

**ENVIRONMENTAL HEALTH CONDITIONS AND
QUALITIES IN BUDDHIST TEMPLES
IN BANGKOK METROPOLITAN REGION**

The seal of Mahidol University is a circular emblem. It features a central blue circle containing a golden stupa (a Buddhist monument). The stupa is topped with a flame-like finial. Below the stupa are two golden swans facing each other. The entire central design is surrounded by a golden ring. The Thai text 'จุฬาลงกรณ์มหาวิทยาลัย' (Mahidol University) is written in Thai script around the inner edge of the ring. The outer edge of the ring contains the university's name in English: 'MAHIDOL UNIVERSITY'.

RUNGRAT LAPCHAROENWONG

**A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF SCIENCE
(ENVIRONMENTAL SANITATION)
FACULTY OF GRADUATE STUDIES
MAHIDOL UNIVERSITY**

2005

ISBN 974-04-6530-7

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Thesis
entitled

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IN BANGKOK METROPOLITAN REGION**

Rungrat Lapcharoenwang...
Miss Rungrat Lapcharoenwang
Candidate

Si Sill...
.....
Asst.Prof.Siranee Sreesai,
D.Tech.Sci.
Major-Advisor

Phitaya Chl, M.D.
.....
Assoc.Prof.Phitaya Charupoonpol,
D.V.M.,M.D. Dip of Thai Board of
Clinical Preventive Medicine.
Co-Advisor

Suporn Apinuntavech
.....
Lect.Suporn Apinuntavech
B.Sc. (Public Health),M.D. Dip of Child
and Adolescent Psychiatry, Dip of Thai
Board of Family Medicine
Co-Advisor

M.R. Jisnusun Svasti
.....
Prof. M.R. Jisnusun Svasti, Ph.D
Dean
Faculty of Graduate Studies

Udom Kompayak
.....
Assoc.Prof.Udom Kompayak,
M.P.H
Chair
Master of Science Programme
in Environmental Sanitation
Faculty of Public Health

Thesis
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was submitted to the Faculty of Graduate Studies, Mahidol University
for the degree of Master of Science (Environmental Sanitation)
on
29 September, 2005

Rungrat Lapcharoenwong.....
Miss Rungrat Lapcharoenwong
Candidate

Si Sill

Asst.Prof.Siranee Sreesai,
D.Tech.Sci.
Chair

Dr. R.

Phitaya Chl, M.D.

Assoc.Prof.Prayoon Fongsatitkul,
Ph.D.
Member

Assoc.Prof.Phitaya Charupoonpol,
D.V.M.,M.D. Dip of Thai Board of
Clinical Preventive Medicine.
Member

Udom Kompayak

Assoc.Prof.Udom Kompayak,
M.P.H.
Member

Luporn Apinuntavech

Lect.Suporn Apinuntavech
B.Sc. (Public Health),M.D.
Dip of Child and Adolescent
Psychiatry, Dip of Thai Board of
Family Medicine
Member

Bras

Prof. M.R. Jisnuson Svasti, Ph.D
Dean
Faculty of Graduate Studies
Mahidol University

A. Chalermchai

Assoc.Prof.Chalermchai Chaikittiporn,
Dr.P.H (Epidemiology)
Dean
Faculty of Public Health
Mahidol University

ACKNOWLEDGEMENT

The success of this thesis can be attributed to the extensive supports and assistances from my major advisor, Assist. Prof. Dr. Siranee Sreesai, who continuously provided valuable guidance, support, and encouragement to me all the processes of my study.

I am deeply thanks my co-advisors, Assoc. Prof. Dr. Phittaya Charupoonphol and Dr. Suporn Apinuntanavech, for their constructive comments, supervision, and encouragement.

I wish to thank, Assoc. Prof. Dr. Prayoon Fongsatitkul, for his kindness in examining the research instrument and providing suggestions for improvement, and was the external examiner of the thesis defense.

I would like to thank Assoc. Prof. Udom Khompayak, Chairman of the M.Sc. program majoring in Environmental Sanitation for valuable advice and guidance in this research.

I would like to thank Assist. Prof. Pakorn Somethanurungul for his kind help of the data collection processes as well as transportation to research sites.

My heartfelt thanks also go to the abbot of all the temples where data collection took place, as well as all monk subjects who willingly participated in the study.

I would like to thank all of my friends in Department of Environmental Sanitation, especially Mr. Suwat Tharayuth, Miss. Neeranart Narksagul, Miss. Nuttaporn Boontong, and Miss. Wanwisa Chinasote, for getting up very early on sampling day and their kind assistance. My grateful is also goes to a large number of supporting people which I am not able to include their names here.

Last but not the least, my deepest gratitude goes to my beloved parents, whose sacrifice has led me success and happiness. Without their love, affection, support, encouragement, and funding, the completion of this study would not have been possible. Thus, I would like to dedicate all the merits of thesis to them whose supported and enabled me to come this far. I also would like to dedicate all the merits of this thesis to my both brothers who passed away before having a chance to witness my accomplishment today.

Rungrat Lapcharoenwong

ENVIRONMENTAL HEALTH CONDITIONS AND QUALITIES IN BUDDHIST TEMPLES IN BANGKOK METROPOLITAN REGION**RUNGRAT LAPCHAROENWONG 4636090 PHES / M****M.Sc. (ENVIRONMENTAL SANITATION)****THESIS ADVISORS: SIRANEE SREESAI, D.Tech. Sci.,
PHITAYA CHARUPOONPHOL, D.V.M., M.D., SUPORN APINUNTAVECH, M.D.****ABSTRACT**

A cross-sectional study was conducted to investigate environmental health conditions and qualities in Buddhist temples in three zones of the Bangkok Metropolitan Region (BMR). The environmental health conditions in each temple were divided into housing sanitation, water consumption, and food for monks. 417 monks from 30 temples were interviewed and 240 environmental samples including ready-to-eat food, used water, drinking water, water supply, contact surface of food utensils, and suspended dust from 12 temples were analyzed. The indoor sound level and lighting intensity were also measured. All data were acquired using a questionnaire, inspection form and environmental analysis instruments.

Temples in BMR have a long history of development, and thus the infrastructures are of an unplanned design and construction. Although all studied temples received solid waste collection services from the Department of Public Cleansing in BMA, there is still a problem of wastes scattering from left over solid wastes and animal feces. Suspended dust quantity in ambient air was highest in urban fringe temples (0.4570 mg/m^3 of air) whereas the amount of bacteria in suspended dust was highest in the inner city temples (28.9×10^4 colony/g of dust). Day-light intensity in a monk's residence was often quite low and unsuitable for monk activities. There were five temples (42%) which had natural lighting intensity lower than 20 Lux. The average indoor sound level did not exceed the indoor day time nuisance noise level for residential areas. Bacteriological quality of water supply for all studied temples was good and there were acceptable residual chlorine concentrations. In contrast, bacteriological quality of each type of water consumption was poor. 7 samples (19%, $n=36$) of used water and 5 samples (21%, $n=24$) of drinking water had an unacceptable permission level in terms of total coliform bacteria and fecal coliform bacteria. Monks had a high frequency (3-30 times per month) of receiving spoiled food offerings during the alms in the morning. 84 of 120 samples (70%) of ready-to-eat food had exceeded the bacteriological standard level. Forenoon food had more significantly increased numbers of bacterial contamination than that of breakfast ($p<0.05$). There was no significant difference in bacterial contamination among each type of food. Besides this, 27% ($n=13$) of contact surfaces of food utensils had total bacteria contamination higher than the standard permission level.

Environmental health conditions of many studied temples were poor and frequently caused health problems for monks. It has relationships and impacts of a dynamic system. It is recommended that a virtue cycle which calls for cooperation in creating healthy environment and enabling better quality of life for monks as a whole is created.

KEY WORDS: ENVIRONMENTAL HEALTH CONDITION / BUDDHIST TEMPLE / BACTERIOLOGICAL QUALITY

114 P. ISBN 974-04-6530-7

สภาวะและคุณภาพด้านอนามัยสิ่งแวดล้อมของวัดในพระพุทธศาสนาซึ่งอยู่ในเขตกรุงเทพมหานคร

(ENVIRONMENTAL HEALTH CONDITIONS AND QUALITIES IN BUDDHIST TEMPLES IN BANGKOK METROPOLITAN REGION)

รุ่งรัตน์ ลากเจริญวงศ์ 4636090 PHES/M

วท.ม. (สาขาภิบาลสิ่งแวดล้อม)

คณะกรรมการควบคุมวิทยานิพนธ์: ศิราณี ศรีใส, D.Tech. Sci., พิทยา จารุพูนผล, ศพ.บ., พ.บ., สุพร อภินันทเวช, พ.บ.ว. (จิตเวชศาสตร์เด็กและวัยรุ่น) อ.ว. (เวชศาสตร์ครอบครัว)

บทคัดย่อ

การวิจัยเชิงภาคตัดขวาง มีวัตถุประสงค์เพื่อศึกษาสภาวะและคุณภาพด้านอนามัยสิ่งแวดล้อมของวัดในพระพุทธศาสนาในเขต 3 ชั้นของกรุงเทพมหานคร สภาวะด้านอนามัยสิ่งแวดล้อมของแต่ละวัดแบ่งเป็น การสุขาภิบาลที่พักอาศัย น้ำอุปโภค-บริโภค และอาหารสำหรับพระสงฆ์ พระสงฆ์จำนวน 417 รูป จาก 30 วัดได้รับการสัมภาษณ์และตัวอย่างทางสิ่งแวดล้อมจำนวน 240 ตัวอย่างจาก 12 วัด ได้แก่ อาหารสำหรับพระสงฆ์ น้ำใช้ น้ำดื่ม น้ำประปา พื้นผิวภาชนะสัมผัสอาหารและฝุ่นแขวนลอยในอากาศได้นำมาวิเคราะห์ทางห้องปฏิบัติการ นอกจากนี้ได้มีการวัดระดับเสียงและความเข้มของแสงในที่พักอาศัยในวัดดังกล่าวด้วย การเก็บข้อมูลทำโดยใช้แบบสอบถาม แบบสำรวจและเครื่องมือการวิเคราะห์ทางสิ่งแวดล้อม

วัดในกรุงเทพมหานครมีประวัติและการพัฒนามายาวนาน ดังนั้นโครงสร้างภายในวัดจึงถูกออกแบบและสร้างขึ้นอย่างไม่มีแบบแผน ถึงแม้ว่าวัดที่ศึกษาทั้งหมดได้รับการบริการรวบรวมมูลฝอยจากสำนักรักษาความสะอาด กรุงเทพมหานคร แต่ยังคงมีปัญหากับการกระจายของมูลฝอยตกค้างและอุจจาระของสัตว์ต่างๆ ปริมาณฝุ่นแขวนลอยในอากาศภายนอกกุฏิพบมากที่สุดที่วัดเขตนั่นกลาง (0.4570 มิลลิกรัมต่อลูกบาศก์เมตรของอากาศ) แต่ปริมาณแบคทีเรียในฝุ่นแขวนลอยพบมากที่สุดที่วัดเขตนั่นใน (28.9×10^4 โคโลนีต่อกรัมของฝุ่น) ความเข้มของแสงในกุฏิเวลากลางวันมีค่าต่ำและไม่เหมาะสมกับกิจกรรมของพระสงฆ์ วัดจำนวน 5 วัด (42%) มีความเข้มของแสงจากธรรมชาติต่ำกว่า 20 ลักซ์ ระดับเสียงเฉลี่ยภายในกุฏิมีค่าไม่เกินมาตรฐานระดับเสียงที่ไม่รบกวนความสงบสำหรับการพักอาศัยภายในอาคารเวลากลางวัน คุณภาพทางแบคทีเรียของน้ำประปาในวัดที่ศึกษาทั้งหมดอยู่ในเกณฑ์ที่ดีและมีความเข้มข้นของคลอรีนที่หลงเหลืออยู่ในน้ำอยู่ในเกณฑ์ที่ยอมรับได้ ในทางตรงกันข้าม คุณภาพทางแบคทีเรียของน้ำอุปโภค-บริโภคแต่ละชนิดอยู่ในเกณฑ์ต่ำ น้ำใช้ 7 ตัวอย่าง (19% จากจำนวน 36 ตัวอย่าง) และน้ำดื่ม 5 ตัวอย่าง (21% จากจำนวน 24 ตัวอย่าง) มีปริมาณโคลิฟอร์มแบคทีเรียและฟีคัล โคลิฟอร์มแบคทีเรียอยู่ในเกณฑ์ที่ยอมรับไม่ได้ ความถี่ในการรับอาหารบูตจากการบิณฑบาตตอนเช้าของพระสงฆ์อยู่ในระดับสูง (3-30 ครั้งต่อเดือน) อาหาร 84 ตัวอย่างจาก 120 ตัวอย่าง (70%) มีค่าเกินกว่าระดับมาตรฐานทางแบคทีเรีย อาหารมื้อกลางวันมีการเพิ่มจำนวนการปนเปื้อนของแบคทีเรียมากกว่าอาหารมื้อเช้าอย่างมีนัยสำคัญ ($p < 0.05$) และไม่มีความแตกต่างของการปนเปื้อนแบคทีเรียในอาหารแต่ละชนิดอย่างมีนัยสำคัญ นอกจากนี้ 27% (จำนวน 13 ตัวอย่าง) ของผิวภาชนะสัมผัสอาหารมีการปนเปื้อนของปริมาณแบคทีเรียทั้งหมดมากกว่าระดับมาตรฐานที่ยอมรับได้

