IJFNPH
5,1/2/3

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MICROBIAL AND HEAVY METAL CONTAMINATION MONITORING OF READY-TO-EAT FOOD IN NAKHON RATCHASIMA PROVINCE

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Abstract: *Purpose:* Microbiological and chemical risk assessment in food and drinks are important. This research were attempted to survey the quality of food and drinks from various locations in 2 seasons of the year (winter and summer).

Methodology: Samples of raw food, cooked-food, ready to eat food, drinking-water and freshly-made fruit juice from 8 locations in Nakhonratchasima province, Thailand, were collected to analyze for microbial indices and heavy metals contamination.

Findings: Results were compared between 2 seasons of the year. For the food, microbial indices were found higher than standard level in all types of food in both seasons of the year, though slightly different from location to location. For the food-borne pathogens, Staphylococcus aureus, Salmonella spp. and Vibrio cholera were detected higher in summer than in winter, also varying in different locations. Results of Pb, Hg, As and Cd analyses shows Pb extremely higher than standard level in all types of food collected in winter. Hg was also detected higher in only raw and cooked-foods collected in winter. For the drinks, no heavy metals were found in any drinking water. In contrary, Pb, Hg and As were detected less than standard level in summer in freshly-made fruit juice.

Value: The food-borne pathogens found evidential risk on food safety as is

International Journal of Food, Nutrition & Public Health
Vol. 5 No. 1/2/3, 2012

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confronted in public. Good hygiene practice and good manufacturing practice should be realized by the relevant control units to monitor public sanitation on foods and drinks regularly.

Keywords: *Ready-To-Eat Food; Food Safety; Pathogens and Heavy Metals in Food*

INTRODUCTION

Thailand is the 14th largest world exporter of food and agricultural products, particularly, 80% of Thai ready-to-eat (RTE) food which are items that are generally uncooked before eating, were exported to United States and Europe (Jocelyn 2005; News 2011) A science-based safety standards and regulations as well as an effective farm to table control system is internationally realized at this the level. The quality and safety of Thai food, therefore, would gain greater recognition at all the international levels (Prema and Sisira 2003).

Determination of the microbiological and heavy metal safety of ready-to-eat foods to indicate contamination levels considered to be a public health risk, since their presence could suggest faults in the production or subsequent handling of food which, if not controlled, could lead to an unacceptable increase in risk (Ahmet 2005; Warapa et al. 2010; Sunday et al. 2011). In order to protect the consumer against hazards, Food safety government agencies must implement good hygienic practices (GHP) and apply the principles of the Hazard Analysis Critical Control Point system (HACCP). The actual situation of health conditions, caused by the food consumption, regarding the morbility and mortality of foodborne disease should determine the acceptable risk or appropriate level of protection (ALOP) (IFT Expert Report on Emerging Microbiological Food Safety Issues 2005; Food Safety Around the World 2005)

Nakhon Ratchasima Province, one of the large provinces in Thailand, in which RTE are widely available. None of the

quantitative risk assessments are performed. Surveys of safety on food and drinks in such places, are therefore, conducted as a basis for evaluating the risk which corresponds to the Ministry of Public Health policy on food safety, and supporting Thai foods as the "Kitchen of the World" and from "farm to table" to international standard of GHP and GMP (Darla et al. 2005; Food Safety Around the World 2005).

The purposes of this research were to determine the contamination levels of the microorganisms and heavy metal index in widely and seldomly found problem foods from 8 locations during two periods of time, the hot season and the cold season, in Nakhon Ratchasima Province. Five food sample types, raw food, cooked-food, ready to eat food, drinking-water and freshly-made fruit juice were collected to assess the food contamination risk of two different periods of the year.

