International Journal of Research

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 07 Issue 10
October 2020

Microbial Quality Assessment Of Foods Served To Students In Select High School Canteens In Eastern Visayas, Philippines

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Abstract

Numerous foodborne disease outbreaks are reported to occur in schools. In the present study, the microbialquality of foods including drinking water being served to students in select school canteens in Eastern Visayas, Philippines was investigated. An incidence of high aerobic plate count (APC) (78 %) in fully-cooked foods was seen for school canteens classified as "poor" with minimum and maximum values of 2.32 and 8.04$\log_{10}$coliform forming unit (CFU) g^{-1} while this was only 22 and 11 % for school canteens classified as "medium" and "good", respectively. Incidence of high APC was also noted for fully-cooked food requiring further handling prior to consumption (66 %) and in sweet desserts (67 %) in school canteen classified as "poor". The levels of *Escherichia coli*in most food samples belonging to different food groups were in conformity with the permissible limits of the Health Protection Agency (< 10 CFU g^{-1}). Strikingly, incidence of high heterotrophic plate count (HPC)in drinking water was noted in all school canteens irrespective of its classification (> 500 CFU g^{-1}). Levels of APC isolated from food handlers and contact surfaces exceeded the permissible limit of ≤1.65$\log_{10}$ CFU/g. Overall, the findings from this study indicate the importance of providing support and input for public health program including trainings on good manufacturing practices (GMPs) and Hazard Analysis and Critical Control Point (HACCP) principles among food handlers in the region in order to improve the quality of food delivered in school canteens and to promote the significance of good hygiene practices.

Keywords: School canteens, microbial quality, contact surfaces, water quality, school meals

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e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 07 Issue 10
October 2020

1. Introduction

Food is a basic human right (Hossain et al. 2019). It provides nutrient so we can grow, be active and healthy. However, very often we come across illnesses attributed to wrong consumption of food or to ingestion of contaminated food. Since we consume food every day, it is likely to forget that food can also become source of potentially dangerous bacteria if it is not handled, prepared and stored correctly.

Foodborne diseases are widespread both in developed and more so in developing countries and several of these outbreaks are reported to happen in schools(Nicholas et al., 2002). In Japan, for example, 11,826 foodborne cases were reported between May and December 1996, 12 of which resulted to death from *Escherichia coli* O157:H7 infection. School lunches that were served in elementary and nursey schools were the major sources of this food infection(Michino&Otsuki 2000). In Brazil, schools were reported responsible for 11.6% of the foodborne disease outbreaks in 2005 (Santana et al. 2009). Outbreaks of foodborne diseases were also noted in countries such as Malaysia where 48 % of the total food poisoning cases that took between 2007 and 2008 occurred in school canteens (Aziz &Dahan 2013). The Philippines is no exemption. Infact, from March to April 2005, a least 7 major outbreaks were reported resulting in 200 morbidities and 27 mortalities. Earlier records from 1995 until 2004 showed that out of 20 % foodborne outbreaks, 15 % involved schools and workplaces (Avanza 2004). In many cases, approximately half of the reported foodborne illnesses happened in younger children below 15 years old (Pew Health Group and Center for Foodborne Illness Research & Prevention2011).

The role of food handlers in providing safe food thus preventing the occurrence of foodborne diseases in schools cannot be underestimated (Medeiros et al. 2004).Hence, food handlers' practices should be given serious attention and evaluation of the quality and safety of foods in school canteens is necessary(Avanza2004).It is therefore the aim of the present study to evaluate the microbial quality of the food served to students in select public and private high school canteens in Eastern Visayas, Philippines to determine whether foods served in these establishments are of good quality. Microbial quality of food handlers' hand and selected food preparation surfaces are also assessed.

2. Methodology

2.1 Selection of School Canteens

Earlier paper of Pascual&Abenis (2016) identified a total of twenty-two (22) high school canteens of which fifteen (15) comes from the public and seven (7) comes from the private schools in Eastern Visaya Philippines. These canteens prepared food following the "cook-serve" method characterized by on-premises preparation of food from a raw state on a daily basis for each meal (Marzano &Balzaretti 2011). Following a checklist adopted from Santana et al. (2009), these canteens were classified by the authors as: Excellent: 9.1–10; good: 7.0–9.0; medium: 5.0–6.9; poor: 2.0–4.9; and very poor: 0–1.9 (Table 1 and Table 2). On the basis of this classification, three (3) school canteens were randomly selected for microbial evaluation, these are: school A8, a public school which obtained a score of 3.94 (classified as "poor"), school A7, a public school with a score of 5.45 (classified as "medium") and school B4, a private school which obtained a score of 8.51 (classified as "good").

