coli*, members of the family Enterobacteriaceae and *S. aureus*. The detection of coliforms is widely used as a means of measuring the effectiveness of sanitation programmes and their presence could indicate a substantially increased risk of the presence of pathogens (Lues and Van Tonder, 2007). *E. coli* is normally absent from hands and its presence is thought to give a better indication of faecal contamination (enteric pathogens in particular) than the entire group of Enterobacteriaceae (De Wit and Rombouts, 1992).

Materials and Methods

A cross sectional study was conducted in 32 primary school canteens. The study was conducted between January 2013 and September 2013. The target study concern were thirty-two school canteen, 45 food handlers, nine chopping board, knife, wipe-table cloth and spoon container each. A two-stage sampling was applied in this study. The first stage involved a simple random sampling to choose 32 schools out of 98 using an Excel® programme for random sampling (Naing, 2002). The second stage of sampling was to select nine schools for microbiological sampling using simple random sampling as well.

The Food Premise Assessment Format (BORANG KKM-PPKM-2/09) was used to assess the school canteen hygiene level via premise inspection. The inspection identifies 31 types of violations, including items defined as "critical" (high risk to cause food borne disease) or "non-critical" (less risk to cause food borne disease). Scores was calculated by deleting marks, weighted for severity, from a perfect inspection score of 100 (no noted violations), thus inspection scores can range from 0 to 100. To fill in this form, researcher did a premise inspection and examination from the running of the food preparation up to display of cooked or ready-to-eat food. Similar trained person did premise inspection in order to avoid inconsistency in the evaluation procedures. In addition, food handlers were not informed about the day of the visit to avoid biases of false practice when they were evaluated.

The microbiological analysis was done by taking a swab from food handlers' hand, apron and from chopping board, knife, table wipe cloth and spoon container. Five indicator organisms were inoculated to be able to assess the hygiene status of utensils and personal hygiene of food handlers. The chosen indicator organisms were total plate count (TPC), total coliforms (TC), *Escherichia coli (E. coli)*, *Bacillus cereus (B. cereus)* and *Staphylococcus aureus (S. aureus)*.

Swab was taken using a sterile cotton swab wet with 0.1% Pepton Water. After swabbing, the swab head was gently immersed in the 0.1% Pepton Water. At the same day, the sample was serially diluted ten-fold in sterile 0.1% peptone up to 10^4 dilutions. Colony forming units (cfu) were determined using the surface spread plate method inoculated on following media, temperatures and incubation periods: Nutrient agar (Oxoid, U.K.) 37 °C, 24-48 hrs; MacConkey agar (Oxoid, U.K) 37 °C, 24 hrs; MacConkey agar (Oxoid, U.K) 44.5 °C, 24-48 hrs; Baird Parker agar (Oxoid, U.K) 37 ^{o}C, 48 hrs; and Bacillus Cereus agar (Oxoid, U.K) 37 ^{o}C, 24 hrs. The colonies of the above microorganisms were differentiated based on their appearance and color and reported as presumptive result. The present of red non-mucoid (lactose fermenter) colony on MacConkey agar incubated at 44.5 ^{o}C was further inoculated on Eosin-methylene blue agar (Oxoid, U.K) at 37 ^{o}C for 24 hrs for confirmation of *E. coli*.

Number of colonies counted further classified as satisfactory and unsatisfactory. TPC was considered unsatisfactory if≥10 colonies counted from cleaned and prior to use template area swab or≥10^3 colonies counted from in use ready-to eat food contact template area swab. For TC, unsatisfactory was refer to colonies counted≥1 from cleaned and prior to use template a rea swab or≥10^2 from in use ready-to eat food contact template area swab (Willis *et al.*, 2012). Unsatisfactory level for *S. aureus* was defined as the present of≥1 colonies regardless of any type of template area surface. *E. coli* and *B. cereus* were reported as absent or present only.

All data entry and statistical analyses were performed using the PASW version 18.0 software. The data was first analysed using descriptive statistic and presented as frequency and percentage (%) for categorical data. For numerical data, results were presented as mean and standard deviation (SD). Fisher's Exact Test was used to determine the difference of microbiological level and sources of swab, surface of utensils and condition of utensils. All the statistical significance was accepted at *p* less than 0.05.