สภาวะด้านอนามัยสิ่งแวดล้อมของหลายวัดที่ทำการศึกษา อยู่ในสภาพไม่ดีและก่อให้เกิดปัญหาสุขภาพแก่พระสงฆ์ โดยองค์ประกอบเหล่านี้มีความสัมพันธ์เกี่ยวเนื่องกันและสามารถส่งผลกระทบซึ่งกันและกันเป็นพลวัตร จึงแนะนำให้มีการเสริมสร้างวงจรคุณธรรมขึ้นมาแทนที่ เพื่อสร้างสิ่งแวดล้อมที่ส่งเสริมต่อสุขภาพ และพัฒนาคุณภาพชีวิตที่ดีของพระสงฆ์ในภาพรวม

114 หน้า ISBN 974-04-6530-7

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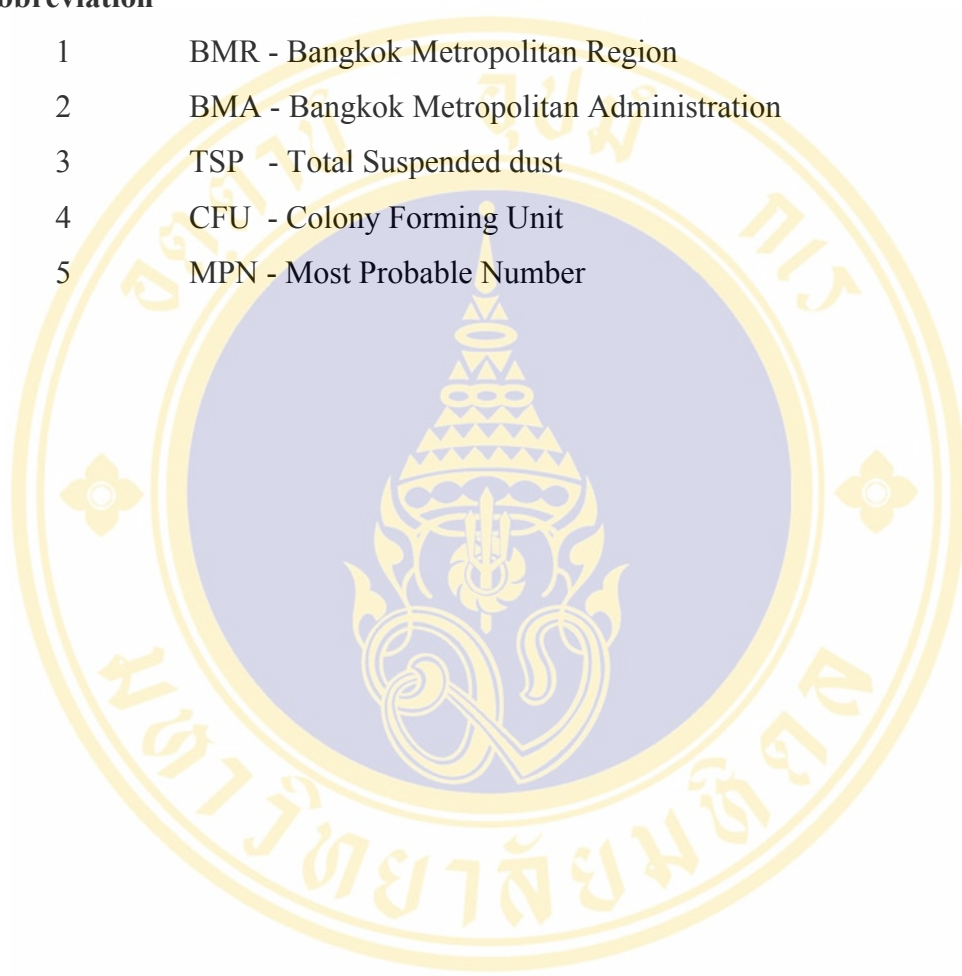
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LIST OF ABBREVIATIONS

Abbreviation

- 1 BMR - Bangkok Metropolitan Region
- 2 BMA - Bangkok Metropolitan Administration
- 3 TSP - Total Suspended dust
- 4 CFU - Colony Forming Unit
- 5 MPN - Most Probable Number



CHAPTER I

INTRODUCTION

1.1 Statement of problems

Buddhism is a dominant religion in Thailand, in which, around 95 % of the total population are Buddhists (1). It is a common sight all over Thailand and ever present in Thai life from the myriad Buddha images to the monks and many temples at which local people worship. Buddhist monk has an important role as the moral philosopher and direct the way of life in Thai kingdom. Beside this, they also play a leading role in many environmental conservations and health promotion activities. A study of Nantavisarn T. (2) found that the monks become monk doctors who play a role in promoting health of people from inside and outside the community. Besides this, Grawanchid D. (3) discovered that monks also play a role in preserving the environment regarding conservation activities at moderate level and teaching people about environmental protection at a high level.

During the year 2002, there were 267,818 of Buddhist monks all over a country and around 4.43% (11,862 monks) was living in 436 temples located in Bangkok Metropolitan Region (BMR)(4). Due to the capital city of the country, Bangkok, is a center of both cultural and technological advancements, people from rural areas flooded into the capital city to find jobs. As a result, the problems of crowdedness and pollution follow. According to findings, the temples located in Bangkok or other cities lacked serenity, the environment was too crowded and noisy which affected practice of the lord Buddha's teaching, the monks lacked places to live and had to cram in small dwelling which again did not facilitate the practice of meditation and others (5). It has been found that monks who are stricken with high blood pressure increased from 3,009 in 2001 to 3,133 in 2002, those with emphysema rose from 2,441 to 3,470, those with clogged artery from 1,456 to 1,898, and those with diabetes from 1,376 to 2,939 (6,7). The trends of number of illness and disease

have continuously increased time by time. It implies that the prevalence of monks' sickness caused by risk factor related health behaviors and environment.

There are many risk factors influencing the people health status in BMR. One of that is the factor of environmental health conditions, which give both direct and indirect effects to health. Noise pollution in Bangkok Metropolis is due to economic activities that create by industrial, commercial, and service sectors in the city. Noise can create adverse impacts such as obstruct communication, hearing loss, and slower decision. The left-over solid waste from households can cause many offensive odors and are unsightly as well as being breeding spots for flies and other vectors. Beside this, health impacts from air pollutants can also be considered harmful for respiratory system and carried other dangerous substances into the human body. It is evidenced that respiratory diseases are on the increasing especially during dry season (November-February) (8). Furthermore, many of food and water-borne diseases generally associated with environmental conditions. The Annual Epidemiological Surveillance Report of Epidemiological Subdivision, Disease Control Division, Department of Health, indicated that food supplied in BMR is high contaminated (8). In the year 2002, there were 39,144 cases of acute diarrhea in Bangkok which was 676.98 per 100,000 people (8). Swangjit J. (9) did a study on microbiological quality in vendor street food (fast food, curry, fried food, salad and dessert) in Bangkok and found that 96 of 140 samples (68.6 %) of vendor street food had exceeded the microbiological standard level. The microbiological quality of food, drinking water and food utensils in many schools in BMR were also over the standard requirement. It is confirmed by a study of Pukdeepol L. (10) whose found a contamination of various microbiological indicators in food, water and utensils. These poor environmental health conditions are existed in many parts of BMR especially the public places such as temple. Monks who left in this setting are unavoidable to face with and have environment related diseases.

This awareness of environmental problems was very essential for improving and promoting the health of Buddhist monks. Thus, in this research, the environmental health conditions of some BMR temples in terms of housing sanitation, water consumption, and food for monks were studied. The relationship of many bacteriological qualities and environmental compartments such used water, drinking

water, contact surface of food utensils, food, and suspended dust in ambient air were also determined. The results which indicate environmental health conditions of BMR temples and major environmental problem will be used as a database for health problem solving and promote monk health in a holistic view. As expect, it will promote and develop a good health status and quality of life as well.

1.2 Objectives of study

1.2.1 General objective

To evaluate environmental health conditions and its qualities of temples in Bangkok Metropolitan Region.

1.2.2 Specific objectives

- (1) To survey housing sanitation of Bangkok Metropolitan Region temples
- (2) To determine bacteriological qualities of various types of used water in Bangkok Metropolitan Region temples.
- (3) To compare the residual chlorine concentration with bacteriological qualities of water supply in Bangkok Metropolitan Region temples.
- (4) To study the bacteriological qualities of different types of ready-to-eat food for monk in Bangkok Metropolitan Region temples.
- (5) To compare the bacteriological qualities between breakfast and forenoon meal of food for monks in Bangkok Metropolitan Region temples.
- (6) To determine bacteriological contamination of various types of food utensils in Bangkok Metropolitan Region temples.

1.3 Hypotheses of study

1.3.1 The bacteriological qualities in each type of used water were different.

1.3.2 The bacteriological qualities in water supply were related to the residual chlorine concentration.

1.3.3 The bacteriological qualities in each type of ready-to-eat food for monk and meal were different.

1.3.4 The bacteriological contamination level in each type of contact surface of food utensils was different.

1.4 Variables of study

1.4.1 Independent variables

- (1) Type of water consumption.
- (2) Residual chlorine concentration in water supply.
- (3) Type of ready-to-eat food for monk.
- (4) Type of meal.
- (5) Type of food utensils.

1.4.2 Dependent variables

- (1) The bacteriological qualities of water.
- (2) The bacteriological qualities of food
- (3) The bacteriological contamination level of contact surface of food utensils.

1.5 Definition of Terms

1.5.1 Buddhist monk: A bhikkhu (man) between 20 and 75 years old who retires from the ordinary temporal concerns of the world, and devotes himself to Buddhist religion (Webster Dictionary). Monk life is based on 227 monastic rules and 5 major precepts. Monk, in this research, has to stay at a temple in BMR temple for at least one *vassa* (rainy season) and give a good collaboration.

1.5.2 Bangkok Metropolitan Region temple: The Buddhist temple locates in BMR. There are 30 sampled temples which located at inner city, urban fringe, and suburb area of BMR.

1.5.3 Environmental health conditions: The sanitary condition of housing, used water, drinking water, water supply, ready-to-eat food, and food utensils.

1.5.4 Housing sanitation: The physical environment of monk's dormitory (or KUTI) and temple. It is divided into outdoor environment (structure of housing,

solid waste management and ambient air quality) and indoor environment (facilities, lighting and noise).

1.5.5 Ambient air quality: The ambient air sample in front of KUTI and at 0.8 meter height from the ground is collected by using sterile glass filter type E of Hurricane air sampler for 10 minutes. Air sample flow of 10 ft³/min is as used.

1.5.6 Water supply: Source of water supply in this study was a tap water from Water Work Authority.

1.5.7 Residual chlorine concentration: Residual chlorine concentration in water supply was measured on-site by kit test.

1.5.8 Type of water consumption: A purpose of water usage in the temple. It was divided to used water (cleansing water in toilet, food utensil washing water and cloth cleansing water) and drinking water (water in container and bottled water).

1.5.9 Type of food for monk: It was composed of ready-to-eat food, meal, and food utensil.

1.5.10 Type of ready-to-eat food for monk: A ready-to-eat food which coming from offering food on the alms round in the morning and without reheating. There were five types of studied food namely clear soup, curry, fried vegetable, dressed salad and dessert. They were divided into two sets in order to represent a sample of breakfast and forenoon meal. A set of breakfast samples were kept in the morning and then the second set for forenoon meal samples were left out at ambient temperature until 11.00 a.m. without reheating.

1.5.11 Type of meal: Dining time of Buddhist monk. There were breakfast (before 7.30 a.m.) and forenoon meal (11.00–12.00 a.m.).

1.5.12 Type of food utensil: The food utensils were equipments which monk used for dining. The studied food utensils were dish, bowl, spoon, and glass.

1.6 Scope of study

1.6.1 The study was conducted with monks who had been ordained for at least one rainy season and had been living in temple in three zones of BMR (inner city, urban fringe, and suburb).

1.6.2 The environmental health conditions study covered only the aspect of sanitary condition of housing sanitation, water supply, water consumption, ready-to-eat food for monk, and contact surface of food utensils.

1.6.3 The data collection was conducted by using survey, inspection, questionnaire techniques, and environmental instrument.

1.6.4 The ready-to-eat food for monk which sampled in the morning time (before 7.30 a.m.) was a breakfast and the similar sample after holding in ambient temperature until 11.00 a.m. without reheating for forenoon meal.

1.7 Limitation of study

1.7.1 The study was done at only 30 temples that located at inner city, urban fringe, and suburb area of Bangkok Metropolitan Region.

