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Assessment of Drinking Water Quality and Coliform Bacteria Contamination in Food: A Case Study of Child Development Centers of Muang Yala Municipality, Yala, Thailand

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Abstract. Food safety in the Child Development Centers is everyone's responsibility especially food handlers who often come in exposed to the food served to the children. The purpose of this study was to analyze the drinking water quality and coliform bacteria contamination in food, water, food utensils, and food handlers and to assess food sanitation from assessment form in five canteens in Child Development Centers of Muang Yala Municipality during March and July 2020. Ten drinking water samples were analyzed in comparison to the Drinking Water Quality Criteria. Eighty-five samples were examined for the coliform bacteria contamination using SI-2 and DOH-11 test kits. The results showed that seven drinking water samples were collected from the water supply through a filter, groundwater through a filter and 20 liters closed containers that found coliform bacteria and fecal coliform bacteria. Fifty-six of eighty-five SI-2 and DOH-11 test kits samples were contaminated with coliform bacteria (65.88%). Some of the child development centers did not have grease traps, ventilation systems for their food preparation, and no evidence of food sanitation training for food handlers. Therefore, the responsible authorities should supervise and train about safe food handling practices to relevant personal.

Keywords: Child Development Centers, Drinking Water Quality, Coliform Bacteria Contamination, Food Sanitation

INTRODUCTION

Food is an important factor to the survival of human being and pathogens or toxins are contaminated may be affected to people illness. Therefore, food sanitation is an important public concern. The spread of foodborne illness is growing and critical public health problem [1], especially Thailand is a tropical country within the World Health Organization's Southeast Asia Region which has high rates of morbidity and mortality from foodborne illnesses [2]. More than one million acute diarrhea cases were reported in Thailand in 2015 [3].

The child development center is a place to care for preschool children and has the main objective is to increase opportunities for children to be prepared and can develop physically, mentally, emotionally, socially, and intellectually. Furthermore, it also alleviates the burden of parents who do not have a babysitter during the day. Therefore, children must be in the care of child caregivers within the Child Development Center for up to 6-8 hours a day. Children will have lunch at the canteen. Therefore, when considering food sanitation, hygiene monitoring of food establishments, water quality monitoring, chloroform bacterial contamination in food, water, utensils, hands of food handlers, etc. Food, water, and ice contaminated with excess amount of coliforms or bacteria may be also

contaminated with food poisoning bacteria that consumption of coliform-contaminated food can cause gastrointestinal tract diseases, diarrhea, vomiting, fever, headache or even death [4]. In addition, food handlers represent an essential role in either spreading and preventing foodborne illnesses. Poor hygienic practices of food handlers are among the increased risk factors that contribute to sporadic cases or outbreaks of foodborne illnesses around the world [1, 5-7]. To investigate coliform bacteria in food, equipment and containers for food handlers. The Ministry of Public Health, Thailand developed an SI-2 test kit for inspection of food establishments to screen for coliform contamination [8]. Used for surveillance and reduce the risk of bacterial contamination that is a cause of gastrointestinal diseases [9]. The research objective was to analyze the drinking water quality and coliform bacteria contamination in food, water, food utensils, and food handlers and assess food sanitation from assessment form in five Child Development Centers of Muang Yala Municipality.

METHOD

Sampling sites and Sampling Methods

The study was conducted in five canteens of child development center that located in the Muang Yala Municipality, Yala, Thailand. Ten water samples were collected from tap water of water supply through a filter, groundwater through a filter and 20 liters closed containers at each sampling site because each child development center uses water for different consumption. Water collection was carried out in accordance with standard methods. All water samples were collected in sterile glass bottles and polyethylene sampling bottles for biological and chemical analysis, respectively. The samples were stored in an icebox and transported to the laboratory. This study was conducted between March-July 2020.

Analysis

Ten drinking water samples were analyzed at the Laboratory Center (Department of Health, Ministry of Public Health, Nonthaburi province, Thailand) using standard methods for the examination of water and wastewater [10] (Table 1). All samples were analyzed in comparison to the drinking water quality criteria of the Department of Health (2010) [11].