Ethical consideration

The research committee of Universiti Sains Malaysia granted ethical approval (Reference No: USMKK/PPP/JEPeM [259.3. (16)]). Written informed consent was obtained from the participants prior to the study. This study was approved by Malaysian Education Ministry [Reference No: KP(BPPDP)603/5/JLD.02(43)].

Results

Premise hygiene and sanitation

A total of 32 primary school canteens were successfully recruited. Majority of premises did not comply with pest control treatment (68.8%), management of refuse (50.0%), proper clothing of food handlers (46.9%), hand washing facilities (40.6%) and proper personal hygiene (28.1%). Eight (25.0%) premises hired workers who did not undergo medical examination and food handling training.

Critical control point procedure were cot complied by six (18.8%) premises, which included refrigerator temperature more than 5 ^{o}C (three premises), raw chicken meat kept at temperature more than 5 ^{o}C (two premises), and cooked eat chicken kept on room temperature more than 5 hours (one premise). Preventive steps for cross contamination was violated by six (18.8%) premises, encompassed of raw and cooked food not well covered and stored in contact each other, used unhanded and dirty ice dipper, handled food by hand, dirty cutting blade, dirty glass and glass tray and unsatisfactory table cloth.

Microbiological analysis

From the 171 swabs collected from nine schools, 90 (52.6%) were food handlers' hand, 45 (26.3%) from apron and nine (5.3%) from chopping board, wipe table clothes, spoon containers and knives each. The minimum duration of cleaned aprons worn prior washing was one day and the maximum was four days. Majority of chopping boards used for cutting raw fruits or vegetables and most with good surface condition as shown in Table 1.

Table 1: Characteristics of samples for microbiological analysis of indicator organisms

Swab area		**Frequency**	**Percentage**
Food handlers' hand (n=90)	Right hand	45	100
	Left hand	45	100
Cleaned apron (n=45)	Duration used (day)	2.18[Ж]	1.353[Ж]
Chopping board surface (n=9)	Clean	4	44.4
	In used/used	5	55.6
Chopping board condition (n=9)	Good	8	88.9
	Bad	1	11.1
Chopping board used for (n=9)	Raw fruit/vegetable	6	66.7
	RTE food	3	33.3
Knife surface (n=9)	Clean	5	55.6
	In used/used	4	44.4

[Ж] Mean (SD)

Microbiological analysis showed the highest unsatisfactory results accounted for TPC (62.0%) followed by TC (55.0%) and *S. aureus* (42.1%). Less than 5% of samples showed the present of BC and *E. Coli* as illustrated in Table 2.

Table 2: Summary of microbiological analysis from food handlers and environmental swabs (n=171)

Microbiological analysis[€]		**Frequency**	**Percentage**
TPC	Satisfactory	65	38.0
	unsatisfactory	106	62.0
TC	Satisfactory	77	45.0
	unsatisfactory	94	55.0
S. aureus	Satisfactory	99	57.9
	unsatisfactory	72	42.1
BC	Absent	164	95.9
	Present	7	4.1
E. coli	Absent	163	95.3
	Present	8	4.7

[€]Unsatisfactory level for:

TPC: ≥10 cfu (cleaned and prior to use template swab area), $\geq 10^3$ cfu (in use template swab area)

TC: ≥1 cfu (cleaned and prior to use template swab area), $\geq 10^2$ cfu (in use template swab area)

E. coli and S. aureus: ≥1 cfu

Spoon containers were found to be unsatisfied with 88.9% of TPC, 77.8% of TC, 55.6% for *S. aureus* and also 22.2% with the presence of *E.coli* and 11.1% with *B. cereus*. Whereas, 100%, 77.8% and 55.6% of table wipe cloth were unsatisfied for TPC, TC and *S. aureus*, respectively. None of table wipes cloth shows present of *B. cereus* but 22.2% of them were found with *E. coli*.

More than half of hands' swab were not satisfied for TPC, however, no significant different was found between right hand and left hand. For TC, more than 45% of hands' swab was unsatisfied and more than 44% unsatisfied for *S. aureus*. Similar results showed no different between right and left hand. Conversely, less than 4% of these swabs showed unsatisfactory results for *B. cereus* and *E. coli*. Refer to Table 3 for details.