MATERIALS AND METHODS

Five types of a total of 140 samples; raw food, cooked food, ready-to eat food, freshly-made fruit juice and drinking water were collected in the cold and hot season (February and April of 2010/2011) from 8 locations (Fresh markets of M1,M2,M3, open restaurants of M4,M5, University restaurants of M6,M7 and student dorm restaurant of M8) in Nakhon Ratchasima. Each sample was prepared and analyzed on microbiological and heavy metals contamination. For microbiological results, Food and Drug Administration Bacteriological Analytical Manual (FDA- BAM) was applied for Total Bacteria Count (cfu/g) (FDA-BAM, 1998), Coliform and *Escherichia coli* (MPN/g)(FDA-BAM,2002), *Bacillus cereus*, *Clostriduim botulinum*, *Clostriduim perfringens*, *Staphyolcocus aureus* and *Shigella* spp.(FDA-BAM,2001), *Salmonella* spp.(FDA-BAM,2003),*Vibrio cholerae* and *Vibrio parahaemolyticus* (FDA-BAM,2004). For heavy metals determination, samples were

prepared by microwave digestion with conc. HNO_3 prior to be detected using Inductively Coupled Plasma Mass Spectroscopy technique (ICP-MS, Agilent CE 7500). All samples were done in duplicate; data was compared with national standard level and analyzed using SPSS program for windows.

RESULTS AND DISCUSSION

Comparison with the standard level, microbiological contamination of all food samples from all sources, for both seasons were statistically significant (P-value <0.01) in the amount of Total Bacterial Count, Coliform and *E.coli*. for raw, cooked and ready-to eat food, the level of contamination was approximately one log cycle higher than standard level. The contamination of *B.cereus* and C. *perfringens* were found in two samples, raw and cooked food, which were found in the same four locations (M1, M2, M3, M4). The rest of three samples, RTE were found in all eight locations (M1-M8). No was found in the difference locations in both seasons. Focus on *S.aureus*, the food borne pathogen, all samples of raw, cooked and ready-to-eat food samples of the hot season from M1,M2,M3,M4 and M6 were contaminated but only M3 was a significant (P-value <0.01) in cooked and raw foods. *Salmonella* spp. as well as *V. cholerae* are found contaminating all raw food samples of both seasons. *V. parahaemolyticus* is found contaminating raw, cooked and ready-to eat food samples of cold season only. In overview, all samples of both seasons from all locations were contaminated indicating unhygienic conditions by the high levels of Total Bacterial Count, Coliform bacteria and *E.coli*. Whereas pathogenic bacteria; *S.aureus* and *V.parahaemolyticus* in raw, cooked and RTE food samples were found in excessive levels in the hot and cold seasons respectively. Contamination of *Salmonell*a spp. was detected for all raw food samples in both seasons from location, M1, M2, M3 and M4 .The significantly difference of contamination for all food samples in terms of microbial type and level,

might be affected not only from raw materials or ingredients used, normal flora, sanitation or personal hygiene but also from season and location. The result of microbiological contamination is presented in Table 1.

Contamination on heavy metal of lead (Pb) in the cold season exceeded in raw (94.422 mg/kg), cooked (40.469 mg/kg), RTE (12.295 mg/kg) food samples and freshly-made fruit juice (4.963 mg/l) compared to standard level (1 mg/kg, 1