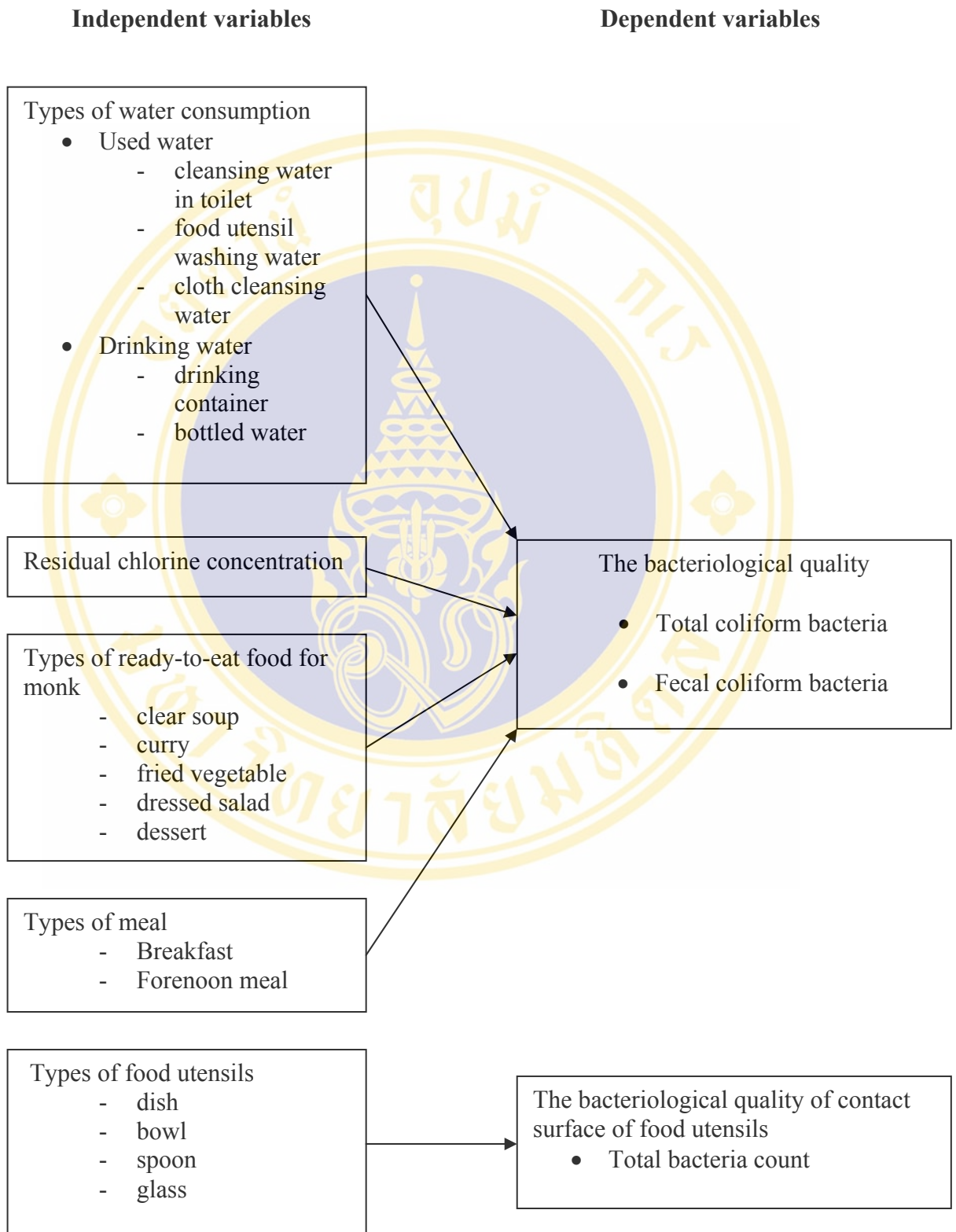
1.7.2 The cross sectional study was done at only period of time and one visiting for each temple.

1.8 Expected outcome

1.8.1 Results will be used as the basic information for improving environmental health condition in BMR temples.

1.8.2 Results will be used as the basic information supporting the holistic health promotion of Buddhist monks.

1.9 Conceptual framework



CHAPTER II

LITERATURE REVIEWS

2.1 Environmental Health Conditions

2.1.1 Housing sanitation

2.1.1.1 Structure of housing (11, 13, 14)

Temples can also be categorized as royal or common temples. Royal temples are registered under royal patronage. Members of other social groups support common temples. Royal temples are further sub-divided into first, second and third class, and are usually identified by the prefixes: Racha or Vora. The temples in each class are further graded by yet another ranking order based on a hierarchical system. Currently, about 180-200 temples are under royal patronage. However, for the highest grade of the first-class royal temples, there are only six temples. Four in Bangkok include Wat Phra Chetupon, Wat Mahathat, Wat Sutat, and Wat Arun. The two in the provinces include Wat Phra Pathom Chedi in Nakhon Pathom province and Wat Phra Phutthabat in Saraburi. Whatever the classification, most temples conform to a similar layout. In general, the temple compound is divided into two segments: the 'Phutthawat' area and the 'Sangkhawat' area. Phuttawat is the area where sacred Buddhist buildings are located. They include the 'bot' (ordination hall), 'viharn' (assembly hall), 'chedi' (pagoda) or 'prang' and other buildings such as gallery (cloister), 'sala karn parian' (a study hall), 'ho trai' (a library used to house the Tripitaka) and belfry. Sanghawath area, on the other hand, is the living quarters of the monastic community. Some temples restrict the entry of women in this area.

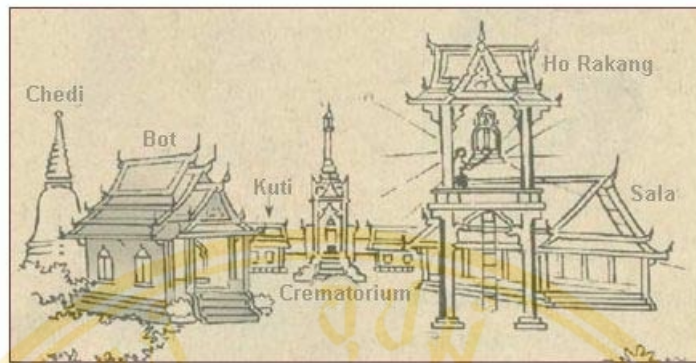


Figure 1 Thai temple compound (12).

Thai temple compound may find the number and type of buildings contained within the walls, and their functions a bit confusing. There was, however, a definite function and significance in each building, which made up a temple complex. The buildings in a Thai temple complex not only served sacerdotal functions in the cycle of Buddhist ceremonies and holy days but also served as the residence for the monks of the temple, and temple space served for educational and community service functions as well. The term Wat referred to a group of religious buildings generally enclosed by a wall with several gateways. According to artistic importance, the principal religious buildings in Thailand are: the Phra Chedi, the Bot, the Vihara, the Phra Prang, the Mondop and the Prasat. The other structures architecturally not very important are: the Kuti, Ho Trai, Sala Kan Parien, ordinary Salas and the Ho Rakhang. A Wat may contain just some of these structures or all of them. The most essential is the Bot, also called Ubosot. In general, with the exception of the Bot or of the Vihara, whose plan is conceived as a single unity within its enclosing gallery, the rest of the monuments are added little by little without special consideration of the general planning.

2.1.1.2 Solid waste management (15, 16, 17)

Solid waste can be classified into different types depending on their source: a) Household waste is generally classified as municipal waste, b) Industrial waste as hazardous waste, and c) Biomedical waste or hospital waste as infectious waste. Municipal solid waste consists of household waste, construction and demolition debris, sanitation residue, and waste from streets. This garbage is generated mainly

from residential and commercial complexes. With rising urbanization and change in lifestyle and food habits, the amount of municipal solid waste has been increasing rapidly and its composition changing. In 1947 cities and towns in India generated an estimated 6 million tonnes of solid waste, in 1997 it was about 48 million tonnes. More than 25% of the municipal solid waste is not collected at all; 70% of the Indian cities lack adequate capacity to transport it and there are no sanitary landfills to dispose of the waste. The existing landfills are neither well equipped nor well managed and are not lined properly to protect against contamination of soil and groundwater.

About collection of solid waste, it should be collected a minimum of once a week, but preferably twice a week. This collection frequency is based on life cycle of the house fly. Under ideal conditions, house flies develop from an egg into an adult in eight days. These flies breed in refuse. If garbage men collect and dispose of the solid waste within an eight day period, they will interrupt the life cycle of the fly. By collecting refuse in a timely manner people can greatly control fly population.

Waste that is not properly managed, especially excreta and other liquid and solid waste from households and the community, are a serious health hazard and lead to the spread of infectious diseases. Unattended waste lying around attracts flies, rats, and other creatures that in turn spread disease. Normally it is the wet waste that decomposes and releases a bad odor. This leads to unhygienic conditions and thereby to a rise in the health problems. The plague outbreak in Surat is a good example of a city suffering due to the callous attitude of the local body in maintaining cleanliness in the city. Plastic waste is another cause for ill health. Thus excessive solid waste that is generated should be controlled by taking certain preventive measures. Solid waste management is a clear indicator of the effectiveness of municipal administration.

The health effect of solid waste management particularly organic domestic waste poses a serious threat, since they ferment, creating conditions favorable to the survival and growth of microbial pathogens. Direct handling of solid waste can result in various types of infectious and chronic diseases with the human being especially, the waste worker. Moreover, uncollected wastes often end up in drains, causing blockages which result in flooding and unsanitary conditions. Flies

breed in some constituents of solid wastes, and flies are very effective vectors that spread disease. Mosquitoes breed in blocked drains and in rainwater that is retained in discarded cans, tyres, and other objects. Mosquitoes spread disease, including malaria and dengue. Rats find shelter and food in waste as well as spread disease. Aerosols and dusts can spread fungi and pathogens from uncollected and decomposing waste. Waste that is treated or disposed of in unsatisfactory ways can cause a severe aesthetic nuisance in terms of smell and appearance.

2.1.1.3 Ambient air quality (18, 19, 20, 21)

Ambient Air Quality affects everyone everywhere. Whether it is agricultural dust, pollution from vehicles, or smog from major industry, ambient air can have major effects on the health of individuals. Particles in ambient air are measured as total suspended particles (TSP), particles less than 10 micrometer in diameter (PM₁₀), black smoke (BS, soot), dust fall and suspended particulate. Suspended particulate includes dust, smoke and pollen and other substances emitted by natural sources and human activities. Transportation, mining operations, thermal power generation plants and waste incinerators are major sources of suspended particulate. Particulate matter is solid matter or liquid droplets from smoke, dust, fly ash or condensing vapors that can be suspended in the air for long periods of time, ranging from several minutes for the larger particles through to several days for very fine material. Particles range in size from molecular clusters of 0.005 mm to coarse particles of 50-100 mm in diameter. Particulate matter results from all types of combustion. The carbon-based particles that result from incomplete burning of diesel fuel in buses, trucks and cars are of particular concern. Another important combustion source is the burning of wood in stoves and fireplaces in residential settings. Dust storms are also a source of particulate matter.

The health effects of suspended particulate matter depend on particle size and concentration. The suspended particulate matter can affect visual air quality and can also have effects on human health, generally by irritating the eyes, mucous membranes and skin. Besides this, people with existing breathing complaints such as asthma, bronchitis or emphysema, are most susceptible to adverse effects from high concentrations of particulates. They include acute effects such as increased daily mortality and increased rates of hospital admissions for exacerbation of respiratory

disease. Evidence is also emerging that long-term exposure to low concentrations of particulate matter in air is associated with reduced life expectancy, increased rates of bronchitis and reduced lung function (WHO, 1999).

2.1.1.4 Lighting (15, 22, 23, 24, 25, 26)

Proper lighting is need of humans. If there is not enough light, eye strain and fatigue may result. Improper lighting can create glare, and hence, may cause accidents in addition to eye strain. Proper lighting can be accomplished by using either natural lighting or artificial lighting.

Some of advantages to providing properly designed lighting installation include fewer personnel mistakes, increased speed, improved morale, and enhanced comfort with less fatigue. A well-designed system may incorporate any one of three commonly used lamps-incandescent, fluorescent or mercury- as a light source. The choice may be based upon the visual task, economic factors, aesthetics, or combination of criteria.

For certain visual tasks requiring a quantity or quality of lamination are not provided by general lighting, the use of supplementary lighting is recommended. This usually implies high intensity luminaries directed on small work areas. Supplementary luminaries should be used in conjunction with an adequate general lighting system and they must be carefully shielded to prevent glare.

Lighting has a significant impact on people and their health, comfort, safety, productivity, and performance. The visual health problems are tiredness, watering or itchy eyes, and eye-focusing problems. All living things adjust their behavior according to natural light. Man's artificial light has done much to safeguard and enhance our night time environment but, if not properly controlled, obtrusive light can present serious physiological and ecological problems. Glare is the sensation produced by a light source that is sufficiently greater than the light level to which a person's eyes are adapted. Glare causes annoyance, discomfort, or loss in visual performance and visibility. The headlamps of an approaching car, for example, may cause glare. Another common source of glare is light shining through a window onto a television screen. Effective lighting designs avoid glare. In the other word, the proper lighting adjustment could be caused by a variety of effects including: increased

visibility, improved health, elevated mood, better behavior, reduction in the effects of daylight deprivation, and higher arousal levels.

2.1.1.5 Noise (27, 28)

Ambient or environmental noise is unwanted or harmful outdoor sound created by human activities, including noise emitted by means of transport - road traffic, rail traffic, air traffic and from sites of industrial activity. In addition, there are various sources of community noise, such as trucks, car, airplanes, helicopters and motorcycles.