Table 3: Microbiological results of swabs from food handlers' hand (n=90)

Microbiological analysis[€]		**Total swabs**	**Right hand**	**Left hand**	**p-value***
TPC	Satisfactory	40 (44.4%)	20 (44.4%)	20 (44.4%)	1.000
	Unsatisfactory	50 (55.6%)	25 (55.6%)	25 (55.6%)	
TC	Satisfactory	49 (54.4%)	22 (48.9%)	27 (60.0%)	0.397
	Unsatisfactory	41 (45.6%)	23 (51.1%)	18 (40.0%)	
E. Coli	Absent	89 (98.1%)	45 (100%)	44 (97.8%)	1.000
	Present	1 (1.1%)	0 (0%)	1 (2.2%)	
S. aureus	Satisfactory	50 (55.6%)	22 (48.9%)	28 (62.2%)	0.289
	Unsatisfactory	40 (44.4%)	23 (51.1%)	17 (37.8%)	
B. cereus	Absent	87 (96.7%)	45 (100%)	42 (93.3%)	0.242
	Present	3 (3.3%)	0 (0%)	3 (6.7%)	

*Fisher's Exact Test

[€]Unsatisfactory level for:

TPC: ≥10 cfu (cleaned and prior to use template swab area), $\geq 10^3$ cfu (in use template swab area)

TC: ≥1 cfu (cleaned and prior to use template swab area), $\geq 10^2$ cfu (in use template swab area)

E. coli and S. aureus: ≥1 cfu

From chopping board swabs, 88.9% (8), 88.9% (8), 22.2% (2) and 44.4% (4) were unsatisfactory for TPC, TC, *E. coli* and *S. aureus*, respectively. None of these swabs showed the presence of *B. cereus*. No significant difference for chopping board surface, condition and used for in relation with indicator organisms level as illustrated in Table 4.

Table 4: Microbiological results of swabs from Chopping board (n=9)

Microbiological analysis[€]		**Chopping board surface, n (%)**			**Chopping board condition, n (%)**			**Chopping board used for, n (%)**		
		Clean	**In used/ used**	***P****	**Good**	**Bad**	***P****	**Raw fruits/ vege**	**RTE food**	***P****
TPC	Satisfactory	1 (25.0%)	0 (0%)	0.444	1 (12.5%)	0 (0%)	1.000	1 (16.7%)	0 (0%)	1.000
	Unsatisfactory	3 (75.0%)	5 (100%)		7 (87.5%)	1 (100%)		5 (83.3%)	3 (100%)	
TC	Satisfactory	1 (25.0%)	0 (0%)	0.444	1 (12.5%)	0 (0%)	1.000	1 (16.7%)	0 (0%)	1.000
	Unsatisfactory	3 (75.0%)	5 (100%)		7 (87.5%)	1 (100%)		5 (83.3%)	3 (100%)	
E. Coli	Absent	3 (75.0%)	4 (80.0%)	1.000	6 (75.0%)	0 (0%)	1.000	5 (8.03%)	2 (66.7%)	1.000
	Present	1 (25.0%)	1 (20.0%)		2 (25.0%)	1 (100%)		1 (16.7%)	1 (33.3%)	
S. aureus	Satisfactory	3 (75.0%)	2 (40.0%)	0.524	4 (50.0%)	1 (100%)	1.000	3 (50.0%)	2 (66.7%)	1.000
	Unsatisfactory	1 (25.0%)	3 (60.0%)		4 (50.0%)	0 (0%)		3 (50.0%)	1 (33.3%)	
BC	Absent	4 (100%)	5 (100%)	-	8 (100%)	1 (100%)	1.000	6 (100%)	3 (100%)	-
	Present	0 (0%)	0 (0%)		0 (0%)	0 (0%)		0 (0%)	0 (0%)	

*Fisher's Exact Test

[€]Unsatisfactory level for:

TPC: ≥10 cfu (cleaned and prior to use template swab area), $\geq 10^3$ cfu (in use template swab area)

TC: ≥1 cfu (cleaned and prior to use template swab area), $\geq 10^2$ cfu (in use template swab area)

E. coli and S. aureus: ≥1 cfu

Nearly 90% of knives showed TPC at unsatisfactory level. Additionally, 78% of samples showed also unsatisfied outcome for TC. *S. aureus* found to be almost 44% were unsatisfactory results. Moreover, nearly a quarter of these samples elicited unsatisfactory results for *B. cereus*. Surprisingly, none of these swabs revealed the presence of *E. coli* as shown in Table 5. However, there was no significant difference between microbiological level and knife surface.