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p-ISSN: 2348-795X
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Table 1. Classification of sanitary conditions of different public high schools in Eastern Visayas (Pascual&Abenis 2016)

School	Part 1 K=5	Part 2 K=10	Part 3 K=15	Part 4 K=25	Part 5 K=20	Part 6 K=25	Mean of Scores	Classification
A6	0.00	3.62	7.20	6.25	3.33	12.03	3.24	Poor
A3	0.00	1.37	6.00	6.25	10.00	12.96	3.65	Poor
A8	0.00	2.24	3.60	6.25	10.00	17.39	3.94	Poor
A11	0.00	4.13	7.20	6.25	10.00	17.39	4.49	Poor
A9	0.00	4.65	7.20	6.25	10.00	17.77	4.58	Poor
A1	0.00	2.06	9.60	6.25	10.00	19.56	4.74	Poor
A2	0.00	4.82	6.00	6.25	10.00	20.65	4.77	Poor
A10	0.00	3.96	7.20	6.25	10.00	20.65	4.80	Poor
A4	0.00	3.79	7.80	6.25	10.00	20.37	4.82	Poor
A13	0.00	3.10	6.00	6.25	10.00	20.65	5.10	Medium
A14	0.00	5.86	9.60	9.37	10.00	16.66	5.14	Medium
A12	0.00	4.48	10.20	6.25	10.00	21.73	5.26	Medium
A15	0.00	4.13	9.60	12.5	10.00	17.39	5.36	Medium
A5	0.00	4.65	7.20	12.5	10.00	19.56	5.39	Medium
A7	1.66	4.48	8.40	9.37	10.00	20.65	5.45	Medium

Part 1 = permit and certificates
Part 2 = facility-design
Part 3 = utensils and equipment-maintenance
Part 4 = personal hygiene
Part 5 = quality of raw and ready to eat food
Part 6 = flow production/handler/serve and quality control

Excellent = 9.1–10
Good = 7.0–9.0
Medium = 5.0–6.9
Poor = 2.0–4.9
Very poor = 0–1.9.

Table 2.Classification of sanitary conditions of different private high schools in Eastern Visayas (Pascual&Abenis2016)

School	Part 1 K=5	Part 2 K=10	Part 3 K=15	Part 4 K=25	Part 5 K=20	Part 6 K=25	Mean of Scores	Classification
B5	0.00	2.75	6.00	6.25	10.00	15.21	4.02	Poor
B2	0.00	4.48	7.20	6.25	10.00	18.51	4.64	Poor
B7	0.00	4.65	7.20	7.81	10.00	20.37	5.00	Medium
B6	0.00	3.27	7.80	12.5	10.00	17.59	5.11	Medium
B3	0.00	5.34	12.60	6.25	10.00	19.56	5.37	Medium
B1	0.00	5.51	13.20	12.50	10.00	19.56	6.07	Medium
B4	5.00	6.72	15.00	15.62	20.00	22.82	8.51	Good

Part 1 = permit and certificates
Part 2 = facility-design
Part 3 = utensils and equipment-maintenance
Part 4 = personal hygiene
Part 5 = quality of raw and ready to eat food
Part 6 = flow production/handler/serve and quality control

Excellent = 9.1–10
Good = 7.0–9.0
Medium = 5.0–6.9
Poor = 2.0–4.9
Very poor = 0–1.9.