Indoor noise consists of sound generated by the electric home can opener, mixer, knife, air conditioner, fan, radio and television.

Protection against excessive noise is need of humans. Housing in noisy environments needs soundproofing materials to reduce the noise. Adequate soundproofing is essential in multi-unit housing.

The health effects of noise according to The World Health Organization (WHO) lists are:

- Hearing impairment
- Speech intelligibility (when noise prevents us from being heard or understood)
- Sleep disturbance
- Physiological functions (such as hypertension)
- Mental illness (in terms of accelerating or intensifying mental disorders)
- Performance
- Social & behavioral problems (including annoyance and increased aggressive behavior)

Guideline values for community noise in specific environments are set by the World Health Organization, key guidelines include:

- During the day-time (7.00 a.m. – 11.00 p.m.), outdoor noise levels of 50 dB(A) should not be exceeded in order to prevent people from becoming 'moderately annoyed'.
- At night (11.00 p.m. – 7.00 a.m.), noise should not exceed 30 dB(A) to allow undisturbed sleep.

2.1.2 Water consumption

2.1.2.1 Used water (15)

Water is using for personal use, drinking, dishwashing and cleaning surfaces. There are many types of water as tap water, underground water and natural sources. They should be tested for bacteriological and chemical quality by the local public health, before it is used. Tap water is received directly from the main distribution pipelines. The storage containers are cleanliness and waterproof from the insides to prevent seepage. They should be kept covered as liable to contamination from pests, insects and animal. Furthermore, in water supplies it is necessary to prevent cross connection. A cross connection is physical connection between a potable water line and a line that contains a source of contamination. An example is a common garden hose attached to a faucet with the end of the hose lying in overflowing septic tank discharge.

2.1.2.2 Drinking water (29, 30, 31, 32)

There are many types of drinking water, which can classify to drinking water from natural resources, tap water and drinking water in close container. In Thailand, Food and Drug committee of Ministry of Public Health control drinking water in close container. The bacteriological standard of drinking water are not more than 2.2 MPN/100 ml and no detected in terms of total coliform and fecal coliform bacteria, respectively.

Bottled water products are normally categorized according to the source of water and the methods used by the bottled to treat it. Bottled water products are generally required to undergo disinfecting; ozone or ultraviolet technology.

The waterborne diseases remain one of the most significant threats to human health worldwide. According to WHO statistics, there are approximately 4 billion cases of diarrhea each year, caused by a number of different pathogens, including *Shigella*, *Campylobacter jejuni*, *Escherichia coli*, *Salmonella*, and *Cholera*, so these pathogens would have to be considered the most dangerous. Other major diseases related to unsafe water include *Schistosomiasis* and guinea worm.

There were researchers about quality of drinking water as follow;

Thantasupphasiri A. et. al. (33) reported quality of drinking water in Bangkok Metropolitan Authority (BMA) found that 159 bottled water samples, sold in

the market showed that physical and chemical aspects were within standards except the bacterial aspect which showed many kinds of bacteria and in high quantity. These included total coliform, coliform antagonists, *Ps. aeruginosa*, *S.aureus*, *Aeromonas sp.* and *C.perfringens*.

Nsanze H. et. al. (34) reported types of bottled were effect on the bacterial contamination of bottled. The rate and frequency of microbial contamination in 20 liters bottles was higher than 1.5 liters bottles. These organisms were more multiply easily under 25-37°C; whereas refrigeration or high temperature (around 42°C) could be reduce or maintain the status for at least 3 days.

Jeremy S. et. al. (35) reported sources of water, stored water and beverage samples were contaminated with total coliform bacteria and fecal coliform bacteria and hand rinse samples were contaminated with fecal coliform bacteria. They found that municipal piped water contaminated no detected fecal coliform bacteria, while 15-31 % of stored water samples were contaminated with fecal coliform bacteria.

2.1.3 Residual chlorine (36, 37)

Chlorine has been used since 1908 to disinfect water supplies in the United States to protect public health. Chlorine kills bacteria, including disease-causing organisms and the nuisance organism, iron bacteria. However, low levels of chlorine, normally used to disinfect water, are not an effective treatment for giardia cysts. The effectiveness of chlorination depends on the chlorine demand of the water, the concentration of the chlorine solution added, the time that chlorine is in contact with the organism, and water quality.

The safest way to be sure that the amount of chlorine added is sufficient is to add a little more than is required. This will result in a free residual chlorine that can be measured easily. This residual chlorine must be maintained for several minutes depending on chlorine level and water quality.

The amount of residual chlorine in the water should be measured on a regular schedule. Tests should be done at least twice daily for small plants and more frequently for larger plants. Most large plants will have an automatic chlorine analyzer that automatically measures the residual.

Residual chlorine measurements should be done on the distribution system at the areas farthest from the source of the water-treatment plant or the well. This ensures that the entire distribution system is receiving enough chlorine. If breakpoint chlorination is being practiced to obtain a free residual chlorine, the residual should be at least 0.2 to 0.5 ppm. If a combined-chlorine residual is being used for chlorination, the residual should be 1 to 2 ppm.

If the residual is low, the disinfection of the water system cannot be assumed to be complete and disease-causing bacteria (pathogens) may still be present in the water distributed.

Most chlorine analysis is preformed with the DPD method. Special DPD tablets that will change color in the presence of chlorine are added to a water sample. A color comparator or a colorimeter that automatically measures the intensity of the color is used to determine the concentration of chlorine residual in the water sample. Nowadays, kits are available for measuring the residual chlorine by looking for a color change after the test chemical is added. The test is simple and easy for a homeowner to perform. If chlorination is required for the water supply, the residual chlorine should be tested regularly to make sure the system is working properly.

2.1.4 Food (22, 31, 32, 39, 41)

To prevent food from causing illness, the following principle of proper food handing should be observed during purchasing, storage, preparation and service of food. Cooking food reduces the number of bacteria present in food. The food handlers should realize that conventional cooking procedures do not kill all bacteria and spores or inactive their toxins. Hence, even cooked food should be handled very carefully. Bacteria present on the surface of food get distributes throughout the food and it is necessary for the centre of food to reach a temperature of at least 70 °C for two minutes while it is being cooking. Moreover, food should be prepared when it is needed and served as soon as it is prepared. Proper holding is necessary to keep food for a period and also occasionally heating. Food is frequently considered “spoiled” when quantitatively minor and physiologically insignificant changes occur but where there is a marked change in taste, odor, texture and/or appearance. Much of the microbial origin of these changes can be traced to environmental contamination rather than inherent micro flora.

Foodborne diseases are the illnesses contracted from eating contaminated food or beverages. Illnesses include foodborne intoxications and infections, which are often incorrectly referred to as food poisoning. The following questions link to resources that provide safety and health information relative to foodborne disease. There are more than 250 known foodborne diseases. Bacteria cause most cases, followed by viruses and parasites. People infected with foodborne germs may have no symptoms or develop symptoms ranging from mild intestinal discomfort to severe dehydration and bloody diarrhea. Symptoms of foodborne illness range from mild gastroenteritis to life-threatening neurologic, hepatic, and renal syndromes.

Foodborne illness is caused by bacteria like campylobacter and salmonella. The bacteria multiply very fast in warm, moist conditions. Luckily these illnesses are avoidable. By following these simple food handling tips in order to safe from foodborne illness.

Clean

Clean hands are hands that are washed with soap and dried with a clean towel. It's important to always wash your hands before handling food, but just as important to wash them after:

- handling raw meat and poultry
- going to the toilet
- changing nappies
- handling pets
- gardening.
- Wash knives and utensils, and scrub chopping boards between preparation of raw and cooked foods.
- Keep your fridge clean.

Cook

- Defrost frozen foods thoroughly before cooking.
- Never leave hot food to cool for more than two hours before putting it in the fridge. Keep foods covered.
- Reheat leftovers until steaming hot throughout and do not reheat more than once.

- Cook minced meat and sausages thoroughly (meat should not be pink) and cook poultry until juices run clear.

- Pre-cook minced meat, sausages and poultry before barbecuing.
- Do not put cooked meat back on the same plate that held raw meat.

Cover

- Cover all foods before storing.
- Keep raw meat and poultry covered and away from ready-to-eat food, fruit and vegetables.
- Cover food when outdoors to prevent insects and bugs getting into it.
- Keep raw meat and poultry in the bottom of the fridge to ensure juices don't drip onto other foods.
- The only time your food should be uncovered is when you're eating it.

Chill

- Bacteria that cause foodborne illness thrive at room temperature - keep food very cold or very hot.
- A chilly bin is a good way of keeping chilled and frozen products cold when taking them home from the supermarket.
- While picnicking, keep food cool by using a frozen chilly pad.
- Defrost frozen foods in the fridge.
- Marinate food in the fridge, not on the bench.
- Ensure your fridge is operating at a temperature of between 0 and 4°C.

2.1.5 Food utensil (38, 39, 40)

Utensils and equipment should be functional, easy to clean, durable, with smooth sealed surfaces which do not harbor dirt, made of non-toxic and corrosive material and safe to use. While washing and air drying utensils and equipment are also realizing manner.

The importance of proper cleaning can be appreciated when one realizes that contaminated equipment (equipment and utensils which are not clean) is another major cause of foodborne disease outbreaks. Cleaning comprises many operations in the food establishment, and the process is usually specific to the type of cleaning necessary. No cleaning task in the food establishment is as important as the cleaning

and sanitization of food contact surfaces of equipment and utensils. Food contact surfaces of equipment and utensils are those surfaces with which food normally comes into contact. These surfaces also include surfaces from which food may drain, drip or splash back onto surfaces normally in contact with food. Effective cleaning and sanitization of food contact surfaces of equipment and utensils serve two primary purposes:

- Reduces chances for contaminating safe food during processing, preparation, storage and service by physically removing soil, bacteria and other microorganisms.
- Minimizes the chances of transmitting disease organisms to the consumer by achieving bacteriologically safe eating utensils.

Although we all know about the practice of "washing" many do not understand and/or appreciate the principles and exactness of the process. For the most part, chemistry plays a very important part in the cleaning and sanitization process. Washing equipment and utensils until visibly clean is just not enough.

Ware washing cycle

The following numerated list and comments pertaining to the wash cycle of food contact surfaces in figure 2 will help supervisors and managers appreciate why there is a particular order in the process.

1. Equipment and Utensils Clean Prior to Use. Properly cleaned and sanitized equipment and utensils should be bacteriologically safe prior to use. Should contamination be suspected, the equipment and/or utensils should not be used, but recleaned and sanitized.

2. Soiled Equipment and Utensils. During use, equipment and utensils become soiled and contaminated with bacteria.

3. Scraping, Preflushing and Presoaking. Scraping, preflushing and presoaking, as necessary, are methods for removing gross amounts and stubborn soil from equipment and utensils.

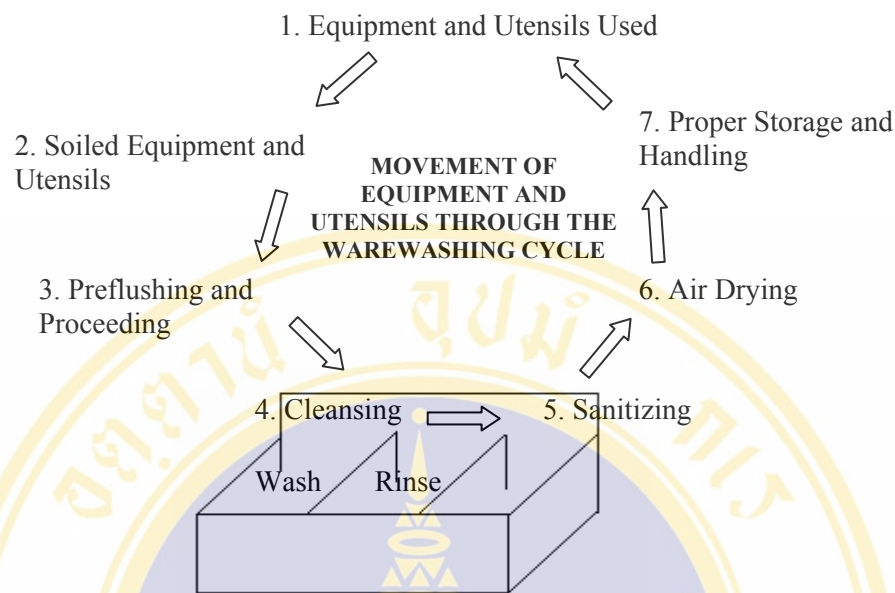


Figure 2 Movement of equipment and utensils through the ware washing cycle (40).

4. Cleaning. There are four steps in the cleaning process washing, rinsing, sanitizing and air drying:

Washing. When using proper detergents, cleaners, chemicals and abrasives, removes the remaining soil from equipment and utensils. This is a physical and a chemical process. The soil and bacteria, as well as cleaning compounds, are suspended in the wash water; and

Rinsing. Removes most of the suspended soil, bacteria and cleaning compounds from the equipment and utensils. Although the equipment and utensils look visibly clean at this point, they are still contaminated with many bacteria.