Table 5: The occurrence of microorganisms on knives of primary school canteens (n=9)

Microbiological analysis[€]		**Total swabs**	**Knife surface**		**p-value***
			Clean	**In used/used**	
TPC	Satisfactory	1 (11.1%)	1 (20.0%)	0 (0%)	1.00
	Unsatisfactory	8 (88.9%)	4 (80.0%)	4 (100%)	
TC	Satisfactory	2 (22.2%)	1 (20.0%)	1 (25.0%)	1.00
	Unsatisfactory	7 (77.8%)	4 (80.0%)	3 (75.0%)	
E. coli	Absent	9 (100%)	5 (100%)	4 (100%)	-
	Present	0 (0%)	0 (0%)	0 (0%)	
S. aureus	Satisfactory	5 (55.6%)	3 (60.0%)	2 (50.0%)	1.00
	Unsatisfactory	4 (44.4%)	2 (40.0%)	2 (50.0%)	
B. cereus	Absent	7 (77.8%)	5 (100%)	2 (50.0%)	0.167
	Present	2 (22.2%)	0 (0%)	2 (50.0%)	

*Fisher's Exact Test

[€]Unsatisfactory level for:

TPC: ≥10 cfu (cleaned and prior to use template swab area), $\geq 10^3$ cfu (in use template swab area)

TC: ≥1 cfu (cleaned and prior to use template swab area), $\geq 10^2$ cfu (in use template swab area)

E. coli and S. aureus: ≥1 cfu

Discussion

This study evaluated the school canteen hygiene and sanitation status based on inspection and microbiological detection of indicator organisms. Six indicator organisms, namely TPC, TC, FC, *E. coli*, *B.cereus* and *S. aureus* were used to reflect the hygiene and sanitation status of premise environment. Lues and Tonder (2007) had used these indicator organisms as a mean to measure the sanitation and risk for cross contamination to food.

Our study found that majority of premises did not comply with pest control treatment (68.8%), management of refuse (50.0%), proper clothing of food handlers (46.9%), hand washing facilities (40.6%) and proper personal hygiene (28.1%). Additionally, eight (25.0%) premises hired workers who did not underwent medical examination and food training course. The percentage of nonfunctional hand washing facilities including toilet was 15% to 48% by other study carried in restaurants (Cotterchio, Gunn, Coffill, Tormey, & Barry, 1998). Similar study also reported that poor pest control was between 48% and 70%. The failure to practice good environmental hygiene found in this study could compromise food safety and introduce the risk of foodborne illness. According to Food and Drug Administration Food Code, environmental aspects that come in concern for food premises in combating food borne diseases are effective pest control programme as well as the, proper storage and disposal of garbage and refuse. Besides, the hand washing facilities should properly equipped, conveniently located, well maintain and never be used for purpose other than hand washing (McSwane *et al*., 2004).

There is a direct correlation between poor personal hygiene and food borne illness because it could contaminate the food during the performance of their activities. Food handlers can be the carriers of organisms such as *salmonella, staphylococci,* and other gastrointestinal microbes like *E. coli.* They also frequently serve as efficient vehicles for transmission of food poisoning organisms from raw food to cooked or processed foods (Oteri and Ekanem, 1989). Bacteria, viruses, and parasites (microscopic parasites) could be spread by multiple means such as unwashed hands or contaminated gloves, employees who touch their faces and mouths with their hands and unwashed and poorly sanitized preparation surfaces, utensils, and preparation areas (Simonne *et al.*, 2010).

Properly equipped and convenient hand washing facilities are crucial in preventing food borne disease. Even though this study did not assess specifically on hand washing practice, but lack of this facility would contribute to difficulty in full practice of regular hand washing. Inadequate hand washing by workers was reported by Mitchell *et al.* (2007) where over 53% of fast food restaurants and 72% of full service restaurants in United States were out of compliance in this regard. Study among restaurant workers reported that poor hand washing and hygiene was noted between 18% and 30% (Cotterchio *et al*., 1998). CDC stated that contaminated hands could be the most important means by which enteric organisms were transmitted (Lillquist *et al*., 2005).