TABLE 1. Methods utilized for water quality analysis

Parameters	Unit	Method
Physical characteristics		
pH (at 25 °c)	-	Electrometric method
Color	Platinum-cobalt	Spectrophotometric-single-wavelength
Turbidity	NTU	Nephelometry
Hardness	mg/l	EDTA Titration
Total dissolved solids (TDS)	mg/l	Drying at 180 °C
Chemical characteristics		
Iron (Fe)	mg/l	Inductively coupled plasma (mass spectrometry) (ICP-MS)
Manganese (Mn)	mg/l	ICP-MS
Copper (Cu)	mg/l	ICP-MS
Zinc (Zn)	mg/l	ICP-MS
Lead (Pb)	mg/l	ICP-MS
Chromium (Cr)	mg/l	ICP-MS
Cadmium (Cd)	mg/l	ICP-MS
Arsenic (As)	mg/l	ICP-MS
Mercury (Hg)	mg/l	ICP-MS
Sulfate	mg/l	Ion Chromatography
Chloride	mg/l	Ion Chromatography
Nitrate (NO ₃)	mg/l	Ion Chromatography
Fluoride (F)	mg/l	Ion Chromatography
Biological characteristics		
Coliform bacteria	MPN/100 ml	Multiple-Tube Fermentation Technique
Fecal coliform bacteria	MPN/100 ml	Multiple-Tube Fermentation Technique

Coliform bacteria contamination was inspected from ready-to-eat food, utensils (food hole trays, spoons, forks and glasses) and food handler hands. Sample were collected 2 times by using Test Kit for Detection of Coliforms in Food (SI-2 Test Kit) and water samples for cooking and drinking were inspected with DOH-11 Test Kits during March and July 2020. SI-2 Test Kit contains a culture broth that supports the growth of coliform bacteria, with bromocresol purple as a pH indicator, and which was developed by the Ministry of Public Health, Thailand [8]. The test kit gives a qualitative result, as positive or negative for contamination with coliform bacteria. A sterile swab wet with an SI-2 medium was swabbed onto approximately four square inches of each hole trays, spoons forks and glasses; each swab was slowly rotated three times and then left in the bottle of SI-2 medium. For each ice sample, one milliliter of melted ice was pipetted into the SI-2 medium. For the hands of food handlers, A sterile swab wet with an SI-2 medium was swabbed to smear the hand of both hands from the tip of the finger to the 2nd item, except the thumb was smeared from the tip of the finger to the 1st item. All SI-2 samples were left at room temperature (approximately 32 °C-35 °C) for 24 hours. At the end of 24 hours, if the color of the SI-2 medium had changed from purple to yellow, yellowish, turbid and foamy bubbles appear, this indicated the presence of coliform bacteria and was interpreted as positive for contamination [8,12]. As well as DOH-11 Test Kits, at the end of 24-48 hours, if the color of medium had changed from red to yellow was interpreted as positive for coliform bacteria contamination.

Food sanitation assessment was conducted by using food sanitation standard checklist form for food establishments (According to the Ministry of Hygiene of Food establishments 2018) [13] that was divided into four sections (section I food establishments, section II fresh food, dry food and ready-to-eat food, section III hygiene of utensils, equipment and other utensils and section IV Personal hygiene of food owner and food handlers), containing total 74 checklists (completely correct, need to improve and no activity).

Data Analysis

The data were analyzed and described using descriptive statistics, i.e., mean, frequencies and percentage.

RESULTS AND DISCUSSION

The mean values of each water quality parameter from five canteens of child development center in Muang Yala Municipality are shown in Table 2. Based on the measured values of the various parameters, only three from ten water samples passed the drinking water quality criteria of the Thai Department of Health. Groundwater sources from CDC2 have a variance in pH, which pH value from the first collection was 6, and the second collection was taken with a value of 4, which failed to pass the standard because the optimal value should be in the range of 6.5-8.5. The low pH of this water may be related to its geographical location. Alkaline additions to raw water sources with a low pH value must be done to adjust the pH to the appropriate range. Exposure to low pH values results in irritation especially in sensitive individuals.