Sanitizing. Sanitizing kills the remaining pathogenic organisms on the equipment and utensils. Sanitization will occur when certain specific chemical concentrations, temperature requirements, time requirements and water conditions are satisfied. These conditions are crucial for effective sanitization. Therefore, precise measurements of the sanitization process are made periodically. No rinsing or any other cleaning process should take place after the sanitizing process

Air drying. The only acceptable method of drying equipment and utensils is air drying. The use of towels for drying, polishing or any other purpose re-contaminates equipment and utensils with bacteria.

5. Proper Storage and Handling. Proper storage and handling of cleaned and sanitized equipment and utensils is very important to prevent recontamination prior to use. Cleaned and sanitized equipment and utensils must be stored on clean surfaces and handled to minimize contamination of food contact surfaces.

2.2 Relationship between health and environment (15, 22)

Considering the world's population as a whole, the environment more strongly affects people's health than any of the other determinants. For example, the water we drink, the food we eat. The air we breathe, become part of our body. In the past, due to poor environmental management, many people have died from environmentally – related diseases such as typhoid fever. Some estimates, based on morbidity and mortality statistics, indicates that the impact of the environment on health status ranges to as high as 80 percent.

A lack of sanitation may result in the spread of communicable diseases. In lesser developed countries, this is the most important component in determining the state of the public's health. Therefore, environmental control is very important in controlling the etiological (causative) agents of disease before they get to people.

Environmental health practice, as the name suggests, encompass the relationship between environment and health. Some important aspects of environmental health practice, the first time of defense against disease, include the following:

1. Water quality management – insuring that potable water is available through treatment of water supplies.
2. Human waste disposal – disposing of human wastes in septic tank systems and sewage treatment plants
3. Solid and hazardous waste management – treating and disposing of solid and hazardous wastes.
4. Rodent control – removing potential harborage and sources of food.
5. Insect control – utilizing biological or other methods to control insects.

6. Milk sanitation – insuring that all milk for human consumption is produced under sanitary conditions and is pasteurized.

7. Food quality management – maintaining surveillance over the food from the farm to the consumer so as to prevent contamination.

8. Occupational health practice – assuring that a healthy and safe work environment is available.

9. Interstate and international travel sanitation – preventing the spread of communicable disease between states and nations.

10. Air pollution control – controlling the emission of pollutants to the atmosphere.

11. Water pollution control – reducing the effect of industrial waste, etc., on water supplies and recreational areas via the pretreatment of industrial and domestic waste water.

12. Environmental safety and accident prevention – designing into the environment features that promote safety or compensate for people's inadequacies, such as pedestrian ramps.

13. Noise control – controlling noise in industrial settings and in the community to avoid degrading the public's health.

14. Housing hygiene – insuring that house contains conditions necessary for the physiological and psychological well – being of humans.

15. Radiological health control – controlling radiation sources such as X-ray equipment, nuclear fission plants, and radioactive waste.

16. Recreational sanitation – monitoring the environment to prevent unsafe conditions at swimming pools and other recreational area.

17. Institutional environmental management – preventing the spread of nosocomial infections.

18. Land use management – zoning so as to limit the use of land to only desirable purposes.

19. Product safety and consumer protection – insuring that drugs, toys, appliances, etc., are safe for human use.

20. Environmental planning – applying environmental design in order to minimize human stress and accidents.

2.3 Some bacterial indicators of environmental health conditions

One of the important biological organisms in environmental health is bacterial, these organisms capable to infect or cause transmission disease to humans. Many species are able to survive in environment and maintain their infectious capabilities for significant period of time (42). Indicator bacteria are also important to determine the quality of environment. Microbiological examination for fecal indicators is the most sensitive and specific method for detecting recent fecal pollution because it is unsafe for human consumption in terms of unsanitary condition (43).

2.3.1 Total bacteria

Only viable cells are represented if the total count is obtained by plating method and even then only those cells capable of forming colonies under the specific conditions of medium pH, incubation temperature, etc., are enumerated. Total plate counts or aerobic plate counts are favorite method to detect total bacteria.

2.3.2 Coliform bacteria

Total Coliform bacteria are a group of bacteria that are easily cultured and identified in the laboratory. It is most likely a selected bacteria for water quality test. Included in this group of Total Coliform bacteria are the Fecal Coliforms; these bacteria mostly come from warm-blooded animal wastes. One specific subgroup of the Fecal Coliform group is the *E. coli* group of bacteria. These *E. coli* are primarily from human wastes and can pose a threat to human health.

The coliform group of bacteria is members of the family Enterobacteriaceae. It comprises all aerobic and facultative aerobic, gram-negative, nonspore-forming rods able to ferment lactose with production of acid and gas at 32°C within 48 hours, illustrate in figure 3 (44). The coliform group can be grow at temperature as low as 10°C and as high as 46°C. Moreover, it can grow over a pH range of 4.4-9.0. Coliforms grow well on nutrient agar and produce visible colonies within 12-16 hours at 37°C. One source of these organisms is the intestinal tract of warm-blooded animals; certain bacteria of non-fecal origin also are members of this group (called “Total coliform bacteria”). Typically, these organisms are classified in the genera *Escherichia*, *Enterobacter* and *Klebsiella*. The occurrence of this organism in large numbers in processed food does not indicate fecal contamination in the sense of

demonstrating recent contact with fecal matter. Then, the coliform group can be expected to grow in a large number of foods under the proper conditions and poor practice; contaminated or inadequately processed raw materials, personnel contamination, improperly cleaned and sanitized equipment or food contact surfaces. All of which suggest that enteric pathogens may have entered the food product through the same route (45).

Some of the characteristics that make the coliform bacteria important in food spoilage are (46):

- (1) Their ability to grow well in a variety of substances and utilize a number of carbohydrates and some other organic compound as food for energy and a number of fairly simple nitrogenous compounds as a source of nitrogen.
- (2) Their ability to synthesize most of the necessary vitamins.
- (3) Their ability of group to grow well over a fairly wide range of temperature
- (4) Their ability to produce considerable amounts of acid and gas from sugars.
- (5) Their ability to cause off-flavors often described as “unclean” food

Fecal coliform bacteria are defined by the production of acid and gas in EC broth between 44-46°C (usually 44.5–45.5°C). A test fecal coliform is essentially a test for *E.coli* type I (47). Fecal coliform bacteria and *E.coli* may be used interchangeably. It showed that fecal coliform analysis was sufficient for rapid routine determination of fecal contamination (48).

Total coliform is bacterial contamination indicators from environmental condition as polluted soil, water, air, and animals to food. Fecal coliform bacteria is bacterial contamination from only fecal indicator (43).

2.3.3 Indicators organism in assessing the sanitation of food contact surfaces of utensil

The maintenance of an effective sanitation program is essential if food safety is to be assured. Food contact surfaces should be cleaned and sanitized and keep safety to avoid recontamination. The adequacy and effectiveness of cleaning and sanitizing should be monitored adequately with a bacteriological control program. When the surfaces are those of small utensils such as spoon, dishes, knives, etc. improperly

cleaned and sanitized surfaces constitute a significant source of microorganisms to food during processing and handling.

The methods to enumeration of microorganisms on surfaces have many techniques as swab method, agar contact method and surface rinse method. Swab method is the oldest and most widely used techniques for examination of surfaces for microorganisms. It allows for sample dilution and consequently less chance for false positive or negative medium reactions (49).



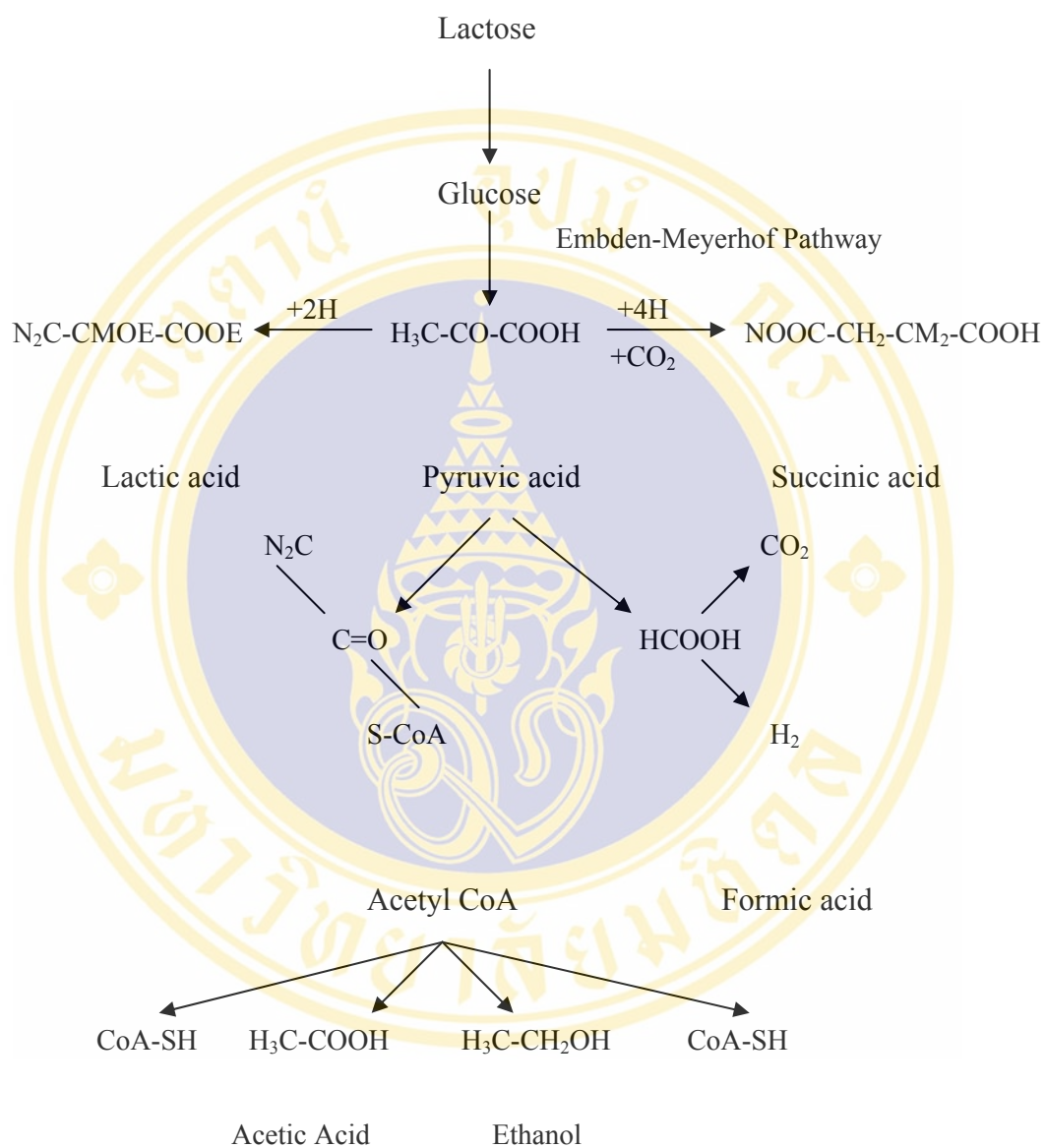


Figure 3 Acid and gas forming from lactose by total coliform and fecal coliform bacteria's mechanism (49).

2.4 Related studies

Swangjit J. (50) studied microbiological quality in vendor street food shops in Bangkok found that vendor street food exceeded the microbiological standard 68.6%. In these samples found total coliform and *E.coli* are 89.6% and 21.9% respectively. The geometric mean of coliform contaminants in fast food (ready-to-eat-cooked) were significant higher than that dessert, fried food and curry (<0.0001), respectively.

Umoh V.J. (51) studied about safety and evaluation of street foods sold in Nigeria. They found that sanitary handling of street food is major contribution to contamination in food. Ready-to-eat foods in unsanitary locations are susceptible to contamination by flies and dust-laden microorganism. Furthermore, most of foods were generally prepared in bulk (84.4%) and displayed for a whole day (more than 6 hour) for sale at ambient temperature without rewarming.

Frank L.B. (52) studied about Hazard and critical control points (HACCP) of vending operations at bus station in Pakistan. They found that the major factor that contributed to outbreaks of food borne diseases in developed countries is holding food at ambient temperature for several times. This situation ought to be important critical control point.

Luksamijarukul P. (53) studied about bacterial quality of Ready-to-eat food and drinking water at Ratchburi province. They were collected 121 samples for determining coliform and fecal coliform by using MPN method. The results revealed that 72.86% and 58.57% of ready-to-eat food were contaminated with coliform and fecal coliform, respectively. Approximately 76.47% and 72.55% of drinking water were contaminated with coliform and fecal coliform. The contamination rates were compared with standard quality of food and drinking water, it was found that 42.86% and 76.47% of food and drinking water samples were contaminated with over cut-off standard level.