The most crucial item that can contribute to the high risk of food borne disease is critical control point. Current study found that there were a violation of refrigerator temperature and the time to keep high-risk food, as well as the lack of complete separation between raw and cooked foods in preventing cross contamination. This finding was parallel with results reported by Legnani *et al*. (2004) in which incorrect food stores and failure in separation of raw and cooked food were the most common mistakes done by food handlers. The issue of food safety among food handlers much related with behavioral sciences. Even though, all food handlers mandatorily have to attend food safety training program, however they failed to practice a safe food handling and good environment for food preparation. Food safety training program provided knowledge to food handlers with the expectation that workers will transform the knowledge into practice. However, knowledge alone is not sufficient to change the behavior (Green, 2008).

Considering all types of surface swab taken, 62% were not conforming to the acceptable limit for TPC, 55% for TC and 47.4% for FC. Lues and Van Tonder (2007) reported that coliforms contaminated surface samples from the food preparation in 56% of the cases, and 20% to 38% of food handlers' hand. Coliform bacteria may pose a serious health risk to the children when this organism contaminated their food (Edema and Omemu, 2004).

Out of all types of surface swab taken, 42.1% were contaminated with *S. aureus* including hand swabs (44.4%), chopping boards (44.4%), knives (44.4%) and spoon containers (22.2%). These organisms could be a serious cause of food spoilage and they may contaminate food during cutting, chopping or mixing and also ready to eat food by contamination from utensils (Edema

and Omemu, 2004; Lues *et al.*, 2006). *S. aureus* is known to produce an enterotoxin of importance in food-borne illness (edema 2004). The presence of *S. aureus* could be introduced by food handlers since they are common inhabitants of the skin and mucous membranes. Talaro and Talaro (1999) reported that 20% to 60% of normal healthy adults were the carriers of these organisms (Lues *et al*., 2006). Observation of food preparation practices reported by similar study indicated that food handlers used knives that not properly sanitised for cutting and chopping of raw vegetables. The cooking utensils also constitute a health risk when stored on the open table, where they can be readily contaminated with food-poisoning organisms from raw food and from environment (Edema and Omemu, 2004).

E. coli contaminated chopping boards and spoon containers in 22.2% of samples each and in 1.1% of hand swabs. *E. coli* is a members of the bacterial family Enterobacteriaceae that normally live in the intestinal tracts of human and animals. *E. coli* from animal and human intestines may also contaminate the water used during food preparation and cleaning the cooking utensils. The presence of *E.coli* on the surface swabs indicates direct or indirect fecal contamination from the hands of food handlers and/or from contaminated working surfaces and utensils. This represents insufficient cleanliness in food handling and improper food storage (Edema and Omemu, 2004). Therefore, particular attention in regards to proper personal hygiene especially hand washing after visiting the toilet or touch dirt area and sanitisation of cooking utensils were of utmost importance.

B. cereus is a spore-forming bacteria that are commonly found in soil, water (through soil-water contamination) and on vegetables. Current study found that less than 5% of all collected samples contaminated with *B. cereus* where the highest environmental contamination was knives (22.2%) followed by spoon containers (11.1%) and food handler' hands (3.3%). Current study much lower compared to *B. cereus* contamination found on 30% of food vendors' mobile phones as reported by Ilusanya *et al.* (2012). Users never washed their mobile phone either using water or sanitiser would be the reason for the presence of these organisms as compared to cooking utensils.

B. cereus can pose health risk on contaminated food (Edema and Omemu, 2004; Granum, 2013; Stenfors *et al*., 2008). Among food-borne disease outbreaks where a causative agent identified, *B. cereus* accounted for 12% of cases (Stenfors Arnesen *et al.*, 2008). The presence of *B. cereus* cells or spores may occur during cross-contamination of food and accompany plant material into food production areas cooking utensils. Failure to follow basic food preparation rules such as inadequate cooling, prolonged stored food at ambient temperature or heat keeping at below 60 ^{o}C, may allow growth of *B. cereus* (Stenfors Arnesen *et al.*, 2008).

Conclusion

It is evident that potential risks of school children contracting food-borne disease(s) by consumption of food from unhygienic school canteen and food handlers. This study was an indicative of degree of ignorance and lack of practicing hygienic behaviour. The needs for improving infrastructure, especially in terms of the establishment of proper pest control treatment, management of refuse and hand washing facilities are urgent. Practices regarding critical control point shall emphasised during food safety training and regular visit by health staffs. Although all food handlers mandatorily have to attend food safety training, but it appeared to be less effective when correlated to their actual practices and microbiological finding. Apart from knowledge, food handlers may need more strengthening and continuous empowerment of their skills and effective follow up on monitoring when trainees returned to the workplace.

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