Seven water samples from all child development centers were contaminated with coliform bacteria, which were collected from tap water sourced from a water filter and 20 litter bottle water. The contamination may come from not cleaning the water filter and not taking care of the pump from a 20 litter bottle. Coliform bacteria are often referred to as "indicator organisms" because they indicate the potential presence of disease-causing bacteria in water. Their presence indicates that a contamination pathway exists between a source of bacteria and the water supply [14]. Consumption of coliform-contaminated food can cause gastrointestinal tract diseases [4].

Three water samples from CDC1, CDC3 and CDC5 were contaminated fecal coliform bacteria.

According to the Drinking water quality criteria standards must not be found. Fecal coliform bacteria are microscopic organisms that live in the intestines of warm-blooded animals. They also live in the waste material, or feces, excreted from the intestinal tract. When fecal coliform bacteria are present in high numbers in a water sample, it means that the water has received fecal matter from one source or another [15].

Drinking water that is contaminated with coliform bacteria and fecal coliform bacteria does not always cause illness. Most of these bacteria are harmless to humans. If disease-causing bacteria are present, symptoms of waterborne diseases may include gastrointestinal illnesses such as severe diarrhea, and nausea, as well as associated headaches and fatigue [4]. It is important to note, however, that these symptoms are not associated only with disease-causing organisms in drinking water. They may also be caused by a number of other factors. In addition, not all people will be affected, Symptoms are most likely in children or the elderly are usually more susceptible [4].

TABLE 2. Mean values of water quality from five child development centers in Muang Yala Municipality, Yala, Thailand compared with the drinking water quality criteria.

parameters	Child Development Centers										Drinking water quality criteria ^a
	CDC1		CDC2		CDC3		CDC4		CDC5		
water source	Water through a filter (Water supply)		Water through a filter (groundwater)		Water through a filter (Water supply)		20 L bottle water				
pH	7.5	7.5	6.7	4.4	7.5	7.0	7.6	7.7	8.1	7.2	6.5-8.5
Color	ND	2	ND	ND	ND	2	ND	1	ND	1	≤15
Turbidity	0.37	0.18	0.23	0.03	1.00	0.66	0.15	0.09	0.34	0.08	≤5
Hardness	27	32	27	2	27	28	23	25	48	ND	≤500
TDS	50	65	59	34	46	59	50	56	77	67	≤1,000
Fe	<0.032	<0.032	ND	ND	<0.032	0.033	ND	ND	<0.032	ND	≤0.5
Mn	0.009	0.044	0.039	0.036	0.0009	0.016	ND	ND	ND	ND	≤0.3
Cu	ND	ND	0.029	0.024	<0.012	<0.012	ND	ND	ND	ND	≤1.0
Zn	ND	ND	0.050	0.045	0.140	0.322	ND	ND	ND	ND	≤3.0
Pb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	≤0.01
Cr	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	≤0.05
Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	≤0.003
As	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	≤0.01
Hg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	≤0.001
Sulfate	8	9	ND	ND	8	9	8	9	8	19	≤250
Chloride	2	3	7	7	2	3	2	2	5	6	≤250
Nitrate as Nitrate	0.28	0.50	7.00	7.01	0.37	0.63	0.31	0.45	0.26	0.41	≤50
Fluoride	ND	ND	ND	0.06	ND	0.09	ND	0.10	ND	0.07	≤0.7
Coliform bacteria	ND	240	ND	7.8	ND	4.5	540	4	45	>1,600	ND
Fecal coliform bacteria	ND	17	ND	ND	ND	2	ND	ND	ND	>1,600	ND

ND=Not Detected, Coliform bacteria and fecal coliform bacteria <1.8 MPN/100 ml means that these bacteria were not found from samples.