CHAPTER III

MATERIALS AND METHODS

3.1 Research design

The research was designed as a cross-sectional study. It was done at selected 30 temples which represent the Buddhist temple in BMR (Figure 4). The environmental health conditions were surveyed and environmental samples from 12 temples were collected for laboratory analysis. There were 4 types of environmental samples for each temple. Each temple, number of water consumption, food utensils, ready-to-eat foods for monk, and ambient air sample was 5, 4, 10 and 1, respectively. Total number of water consumption, food utensils, ready-to-eat foods for monk, and ambient air samples was 60 (12 temples $\times$ 5 samples), 48 samples (12 temples $\times$ 4 samples), 120 samples (12 temples $\times$ 10 samples) and 12 samples (12 temples $\times$ 1 sample), respectively. The overall samples were 240 (60 + 48 + 120 + 12). Indoor lighting intensity and sound level were also measured. Besides, the Buddhist monks who lived in that selected temples were interviewed with questionnaire. There were 417 interviewed monks from all selected temples.

3.2 Place of study

Environmental samples for analysis were collected from the designed temples in BMR that located at inner city, urban fringe, and suburb. They were analyzed in a laboratory at Department of Environmental Health Sciences, Faculty of Public Health, Mahidol University, Bangkok, THAILAND.

3.3 Studied temple and monk

There were around 11,862 Buddhist monks live in 436 temples located in BMR. The selection in this study was based on a number of monks who lived in three

locations of the BMR. The sample in this study was selected based on the following criterias:

1. They had been monks for at least one *vassa* (rainy season) and resided in a temple in Bangkok;
2. They were able to read and write the Thai language;
3. They were between 20 and 75 years old; and
4. They were willing to participate in this study.

3.3.1 Determination of number of studied monk

3.3.1.1 The sampling size was calculated using a statistical formula of Daniel W.W. (54):

$$n = \frac{Z_{\alpha/2}^2 N \pi (1-\pi)}{Z_{\alpha/2}^2 \pi (1-\pi) + (N-1)d^2}$$

When N = the exact size of the population (11,862 Buddhist monks)

n = the sample size when the exact population was known

Z = the standard statistics under the normal curve equal to 1.96

d = the accepted maximum absolute deviation value of 0.05

π = the unknown ratio of the population estimated with the sample ratio (P) (which in this study was derived from the study of Wimala S. (55) ($p = 0.55$). The formula used was as follows:

$$\begin{aligned}
 n &= \frac{(1.96)^2 (11,862)(0.55)(0.45)}{(1.96)^2(0.55)(0.45) + (11,862)(0.05)^2} \\
 &= \frac{11,278.342}{29.657378} \\
 &= 380.2879
 \end{aligned}$$

Therefore, the sample size obtained was 380 monks. However, in this study, data were collected from 417 monks as there were a number of variables in the analysis, and according to the agreement.

3.3.1.2 The sampling method used in this study was probability sampling with stratified random sampling. That is, the monks under the Mahanigaya Sect and Dhammayutika Sect living in Bangkok were divided into three zones according to the classification of the Division of Urban Planning, Bangkok Metropolitan Administration (56): inner city, urban fringe, and suburb as follows:

1. The inner city consisted of 22 districts: Phra Nakorn, Pomprap Sattruphai, Samphanthawong, Patumwan, Ratchatewi, Bang Rak, Dusit, Phaya Thai, Bang Plad, Bangkok Noi, Bangkok Yai, Sathon, Yannawa, Bangkho Laem, Bang Sue, Klongsan, Thonburi, Chatuchak, Huay Kwang, Dindaeng, Khong Toey, and Wattana.

2. The urban fringe is composed of 22 districts divided into 14 districts in the east, namely, Don Muang, Lak Si, Bang Khen, Sai Mai, Lad Phrao, Bangkokpi, Bung Kum, Wang Thong Lang, Kanna Yao, Saphansoong, Suan Luang, Praves, Pra kanong, and Bang Na, and eight districts in the west, namely, Taling Chan, Taweewattana, Phasicharoen, Bangkae, Nong Khaem, Ratburana, Thung Khru, and Chom Thong.

3. The suburb covers six districts, four in the east: Min Buri, Khlong Samwa, Lad krabang and Nong Chok, and two districtes in the west: Bang Khunthian and Bang Bon.

3.3.1.3 This research sample size was determined by proportional allocation with the number of population in each zone using the following formula (59):

$$n_h = \frac{N_h}{N} \times n$$

When n_h = sample size in each zone

n = sample size (400 Buddhist monks)

N_h = population size in each zone

N = Total population (11,862 Buddhist monks)

The number of monks in each zone was as follows:

The inner city = 6,341 Buddhist monks

The urban fringe = 4,689 Buddhist monks

The suburb = 832 Buddhist monks

The sample size in each zone was then calculated using the formula, and the results obtained were shown in the Table 1.

Table 1 Number of monk population and calculated sample size in each zone

Zone	Population	Sample size
Inner city	6,341	214
Urban fringe	4,689	158
Suburb	832	28
Total	11,862	400

3.3.1.4 The samples was then selected using stratified random sampling by cluster sampling technique to select the temples for interviewing from both *Dhammayutika* Sect and *Mahaniggaya* Sect in each zone. For environmental sampling, cluster sampling was reused to determine number of selected temple from 30 sampled temples. The number of sampled temples and Buddhist monks had been revised during data collection period as shown in Figure 4.

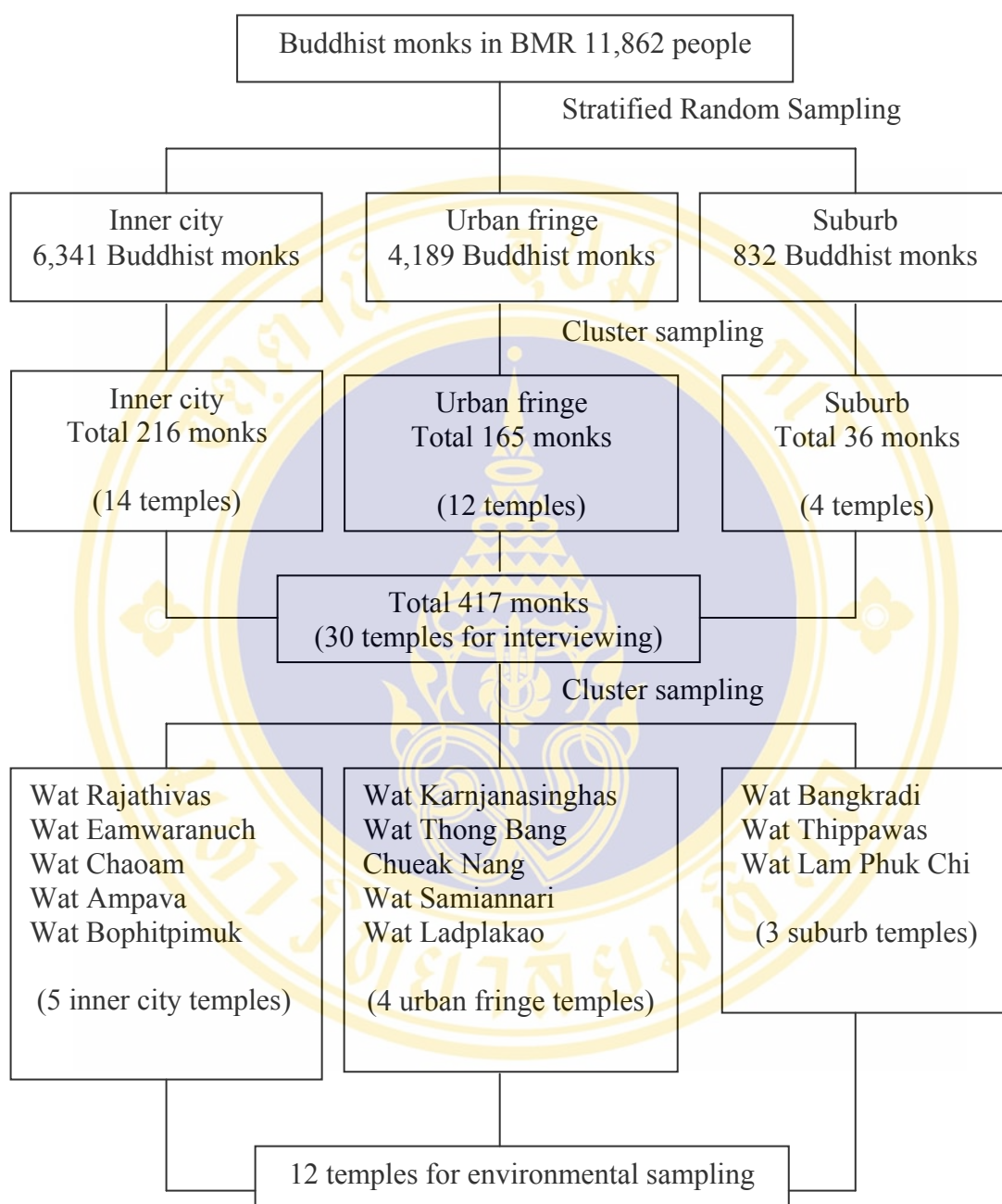


Figure 4 Stratified Random Sampling by Cluster

3.4 Equipment and chemical reagent

3.4.1 Equipment

3.4.1.1 Equipment for sample collection (indoor environmental indices, used water, drinking water, food utensils, ready-to-eat food)

- (1) Ice container
- (2) Sterile bottle
- (3) Alcohol lamp
- (4) Sterile stainless spoons
- (5) Sterile cotton in aluminum foil
- (6) Lux meter (Model Digicon Lx-50)
- (7) Hurricane air sampler (Model 16003)
- (8) Sound level meter (Type 450B Sound level meter Type 3)

3.4.1.2 Equipment and instrument for ready-to-eat food

analysis :

- (1) Steriled petri dishes
- (2) Tubes and durham tubes
- (3) Steriled pipettes 0.1, 1 and 10 ml.
- (4) Steriled stomacher bags (Seward BA 6141 standard bags)
- (5) Stomacher (Stomacher 400 Model BA 7021 Seward)
- (6) Balance meter (Tania Model 1144)
- (7) Hot plate and stirrer
- (8) Water bath
- (9) Autoclave
- (10) Incubator
- (11) Refrigerator
- (12) Vortex mixer (Model K-550-GE)
- (13) Colony counter (Darkfied Quebec)
- (14) Sterile stainless spoons and forceps
- (15) Wire loops
- (16) Stirring rods
- (17) Alcohol lamp

(18) Flasks and beakers

3.4.1.3 Equipment and instrument for used water and drinking

water analysis:

- (1) Sterile pipette 1, 5 and 10 ml.
- (2) Tubes and durham tubes
- (3) Water bath
- (4) Incubator
- (5) Alcohol lamp
- (6) Vortex mixer
- (7) Wire loop
- (8) Test kit for performing colorimetric tests on free and total chlorine in surface water and sewage (Viscolor ECO)

3.4.1.4 Equipment and instrument for food utensils and indoor

air analysis:

- (1) Sterile petri dishes
- (2) Sterile pipettes 1ml.
- (3) Incubator
- (4) Alcohol lamp
- (5) Glass fiber filter

3.4.2 Chemical reagent

3.4.2.1 Reagent for preparation Phosphate Buffered Saline

(PBS):

- (1) Potassium dihydrogenphosphate KH_2PO_4
- (2) Magnesium sulfate ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$)
- (3) Sodium hydroxide (NaOH)
- (4) Distilled water

3.4.2.2 Reagent for water consumption and ready-to-eat food analysis (culture media for total coliform bacteria and fecal coliform bacteria analysis)

- (1) Lactose broth (Merck)
- (2) Brilliant green lactose 2 % bile broth (Merck)
- (3) EC broth (Merck)

3.4.2.3 Chemical reagent for food utensils and ambient air quality (culture media for total plate count analysis)

(1) Plate count agar (Merck)

3.5 Research Methodology

The environmental health conditions studied by these means;

3.5.1 Inspection form

The inspection form was designed as an open end questions. It concluded of general temple information and other qualitative data of environmental health conditions beyond those in the questionnaire.

3.5.2 Questionnaire

The questionnaire was used for interviewing Buddhist monks about the environmental health conditions in temple. It was designed as a multiple choices and fill in blank questions. The developing steps were as follow;

Step 1 Design core content of questionnaire. The content was divided to six parts as follow;

Part 1 : Water use and drinking water

Part 2-5 : Housing sanitation

Part 6 : Food sanitation

Step 2 Determine content validity. The first draft of questionnaire was sent to specialists for auditing the content.

Step 3 Correct wording and vocabulary. All the content was revised as recommendation from specialists and called second draft.

Step 4 Pretest the second draft questionnaire. The questionnaire was tested to find out its reliability. A sample group who had similar characteristics with the research population was selected and trialed with this questionnaire.

Step 5 Rewrite the third draft questionnaire. The questionnaire was rewritten according to all corrections from a pretest study.

Both inspection form and questionnaire were used to interviewing selected Buddhist monks. They were informed for the purpose of study and provided an assurance that the confidentiality of respondents was respected.

3.5.3 Environmental analysis

3.5.3.1 Outdoor environmental analysis

1. Ambient air quality

The suspended dust sample of ambient air quality in front of KUTI and at 0.8 meter height from the ground was collected by using sterile glass filter type E of Hurricane air sampler for 10 minutes. Air sample flow of 10 ft³/min was used. The sampled dust was immediately kept in sterile petri-dish. After that, the sample was brought to analyze for total bacteria count in laboratory and calculated the weight of suspended dust in each temple (mg/m³ of air), total bacteria count by weight of suspended dust (colony/g of dust), and total bacteria count by volume of air (colony/m³ of air).