2.2Sample collection

2.2.1 Food Ready for Consumption

Ready-to-eat (RTE) food samples were collected directly from the kitchen of the three different school canteensclassified as “poor”, “medium” and “good” in terms of sanitary conditions. Samples were obtainedin the morning from 9 a.m. until 12:00 noon wheremeals are

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p-ISSN: 2348-795X
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regularly served. During sampling, aseparate triplicate of 250 gof each food type was collected in a sterile plastic bag. RTE foods were subsequently subdivided into three (3) groups, namely: the fully cooked, fully cooked with further handling before consumption and sweet desserts(Table 3). All samples were kept in one 25-L styrofoam box (36 cm long 9 26 cm wide 9 27 cm deep and 2.0 cm thickness) with ice. The lid of the styrofoam box was sealed using packaging tape. Samples were immediately transported to the Department of Science and Technology (DOST) VIII-Regional Standards and Testing Laboratories situated in Palo, Leyte Philippines for microbial analysis.

Table3. Ready-to-eat (RTE) foodsaccording to their method of preparation.

Ready-to-eat food	Description
Group A- *Fully cooked*	Foods that are served immediately after cooking. Includes spaghetti, burgers, fried chicken and most viands.
Group B- *Fully cooked with further handling before consumption*	Includes cooked meat and rice that are portioned or food that are further sliced/portioned and placed in separate containers before serving. Examples are *chopsuey*, rice, young jackfruit fruit stewed in coconut milk(*ginataang-langka)*, taro leaves-coconut milk stew (*laing*), sautéed chayote, roasted whole chicken or meat.
Group C- *Sweet desserts*	Includes *kakanins*, sweetened banana, individual cakes, pastries, banana andsweet potato cue, etc.

2.3. Utensil and other Food Contact Surfaces

Microbial samples from utensils and other food contact surfaces such as spoons and forks, chopping boards, plates and food preparation tables were collected in triplicate prior to meal preparation using the swab method (Santana et al.2009) Briefly, a sterilized cotton-tipped swabwas moistened with diluents and subsequently scraped longitudinally at 1-2 times into the surface of interestof approximately 10 cm^2 in surface area. Swab, now containing the microorganisms, was moistened again with diluent and the swabbing procedure was repeated three (3) times. All samples were kept and sent to the DOSTVIII-Regional Standards and Testing Laboratories DOST as previously mentioned for RTE foods.

2.4. Food handlers

Sterile swabs were used to take samples from the hands of the cooks and food servers. Sample collection (in triplicates)was done prior to handling foods in the preparation, cooking and serving areas. Sample collection procedures applied for utensils and contact surfaces were also applied for food handlers. All samples were kept and sent to the DOSTVIII-Regional Standards and Testing Laboratories DOST as previously mentioned for RTE foods.

2.5. Water

The microbial quality of both tap and drinking water were analyzed. Before sampling, water from the faucet was left to run for about 3 minutes. Water samples (in triplicates) collected from the faucet and from drinking water dispensers were kept in autoclaved glass bottles. All samples were kept and sent to the DOSTVIII-Regional Standards and Testing Laboratories DOST for analysis.

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2.6. Microbial analysis

2.6.1.Food, Food handlers and Utensils

Microbial analyses on different food groups, food handlers and utensils were focused on the presence of spoilage-microorganisms and hygienic markers such as aerobic plate count (APC). Further test on the presence of the pathogenic and potentially-pathogenic microorganism marker, *Escherichia coli,* was analyzed for the different food samples while presence of *Staphylococcus aureus*was analyzed for food handlers, utensils and other contact surfaces.In carrying out the APC, the standard protocol specified in the Bacteriological Analytical Manual (BAM) produced by the U.S. Food and Drug Administration (2001)was administered. Results were reported as ColonyForming Units per gram(CFU/g) of samples.

For the enumeration of Total coliform and *E. coli* (EC), sample in serial dilution was inoculated to fermentation tubes with appropriate volume of Lauryl Sulfate Broth (Merck), incubated at 35 ± 0.5°Cfor approximately 48 h. Tubes exhibiting growth and/or gas formation were further confirmed using Brilliant Green Lactose Bile Broth (Merck) incubated at 35.5 ± 0.5 °C for 48 h. Presumptive EC tubes were confirmed further following a simplified IMViC tests (Indole, Methyl red, Voges-Proskauer, Citrate test)(Hemraj et al. 2013). The result which was expressed as Most Probable Number per mL or g of samples (MPN/mL or MPN/g) is an estimate of the mean density of coliform in the sample based on probability formula.For the microbial analysis of utensils and food handlers, the presence of *Staphylococci*TNase-coagulase positives was investigated according to BAM (USFDA 2001) on Baird Parker Agar.Coagulase test was conductedon samples with suspected *S. aureus* using brain heart infusion (BHI) broth and Trypticase Soy Agar (TSA).