^aDrinking water quality criteria, Department of Health 2010

Fifty-six of eighty-five samples (65.88%) from SI-2 and DOH-11 test kits were contaminated with coliform bacteria. Coliform bacteria are considered as indicator organisms because their presence in foods indicates that circumstances are suitable for the presence of enteric pathogens and may signify insufficient sanitary conditions. Table 3 showed coliform bacteria contamination in ready to eat food, utensils (food hole trays and glasses) water for cooking and drinking, ice and hand of food handlers. Overall, all types of samples were contaminated with coliform bacteria. All ice samples (100.00%) were contaminated with coliform bacteria although the child development center does not use ice for consumption, it uses ice for soaking milk. Therefore, if the ice is contaminated with coliform bacteria, the child may be exposed and put it in their mouth. Ready-to-eat food should be heat treated to destroy microorganisms and ready-to-eat fresh food should be washed properly. Water for cooking and drinking founded coliform bacteria contamination (61.54%). In addition, the hand of food handlers still founded coliform bacteria contamination (82.35%) that indicated the hands are not clean, they should be washed frequently and wash your hands properly according to the recommendations of the Department of Health, Thailand [16].

TABLE 3. Coliform bacteria contamination of samples

Child Development Centers	Type of sample	Sample	total	
			(n)	Contamination (%)
CDC1	Ready to eat foods	4	4	100.00
	Utensils (food hole trays and glasses)	3	0	0.00
	Water	4	4	100.00
	Ice	2	2	100.00
	Hand of Food handlers	5	5	100.00
CDC2	Ready to eat foods	7	4	57.14
	Utensils (food hole trays spoons and forks)	4	0	0.00
	Water	3	0	0.00
	Ice	-	-	-
	Hand of Food handlers	4	2	50.00
CDC3	Ready to eat foods	7	7	100.00
	Utensils (hole tray spoons and glasses)	5	5	100.00

Child Development Centers	Type of sample	Sample	total	
			(n)	(%)
CDC4	Water	3	2	66.67
	Ice	2	2	100.00
	Hand of Food handlers	2	2	100.00
	Ready to eat foods	4	3	75.00
	Utensils (hole tray spoons and glasses)	6	2	33.33
CDC5	Water	1	0	0.00
	Ice	-	-	-
	Hand of Food handlers	3	2	33.33
	Ready to eat foods	5	3	60.00
	Utensils (hole tray spoons and glasses)	6	2	33.34
Overall	Water	2	2	100.00
	Ice	-	-	-
	Hand of Food handlers	3	3	100.00
	Ready to eat foods	27	21	77.78
	Utensils (hole tray and glasses)	24	9	37.50
	Water	13	8	61.54
	Ice	4	4	100.00
	Hand of Food handlers	17	14	68.75
	total	85	53	82.35

According to the food sanitation standard checklist form for food establishments found 6 of 74 items checklist need to improve inside kitchen and canteen of the child development center, i.e., fire protection tools, grease traps ventilation system in the kitchen must be installed. Furthermore, the cooking area should increase the light intensity to the standard 300 lux and put a lamp cover in the kitchen to prevent accidents and dirt from falling into the food. Food handlers lack evidence of a health check and food sanitation training evidence.

TABLE 4. Number of child development centers that need improvement of hygiene requirements

items	Hygiene requirements	Number of child development centers canteen that need improvement, n (%)
1	Measures/equipment/tools for fire protection	5 (100.00)
2	Adequate ventilation, such as a chimney. and or exhaust fan or air conditioning, etc.	4 (80.00)
3	Grease trap system/wastewater treatment before discharging to the public.	3 (60.00)
4	The cooking area has a light intensity of at least 300 and has a lamp cover.	1 (20.00)
5	Evidence of health checks in that year to check.	5 (100.00)
6	Registration or evidence that everyone has passed the training according to the food sanitation course from the designated training organization.	4 (80.00)

CONCLUSION

Food safety and sanitation is an important issue and public health concerns, especially among children groups who are susceptible to microbial exposure. A case study of canteens in child development centers of Muang Yala Municipality, Yala, Thailand found coliform bacteria contamination in most drinking water, ready to eat food, utensils, ice and hand of food handlers. In addition, should be encouraged proper hand washing and hand frequent washing including annual health checks and food sanitation training every three years. Furthermore, food sanitation-related components in the canteen of the child development center, it was also found to be improved in terms of increasing the light intensity and adding the lamp cover including air ventilation system, wastewater management by installing grease traps and fire protection system.

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