3.5.3.2 Indoor environmental analysis

1. Lighting intensity measurement

Natural and fluorescence lighting of intensity in KUTIs was measured by using Lux meter. The unit of this measured intensity is Lux and determination range is from 0 to 50,000 Lux. It is an international metric unit of luminance and is the unit which indicates the intensity to which a surface is lit, or the brightness of the light. One lux is equal to one lumen per square meter (lm/m²) which indicates how much light that falls on a surface.

2. Sound level measurement

Sound level measurement in KUTIs was measured to evaluate noise by using Sound level meter. It is an instrument designed to react to a noise as same as the human ear. The measurements were taken by sound level meters. The measured result was compared to known standards to identify whether the noise level could have a detrimental effect on human located near the noise source.

3.5.3.3 Water consumption analysis

Used water (cleansing water in toilet, food utensil washing water, and cloth cleansing water) and drinking water (water in container, bottled water) were sampled by aseptic technique and kept in sterile bottles. All samples were maintained at low temperature in an ice container and brought to analyze for total coliform and fecal coliform bacteria in laboratory within 1-3 hours. The analyzed methods followed a procedure of standard method of water and wastewater analysis (7).

Moreover, residual chlorine measurements of water supply were done on-site with the tap water by kit test. Their result could be determined from a color change after the test chemical was added.

3.5.3.4 Food for monk analysis

1. Ready-to-eat foods

Five types of food samples of monk breakfast (before 7.30 a.m.) were sampled by using sterile aluminum spoons and divided to two sets in order to represent a sample of breakfast and forenoon meal. A set of breakfast samples were kept in sterile plastic bags and tighten with rubber ring. After labeled, they were kept in an ice container and brought to analyze for total coliform bacteria and fecal coliform bacteria in laboratory within 1-3 hours. The second set for forenoon meal samples were left out at ambient temperature until 11.00 a.m. then kept in sterile plastic bag and tighten with rubber ring. It followed handling methods as a first set. All samples were analyzed by follow a standard method of food analysis (60).

2. Food Utensils

The monk dining utensils were sampled and determined bacteriological contamination by using cotton swab method. A surface of selected sample was swabbed by sterile cotton bud and kept in sterile phosphate buffered saline. They were brought to analyze for total bacteria count in laboratory as method described in standard method of analysis (60, 61).

The summary of environmental samples analysis was shown in Table 2

Table 2 Parameter and the analytical method for environmental sample analysis

Environmental sample	Analytical method/instrument	Determination parameter
Suspended dust	Bacteriological quality	Total bacteria count
Water consumption		
• Used water	Residual chlorine	
	Bacteriological quality	Total coliform bacteria Fecal coliform bacteria
• Drinking water	Bacteriological quality	Total coliform bacteria Fecal coliform bacteriaa
Food for monks	Bacteriological quality	Total coliform bacteria Fecal coliform bacteria
Food utensils	Bacteriological quality	Total bacteria count

3.6 Statistical analysis

3.6.1 Descriptive statistics

Mean, standard deviation and percentage were used for explaining environmental health conditions of Buddhist monks in BMR temples.

3.6.2 Inferential statistics

Analysis of relationship between bacteriological quality of analyzed samples with type of used water, type of ready-to-eat foods, type of meals, and type of food utensils were calculated by using Chi-Square. The statistical significance was expressed by p-value at $\alpha = 0.05$ in this study.

CHAPTER IV

RESULTS

4.1 Housing sanitation of Bangkok Metropolitan Region temples

In this research, housing sanitation was the physical environment of monk's dormitory (or KUTI) and temple. It was divided into outdoor environment (structure of housing, solid waste management and ambient air quality) and indoor environment (facilities, lighting and noise). All data was inquired by using the questionnaire, inspection form and environmental analysis instruments.

4.1.1 The outdoor environment

From the interview, most temples in BMR had long history of organizing and progression. Temples in BMR were increased significantly in the period of the Third Reign (1824-1851) in which there were 83 temples established (62). For example, most studied temples in inner city had been established since 154 to 181 years ago during the end of Ayutthaya era or King Rama III. Similarly, the studied temples in urban fringe and suburb area had also been created for more than 140 years. There were varieties of type of monk's dormitory. The major building (48.7%) had second floor and constructed with concrete and wood. It was found in the inner city (55.8%), urban fringe (44.2%) and suburb (25.7%). While 39.2% of KUTIs was built from concrete and locates in the inner city 34.0%, urban fringe 47.9% and suburb 31.4%. Only 12.1% was constructed with wood which distributes in the inner city 10.2%, urban fringe 8.0% and suburb 42.9%. However, all structures were both unplanned design and located.

For solid waste management, most temples were serviced by Department of Public Cleansing in BMA. The questionnaire was then asked for a satisfactory level (high, medium, and low) in terms of collection frequency of service, residual solid waste, type and amount of waste container as well as location of them. In case of collection frequency of service, 24% of Buddhist monks had high satisfy level which

was 19.8% for inner city, 26.5% for urban fringe and 37.1% for suburb. 65% of Buddhist monk had medium satisfy level. It was come from inner city 73.1%, urban fringe 59.3% and suburb 42.9%. Only 11.0% of Buddhist monk had low satisfy level which was inner city 7.1%, urban fringe 14.2% and suburb 20.0%. Regarding to the solid waste residue, 53.9% had medium satisfy level and 32.6% had low satisfy level. There was only 13.2% had high satisfy level which came from the zone of inner city 11.3%, urban fringe 14.9% and suburb 17.1%. The percent of medium satisfy level in each studied zone did not much different from 51.4%-57.1%. At the same time the amounts of response in low satisfy level ranged in each zone (28.0%-36.8%) was also similar. For amount of the waste container, 58.0% of the studied monk had medium satisfy level. Those amounts of high and low satisfy level were 24.1% and 17.8%. The three zones gave similarity response of satisfactory. The voice to type of waste container were 18.7%, 58.9%, and 22.1% for high, medium and low satisfy level, respectively. The amount of Buddhist monk who had low satisfied level was not different in each studied zone (17.3%-20.4%). The medium satisfy level 62.9%-68.2% was from Buddhist monks in inner city and suburb area whereas only 45.7% was from an urban fringe. The high numbers of low satisfy level (33%) were given from an urban fringe while the rest areas were 14.5% to 17.1%. In case of location of the waste container, 20.5% of Buddhist monk had high satisfy level in which 20.6% was from the inner city, 19.3% was from the urban fringe and 25.7% was from the suburb area. 57.3% of Buddhist monk had medium satisfy level. It was divided to inner city 64.0%, urban fringe 48.4% and suburb 57.1%. Low satisfy level was 22.2% and given by the inner city 15.4%, urban fringe 32.3% and suburb 17.1%. Besides this, the survey was found the unsanitary management and housekeeping of solid waste. The rubbish and animal feces were main causes of waste scattering around temple and being a breeding site for insects and vectors (rats, flies and cockroaches). 41.6% of Buddhist monk said that wastes were sanitary collection and elimination. 51.3% of them gave the left food to dogs and cats. Almost 82.6% of Buddhist monks had waste container situated nearby (0-400 meters) their KUTIs. Furthermore, 91.4% of Buddhist monks found some insects and carriers inside their KUTIs. There were mosquitoes (46.6%), cockroaches (25.5%), pets (11.1%), rats (8.5%) and flies (8.0%). The favorite eliminated and controlled method was using insecticide in form of aerosol (65.0%).

For ambient air quality, 55.7% of Buddhist monk had dust in the medium level (dust was appeared after cleaning for half to one day) on the surface of temple or KUTIs. It was contributed from inner city 60.5%, urban fringe 54.3% and suburb 34.3%. The highest dust quantity was found in the area around the temple and KUTIs. 44.8% of Buddhist monk had to clean their KUTIs every day that was 44.4% of Buddhist monk in inner city, 46.3% of Buddhist monk in urban fringe and 40.0% of Buddhist monk in suburb. The cleaning methods were sweeping (48.1%) and scrub the floor (43.3%). For dust prevention was pouring some water on the ground (46.6%) and using shield material (25.1%). The sampling of ambient air nearby KUTIs was done in order to determine the amount of suspended dust and total bacterial contamination as shown in Table 3. The analyzed approximate weight of suspended dust was ranged from 0.2208-0.3379 mg/m³ of air. There were different amount of dust in each temple zone. However, the highest dust was in the ambient air of urban fringe area, Wat Karnjanasinghas (0.4570 mg/m³) and Wat Samiannari (0.4519 mg/m³) whereas the lowest was in the suburb, Wat Thippawas (0.2155 mg/m³). Besides this, number of total bacteria count in suspended dust was ranged between 3–100 colony/m³ of air. Figure 5 and 6 showed the average of weight of suspended dust and the average of total bacteria count by weight of suspended dust in each zone. The average total bacteria count by weight of suspended dust was 6.61×10^4 , 2.84×10^4 and 1.95×10^4 colony/g of dust for inner city, urban fringe and suburb, respectively. The high bacterial contamination was from Wat Bophitpimuk (100 colony/m³ of air or 28.9×10^4 colony/g of dust) in the inner city and Wat Thong Bang Chueak Nang (23 colony/m³ of air or 8.04×10^4 colony/g of dust) in the urban fringe. The others were low contamination, especially Wat Karnjanasinghas in urban fringe which had the lowest contamination (3 colony/m³ of air or 0.66×10^4 colony/g of dust). The average weight of suspended dust in each zone was ranged in this order; urban fringe, inner city and suburb. On the other hand, the inner city, urban fringe and suburb were ranged in order of average of total bacteria count by weight of suspended dust. Beside the bacterial contamination, there were also existed with fungi and other microorganisms in the ambient air. For nuisance odor, it was around 55.6% complaints. This problem was contributed from the left solid waste and wastewater.

For the compound of temples, more than half of studied monks (66.7%) were medium satisfied with number of buildings that was 69.5% of Buddhist monks in inner city, 65.8% in urban fringe and 54.3% in suburb. There was 54.1 % of Buddhist monks had medium satisfy level with the rest area of the temples; 56.2% of Buddhist monks in inner city, 52.5% in urban fringe and 48.6% in suburb.

Table 3 Bacteriological quality of suspended dust

Temple	Total bacteria		Weight of suspended dust (mg/m ³ of air)
	Suspended dust (colony/m ³ of air)	Suspended dust (colony/g of dust)	
<i>Inner city</i>			
Wat Rajathivas	4	1.22×10 ⁴	0.3290
Wat Eamwaranuch	3	0.93×10 ⁴	0.3213
Wat Chaoam	3	0.86×10 ⁴	0.3479
Wat Ampava	4	1.16×10 ⁴	0.3450
Wat Bophitpimuk	100	28.9×10 ⁴	0.3461
<i>Urban fringe</i>			
Wat Karnjanasinghas	3	0.66×10 ⁴	0.4570
Wat Thong Bang			
Chueak Nang	23	8.07×10 ⁴	0.2851
Wat Samiannari	5	1.11×10 ⁴	0.4519
Wat Ladplakao	4	1.53×10 ⁴	0.2612
<i>Suburb</i>			
Wat Bangkradi	7	3.10×10 ⁴	0.2258
Wat Thippawas	3	1.39×10 ⁴	0.2155
Wat Lam Phuk	3	1.36×10 ⁴	0.2212
Chi			

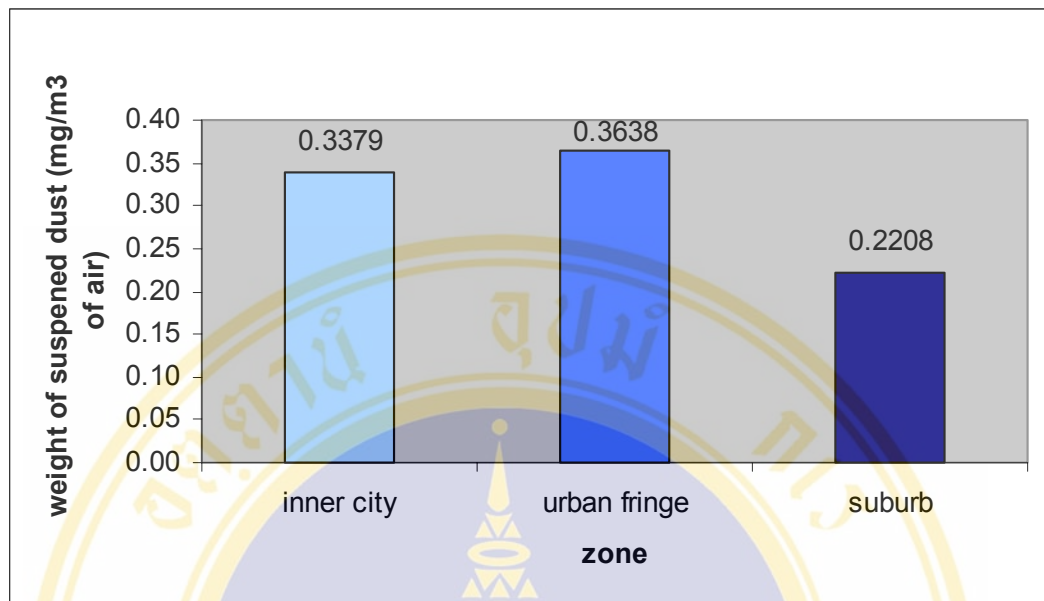


Figure 5 The average weight of suspended dust in each zone.