Microbial Quality Index	Standards level	Type of sample	Cool season (Maximum)	Hot Season (Maximum)	Market (Sampling source.)	
					Cool season (February)	Hot Season (April)
Total Bacterial Count Log (cfu/g)	6.00	- Raw foods	6.70	7.40	M4	M4
		- cooked foods	6.48	7.40	M4	M1 M2 M3 M4
		- RTE	7.40	7.38	M8	M6
		- water	4.95	4.64	M2	M2
		- juice	7.43	6.43	M4	M4
MPN Coliform (MPN/g)	< 500	- Raw foods	1100.00	1100.00	M1 M2 M3 M4	M1 M2 M3 M4
	<500	- cooked foods	1100.00	1100.00	M4	M1 M2 M3 M4
	<500	- RTE	1100.00	1100.00	M1 M2 M3 M4 M5 M6 M7 M8	M1 M2 M3 M4 M5 M6 M7 M8
	<20	- water	23.00	1.10	M6	M1 M2 M3 M4 M5 M6 M7 M8
	<20	- juice	23.00	23.00	M1 M2 M4 M5 M6 M8	M1 M4 M5 M6 M7 M8
Escherichia coli (MPN/g)	<50	- Raw foods	1100.00	1100.00	M1 M2 M3 M4	M1 M2 M3 M4
	<3	- cooked foods	43.00	6.10	M2	M2
	<10	- RTE	1100.00	1100.00	M1 M3 M4 M5 M6 M8	M1 M2 M4 M5 M6 M8
	<2	- water	6.90	23.00	M6	M8
	<2	- juice	23.00	23.00	M1 M2 M3 M4 M5 M8	M1 M3 M5 M6
Bacillus cereus Log (cfu/g)	<2.30	- Raw foods	2.00	2.00	M1 M2 M3 M4	M1 M2 M3 M4
	<2.00	- cooked foods	2.00	2.00	M1 M2 M3 M4	M1 M2 M3 M4
	<2.00	- RTE	2.00	2.00	M1 M2 M3 M4 M5 M6 M7 M8	M1 M2 M3 M4 M5 M6 M7 M8
	Not detected	- water	Not detected	Not detected	-	-
	Not detected	- juice	Not detected	Not detected	-	-
Clostridium botulinum	Not detected	- Raw foods	Not detected	Not detected	-	-
	Not detected	- cooked foods	Not detected	Not detected	-	-
	Not detected	- RTE	Not detected	Not detected	-	-
	Not detected	- water	Not detected	Not detected	-	-
	Not detected	- juice	Not detected	Not detected	-	-
Clostridium perfringens	Not detected	- Raw foods	Detected	Detected	M1 M2 M3 M4	M1 M2 M3 M4
	Not detected	- cooked foods	Detected	Detected	M1 M2 M3 M4	M1 M2 M3 M4
	Not detected	- RTE	Detected	Detected	M1 M2 M3 M4 M5 M6 M7 M8	M1 M2 M3 M4 M5 M6 M7 M8
	Not detected	- water	Not detected	Not detected	-	-
	Not detected	- juice	Not detected	Not detected	-	-
Staphylococcus aureus	<2.30	- Raw foods	1.24	3.75	M3	M3
	<2.00	- cooked foods	1.00	2.91	M1 M2 M3 M4	M3
	<2.00	- RTE	2.81	3.18	M6	M2
	Not detected	- water	Not detected	Not detected	-	-
	Not detected	- juice	Not detected	Not detected	-	-
Salmonella spp.	Not detected	- Raw foods	Detect	Detected	M1 M2 M3	M1 M2 M3 M4
	Not detected	- cooked foods	Not detected	Not detected	-	-
	Not detected	- RTE	Not detected	Not detected	-	-
	Not detected	- water	Not detected	Not detected	-	-
	Not detected	- juice	Not detected	Not detected	-	-
Shigella spp.	Not detected	- Raw foods	Not detected	Not detected	-	-
	Not detected	- cooked foods	Not detected	Not detected	-	-
	Not detected	- RTE	Not detected	Not detected	-	-
	Not detected	- water	Not detected	Not detected	-	-
	Not detected	- juice	Not detected	Not detected	-	-
Vibrio cholerae	Not detected	- Raw foods	Detected	Detected	M2	M4
	Not detected	- cooked foods	Not detected	Not detected	-	-
	Not detected	- RTE	Detected	Detected	M5 M6	M4
	Not detected	- water	Not detected	Not detected	-	-
	Not detected	- juice	Not detected	Not detected	-	-
Vibrio parahaemolyticus (MPN/g)		- Raw foods	6.30	3.00	M1	M1 M2 M3 M4
		- cooked foods	Detected	Not detected	M1 M2 M3 M4	-
		- RTE	Detected	Not detected	M1 M2 M3 M4 M5 M6 M7 M8	-
		- water	Not detected	Not detected	-	-
		- juice	Not detected	Not detected	-	-

The results of the microbiological contamination given in this table are the average of three independent experiments.

M1 = Papar market M2 = Yamoo market M3 = Maegimheng market
M4 = General Stall M5 = Street University M6 = Class room building 1 cafeteria
M7 = Class room building 2 cafeteria M8 = Dormitory cafeteria

Table 1: Microbiological Contamination of Food Samples, Index of the High Risk

mg/kg, 1 mg/kg and 0.5 mg/l, respectively). For mercury (Hg), it was detected higher than standard level in raw (9.256 mg/kg) and cooked (5.641 mg/kg) food samples. Whereas at the location M1 and M7, the amount of arsenic (As) and cadmium (Cd) in fresh-made fruit juice (1.979 mg/l, 0.051 mg/l respectively) was found to exceed levels, compared to standard level (0.05 mg/l, 0.01 mg/l respectively). The data of heavy metal contamination was shown in Table 2.