2.6.2. Water

Microbial analysis of the water used for washing, cooking and drinking in identified school canteens was performed to evaluate presence of pathogenic and potentially pathogenic bacteria according to the standard methods applied for the Examination of Water and Wastewater (APHA 2005). The Standard Plate Count which estimates the number of live heterotrophic bacteria in the sample, was performed with undiluted and diluted samples. Plates were incubated at 35 °C for 48 hours. Result was reported as CFU/mL.

2.7. Statistical analysis

For the statistical analysis, all microbiological counts were converted into logarithms. Data were analyzed using Microsoft Excel(Microsoft, Redmond, Washington, USA). The means, standard deviations,and ranges were calculated for the food, water and swab samples.

3. Results

Table 4 shows the recommended microbial limit applied for the various food groups, utensils and contact surfaces investigated in the present study. Microbial analysis performed on various food groups revealed incidence of high aerobic plate count (APC) (78 %) in fully-cooked foods in school canteens classified as “poor” with minimum and maximum values of 2.32 and 8.04$\log_{10}$coliform forming unit (CFU) g^{-1} while this was only 22 and 11 % for school canteens classified as “medium” and “good”, respectively. Incidence of high APC was also seen for fully cooked food group requiring further handling before consumption (66 %) and for sweet desserts (67 %) with minimum and

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Table 4. Microbial standards used for the different food groups, utensils and other contact surfaces submitted for microbiological analysis.

Samples Collected	Bacteriological Test	Standard (CFU/g)	Reference
Food			
A. Fully cooked	*Aerobic plate count*	10^3	Health Protection Agency (2009)
	E. coli	<10	Health Protection Agency (2009)
B. Fully cooked with further handling prior to consumption	*Aerobic plate count*	10^4	NSW Food Authority (2009)
	E. coli	<10	Health Protection Agency (2009)
C. Sweet desserts	*Aerobic plate count*	10^3	FDA (2013)
	E. coli	<10	Health Protection Agency (2009)
Water			
A. Tap water (from washing and food preparation area)	*Heterotrophic plate counts HPC*	<500	Philippine National Standards for Drinking Water (2007)
B. Drinking water (from water intended for direct consumption)	*Heterotrophic plate counts HPC*	<500	Philippine National Standards for Drinking Water (2007)
Swab from Utensils, food handlers hands and other contact surfaces	*Aerobic plate count*	<45	Provincial Health Services Authority (2010)
	S. aureus	<10	Commission Regulation (EC) No. 1441/2007 (2007)

Table 5.Incidence and levels of aerobic plate count (APC) on the three food groups taken from three school canteens

Food Groups	School canteen classification	Incidence[a] (%)	Geometric mean (log_{10}CFU/g)	Standard deviation (log_{10}CFU/g)	Minimum-maximum level (log_{10}CFU/g)
A. Fully cooked	"Poor"	77.77	4.16	7.56	2.32 – 8.04
	"Medium"	22.22	2.59	3.44	1 – 3.93
	"Good"	11.11	1.93	3.00	1.17-3.49
B.Fully cooked further handling prior to consumption	"Poor"	66.44	4.48	4.75	2.87 – 5.25
	"Medium"	0	1.46	1.55	1 – 2.04
	"Good"	33.33	3.57	4.03	2.56 – 4.44
C. Sweet desserts	"Poor"	66.66	3.87	5.30	2 – 5.70
	"Medium"	11.11	2.22	2.81	1.60 – 3.32

	"Good"	11.11	2.41	2.51	1.77 - 3.04

CFU- Colony Forming Units
[a] Incidence (%) was computed per food group per school canteen based on positive samples that had counts > $3\log_{10}$CFU/g.

maximum values of 2.87 and 5.25log10 CFU $g^{-1}$and 2.0 and 5.70log10 CFU g^{-1}, respectively. APC for food groups collected from school canteens classified as "medium" and "good" in terms of sanitary conditions were within the permissible microbial limit (Table 5) although only fully-cooked foods requiring further handling prior consumption from school classified as "medium" had 100 % conformity with the permissible limit for APCat< $3\log_{10}$CFU/g.

The levels of *E. coli* in most food samples belonging to different food groups were in conformity with the permissible limits of the Health Protection Agency (< 10 CFU g^{-1}). Surprisingly, samples belonging to fully-cooked foods obtained from school classified as "medium" only had 89 % (8 out of 9) conformity with the permissible limits for *E. coli*at$1.30\log_{10}$CFU g^{-1}(Table 6).

Table 6. Conformity of different food groups from three classifications of school canteens to the microbial reference standards.

Food group	School canteen classification	Assessment	Percentage of Conformity[a]	
			APC	***E. coli***
A- *Fully cooked*	"Poor"	Conforming	23.33	100
		Non-conforming	77.77	0
	"Medium"	Conforming	77.78	88.89
		Non-conforming	22.22	11.11
	"Good"	Conforming	88.89	100
		Non-conforming	11.11	0
B- *Fully cooked with further handling prior to consumption*	"Poor"	Conforming	33.35	100
		Non-conforming	66.44	0
	"Medium"	Conforming	100	100
		Non-conforming	0	0
	"Good"	Conforming	66.67	100
		Non-conforming	33.33	0
C- *Sweet desserts*	"Poor"	Conforming	33.34	100
		Non-conforming	66.66	0
	"Medium"	Conforming	88.89	100
		Non-conforming	11.11	0
	"Good"	Conforming	88.89	100
		Non-conforming	11.11	0

[a] % conformity was computed per food group per school canteen based on samples that had counts < $3\log_{10}$CFU/g for APC and $1.30\log_{10}$CFU/g for *E.coli.*

Table 7. Incidence and levels of heterotrophic plate count (HPC) at 35°C on water samples taken from three school canteens.

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Water Samples	School canteen classification	Incidence[a] (%)	Geometric mean (log_{10}CFU/g)	Standard deviation (log_{10}CFU/g)	Minimum-maximum level (log_{10}CFU/g)
A. Tap water *(from washing and food preparation area)* (	"Poor"	0	0.31	0.25	0 - 0.77
	"Medium"	11.11	1.59	5.76	0.47- 6.11
	"Good"	100	2.81	2.57	2.97 – 3.17
B.Drinking water *(from water intended for direct consumption)*	"Poor"	77.77	3.68	5.54	0 - 6
	"Medium"	100	4.75	4.36	4.59 - 5
	"Good"	100	4.49	3.82	4.46 – 4.66

CFU- Colony Forming Units
[a] Incidence (%) was computed per sample collection per school canteen based on positive samples that had counts > 2.69log_{10}CFU/g.

3.1. Water Samples

The HPC mean values at 35°C of water samples collected from the three (3) schools classified either as "poor", "medium" or "good" are presented in Table 7. Strikingly, tap water samples from school classified as "good" obtained highest (100 %) incidence of HPC with minimum and maximum values of 2.97 and 3.17log_{10}CFU/gwhile this were only 11.11 % and 0 % for schools that are classified as "medium" and "poor", respectively. For drinking water collected from the three schools, 100 % incidence of HPC were noted for schools classified as "medium" and "good" while this was only 77.77 % for school classified as "poor".

3.2. Swab Samples from food handlers and other contact surfaces

Table 8 shows the results of the microbial analysis on samples obtained from food handlers'hands and from other contact surfaces. All APC levels from samples collected from food handlers and from contact surfaces exceeded the permissible limit of <1.65log_{10} CFU/g. Considering the levels of *S. aureus*, samples collected from cook's hands have exceeded the permissible limit of *S. aureus* to be <1log_{10} CFU/g. This was 2.38 and 2.30log_{10} CFU/g for samples collected from school classified as "poor" and "medium", respectively. High levels of *S.* aureus (2.79log_{10} CFU/g) were also noted for samples collected from food servers collected from school classified as "poor". Levels of *S. aureus* other samples (i.e. contact surfaces) were not detected.