CONCLUSION

Almost all of the raw, cooked and RTE food samples of both seasons from all locations were contaminated with high levels of various kinds of microorganism. Consumption of these foods in the summer and cold seasons might be unsafe cause by pathogenic bacteria, *S. aureus* and *V.parahaemolyticus* respectively whereas raw foods in both seasons from some location were caused by *Salmonella* spp. In addition, the excessive levels of Pb and Hg in raw, cooked and RTE food samples were found as well as Cd and As of fresh-made fruit juice. Microorganism and heavy metal contamination risk is, therefore, quite

Heavy metal quality index	Standards level	Type of sample	Cool season (Maximum)	Hot Season (Maximum)	Market (Sampling source.)	
					Cool season (February)	Hot Season (April)
Lead (Pb)	1 mg/kg	- Raw foods	94.422	0.136	M3	M1
	1 mg/ kg	- cooked foods	40.469	0.036	M1	M3
	1 mg/ kg	- RTE	12.295	0.429	M1	M2
	0.5 mg/l	- water	0.002	0.00	M4	-
	0.5 mg/l	- juice	4.963	0.168	M2	M3
Mercury (Hg)	0.5 mg/kg	- Raw foods	9.256	1.650	M1	M1
	0.5 mg/kg	- cooked foods	5.641	0.004	M1	M3
	0.5 mg/kg	- RTE	0.657	0.171	M1	M2
	0.002 mg/l	- water	0.001	0.00	M2	-
	0.002 mg/l	- juice	2.270	0.00	M2	-
Arsenic (As)	2 mg/ kg	- Raw foods	0.329	0.754	M4	M4
	2 mg/ kg	- cooked foods	0.475	0.738	M4	M4
	2 mg/ kg	- RTE	1.799	0.100	M8	M1
	0.05 mg/l	- water	0.003	0.008	M2 M4	M4
	0.05 mg/l	- juice	1.979	0.002	M7	M1
Cadmium (Cd)	1 mg/kg	- Raw foods	0.083	0.730	M3	M4
	1 mg/kg	- cooked foods	0.090	0.700	M3	M1
	1 mg/kg	- RTE	0.068	0.011	M3	M2
	0.01 mg/l	- water	0.000	0.000	-	-
	0.01 mg/l	- juice	0.051	0.002	M1	M1 M2

The results of the heavy metal given in this table are the average of three independent experiments.

M1 = Papar market M2 = Yamoo market M3 = Maegimheng market
M4 = General Stall M5 = Street University M6 = Class room building 1 cafeteria
M7 = Class room building 2 cafeteria M8 = Dormitory cafeteria

Table 2: The Results of the Heavy Metal Quality Index With the High Risk

potential. It is suggested that high risk parameters should be further intensively evaluated.Maximum residue levels (MRLs) must be set for criteria contaminants in order to protect public health. GMP/HACCP system for food process or procedures should identified and implementedregularly.

BIOGRAPHY

Lumprai Srithamma, scientist in the field of microbiological analysis, the Center for Scientific and Technological Equipment, Suranaree University of Technology, Nakhon Ratchasima, Thailand. She holds doctoral degree (Dr.rer.nat) in the field of Beverage Technology, Department of Food and Nutrition, Technical University Munich – Weihenstephan (TUM – Weihenstephan), Germany, M.Sc. (Biotechnology) and B.Sc. (Biotechnology) from Suranaree University of Technology and Khon Kaen University respectively. She has worked for 7 years as quality control and production manager in the food processing companies before start working at Suranaree University of Technology in microbiological testing laboratory as scientist in the year 1996. She has been trained for both domestic and oversea in various special courses of food processing and quality control system such as ISO 9000 series for food industry, ISO 17025 for testing laboratory. Not only routine work in microbiological laboratory but also research and consulting for private sectors in the field of her expertise is carrying. Her special experience and interested research topics are quality assurance system of food and beverage products.

Piyawan Gasaluck, Ph.D.degree in Applied Sciences and Biotechnology, and M.Sc.degree in Biotechnology and Biochemistry at the Faculty of Bioresources, Mie University, Japan. She earned her Bachelor degree from Faculty of Science, Khon Kaen University, Thailand. Visiting researcher at the Department of Public Health, Faculty of Medicine,

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ACKNOWLEDGEMENTS

The author is grateful to the office of National Research Council of Thailand and Suranaree University of Technology, Nakhon Ratchasima, Thailand, for financial support.

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