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p-ISSN: 2348-795X
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Table 8. Microbial characteristics of food handlers' hands and other contact surfaces

Swab Samples	School canteen classification	Microbial Tests	
		APC[a] Log_{10} CFU/g	*S. aureus*[b] Log_{10} CFU/g
Food Handlers			
A. Cooks' hands	"Poor"	5.19	2.38
	"Medium"	4.32	2.30
B. Food servers	"Poor"	4.93	2.79
	"Medium"	3.96	-
Contact Surfaces			
A. Spoons and forks	"Poor"	5.02	-
	"Medium"	4.08	-
B. Plates	"Poor"	5.08	-
	"Medium"	4.93	-
C. Tables	"Poor"	5.39	-
	"Medium"	4.23	-
D. Chopping Boards	"Poor"	6.11	-
	"Medium"	5.13	-

[a]Standard<1.65log_{10} CFU/g
[b]Standard<1log_{10} CFU/g

4. Discussion

According to the Food and Agriculture Organization (FAO) (1997), the microbial criterion for food defines the acceptability of a product or a food lot, based on the absence or presence, or number of microorganisms including parasites, and/or quantity of their toxins/metabolites, per unit(s) of mass, volume, area or lot. In the present study, the microbial quality of foods, food handlers and contact surfaces in canteens operating in three (3) schools previously classified by Pascual&Abenis (2016) as "poor", "medium" and "good" based on hygienic performancewas evaluated.

The Aerobic plate counts (APCs) was chosenas one of the indicatorsin the present study as it is reported to effectively assess Hazard Analysis and Critical Control Point (HACCP) plans (Hong et al. 2008). The levels of APC in various foods served from school classified as "poor" did not conform to the permissible APC limit of 3log_{10}CFU/g set by the Health Protection Agency (2009) indicating inferior food handling controls in this school and therefore, HACCP plan, as suggested by Bas et al. (2006) should be in placed to include pre-requisite programs such as good manufacturing practices (GMP) and standard operating procedures (SOP) that would improve employee hygiene practices, cleaning and sanitation programs, and equipment maintenance. The application of food handling controlsis also essential as it was observed that majority of the food groups obtained from the schools irrespective of their classification were mainly prepared using coconut milk that can contain high levels of fats and proteins, a condition favorable for bacterial growth and multiplication (Patil&Benjakul 2018). Of particular mention is food group requiring further handling prior to consumption as these foods may contract bacteria from cross contamination. Presence of *E. coli* were detected in all food groups,

e-ISSN: 2348-6848
p-ISSN: 2348-795X
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however, levels were in conformity with the permissible limit set by the Health Protection Agency (2009).

The high incidence of HPC for tap water and drinking water in school canteens classified either as "medium" or "good" could have been due to the fact that students from these schools have accessed to the faucet/water dispenser. According to Figueras & Borrego (2010), drinking water obtained from water refilling stations is expected to contain very low levels of heterotrophic and aerobic spore-forming microorganisms since water is treated and disinfected at source. One plausible explanation for this could be cross contamination. While students from school classified as "poor" have very limited access to water dispenser and water is made available only through food handlers/servers, students from schools classified either as "medium" or "good" have direct access to water dispenser. Students, whether they just came from their classes or from playing at the gymnasium, easily access the water dispenser which may have led to contamination of the dispenser nozzle and eventually, the water contained in the dispenser. Bacterial contamination in water could be perceived from its taste and odor (Sartory 2004). The high levels of bacterial contamination seen for food handlers' hands and from other contact surfaces may have likely contributed to the high bacterial levels seen for some food groups and water investigated in the present study. Overall, the findings from this study indicate the importance of providing support and input for public health programme including trainings on good manufacturing practices (GMPs) and Hazard Analysis and Critical Control Point (HACCP) principles among food handlers in the region in order to improve the quality of food delivered in school canteens and to promote the significance of good hygiene practices.

5. Conclusion

The various cases of non-conformity to microbial standards seen for food samples, water, food handlers' hands and other contact services indicate the significance of providing support and input for public health programme to improve the quality of food delivered in school canteens and to promote the significance of good hygiene practices.

6. Acknowledgement

The authors are grateful for the support they obtained from the Department of Health (DOH) and the Department of Education (DepEd) of Region VIII. This project is funded by the Eastern Visayas Health Research and Development Consortium (EVHRDC).

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e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 07 Issue 10
October 2020

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