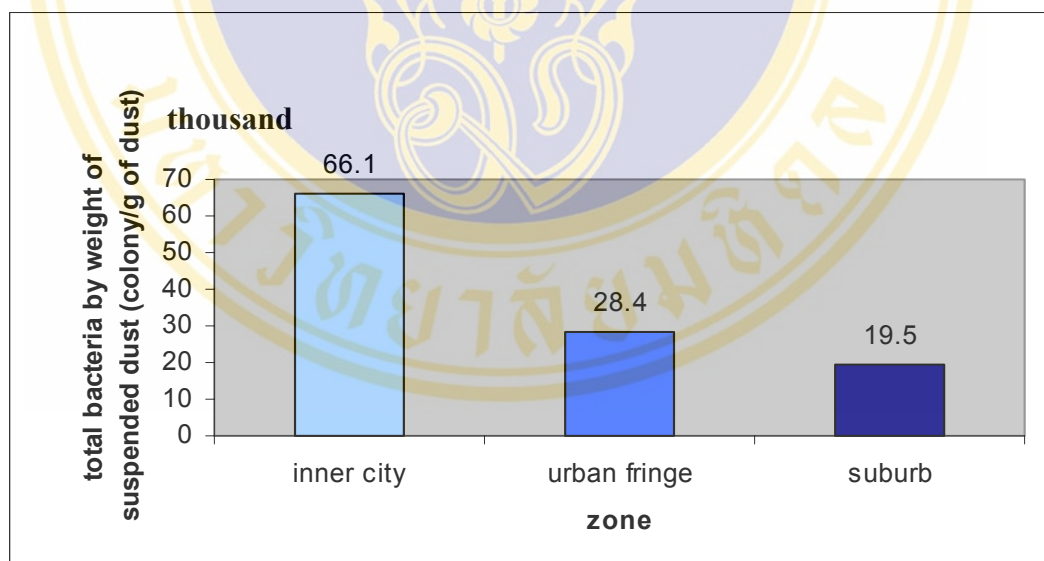


Figure 6 The average total bacteria by weight of suspended dust in each zone.

4.1.2 The indoor environment

There were many facilities inside KUTIs such as fan (15.6%), telephone (11.2%), hot water pot (11.1%), television (10.6%), refrigerator (6.9%), and computer (4.4%). In inner city temples, there was fan (14.9%), telephone (11.9%), hot water pot (11.3%) and television (10.1%). The facilities in urban fringe were fan (16.0%), television (10.9%) and hot water pot (10.3%) and those in suburb were fan (20.3%), telephone (13.9%), hot water pot (13.9%) and television (13.3%).

In case of lighting, the average lighting inside KUTIs was around 38 and 79 lux for room condition of with and without light providing from fluorescence lamp respectively (Table 4). Moreover, Figure 7 showed the average natural and fluorescence lighting of intensity in KUTIs in each zone. The daylight intensity in inside KUTIs was ranged around 7-45 lux in inner city, 14-79 lux in urban fringe and 6-68 lux in suburb area. There were five studied KUTIs that had light intensity less than 20 lux in Figure 8. When giving the lighting from fluorescence lamp, the intensity was increasing to 69-97 lux in inner city, 40-95 lux in urban fringe and 54-98 lux in suburb. The provided lighting could increase much intensity, over 87%, for KUTIs of Wat Eamwaranuch and Wat Ampawa in inner city and Wat Lam Phak Chi in suburb area. These different of light intensity in the inner city (60.40 lux) was higher than urban fringe (21.75 lux) and suburb (34.67 lux). However, around 60% of the surveyed KUTIs did not have the increased light intensity over than 37%. The questionnaire found that there was 34.9% of Buddhist monk lived in a low light intensity in KUTIs in the day time. 20.3% lived in inner city while 12.9% and 1.7% were in the urban fringe and suburb respectively. They had to turn on the light for doing many activities. The activities of studied monks were reading book (15.7%), relaxing (15.2%), cleaning (14.4%), eating (13.3%), watching T.V. (11.9%), writing (11.7%), consulting (9.8%) and others (8%). The major morning activities were eating (32.6%), reading (18.1%) and cleaning (17.8%). The afternoon activities were eating (25.0%), relaxing (14.5%) and reading (14.4%). For cleaning (26.6%), reading (19.3%) and writing (15.3%) were their evening activities. The relaxing (28.3%), reading (25.0%) and watching T.V. (19.3%) were the night time activities.

From the analyzed result, the average noise inside KUTIs was around 45 dB (A) (Table 4) and Figure 9 showed the average noise inside KUTsI in each zone. It

showed that the suburb temples had the highest average noise level (52.74 dB (A)) whereas that of the urban fringe temples and inner temples was 43.75 dB (A) and 40.40 dB (A), respectively. The highest noise level was 58 dB (A) of Wat Lam Phuk Chi in suburb (Figure 10). On contrary, 37 dB (A) of Wat Ampawa in inner city was the lowest noise level. Whenever the Buddhist monk living in KUTIs, 38.5% of them was faced with the noise nuisance problem and 30.6 % of them found it in the morning time. It was 16.53% of studied monks in inner city, 11.98% in urban fringe and 2.07% in suburb. The major source of noise was coming from school (32.2%) and traffic (28.0%). It caused disturbance (53.5%) and sleeplessness (24.8%) problem. Unfortunately, most of Buddhist monk could not find the way to prevent the noise nuisance from these disturbance sources. Furthermore, Buddhist monk required some measures such as limit work and machine time (36.4%) or limit traffic zone (31.1%) and a responsible unit to solve this problem. The other nuisance problems were bad smell from waste (21%) and dust (24%).

Table 4 Natural and fluorescence lighting of intensity and noise level in KUTIs

Temple	Lighting Intensity (lux)		Noise (dB(A))
	Natural lighting	Fluorescence lighting	
Inner city			
Wat Rajathivas	75	45	44
Wat Eamwaranuch	85	7	42
Wat Chaoam	69	15	40
Wat Ampawa	97	9	37
Wat Bophitpimuk	97	45	39
Urban fringe			
Wat Karnjanasinghas	80	72	38
Wat Thong Bang	40	14	50
Chueak Nang			
Wat Samiannari	87	50	42
Wat Ladplakao	95	79	45
Suburb			
Wat Bangkradi	98	68	55
Wat Thippawas	67	41	45
Wat Lam Phuk Chi	54	6	58
Total average	79	38	45

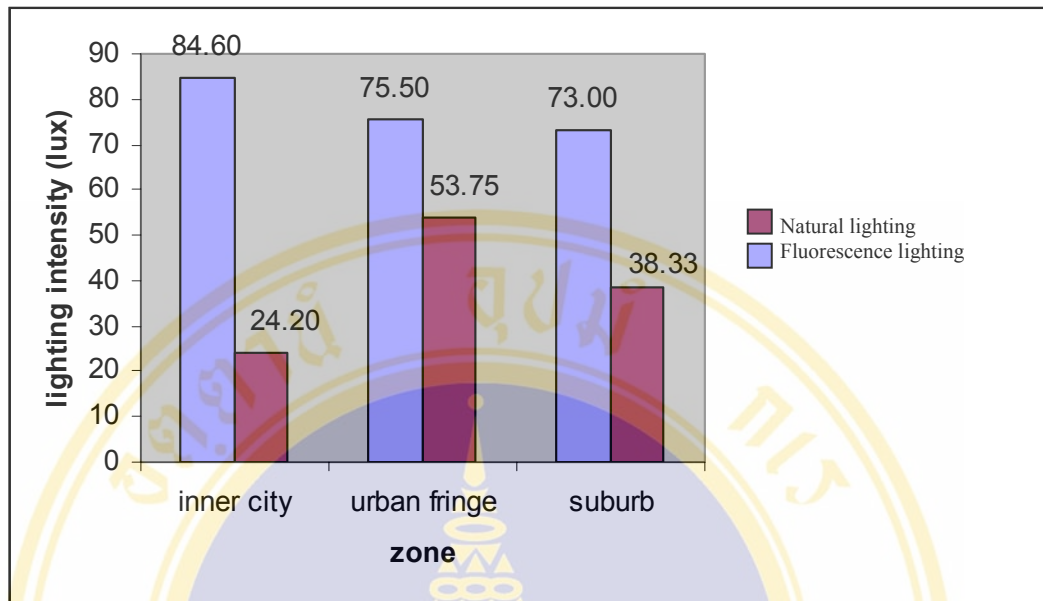


Figure 7 The average natural and fluorescence lighting of intensity in KUTIs in each zone

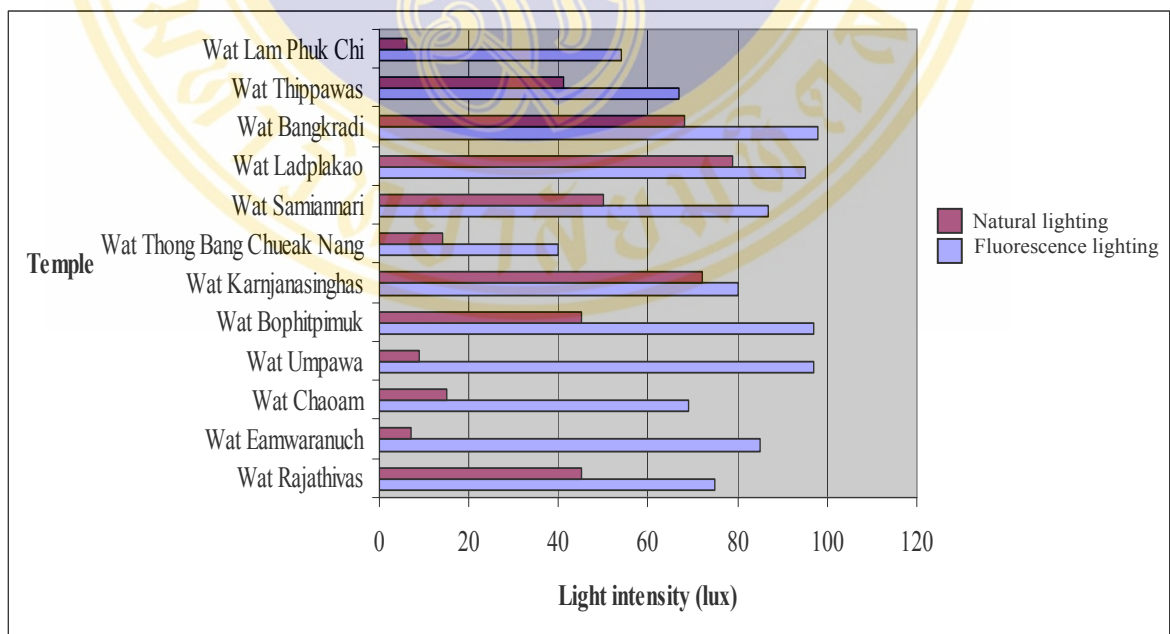


Figure 8 Natural and fluorescence lighting of intensity in KUTIs

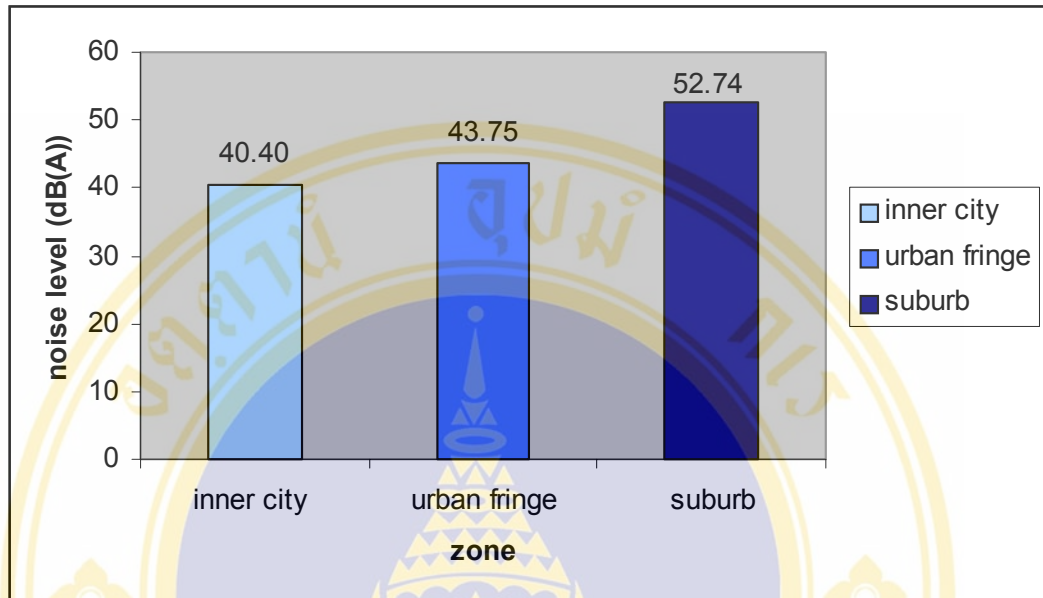


Figure 9 The average of noise level inside KUTIs in each zone.

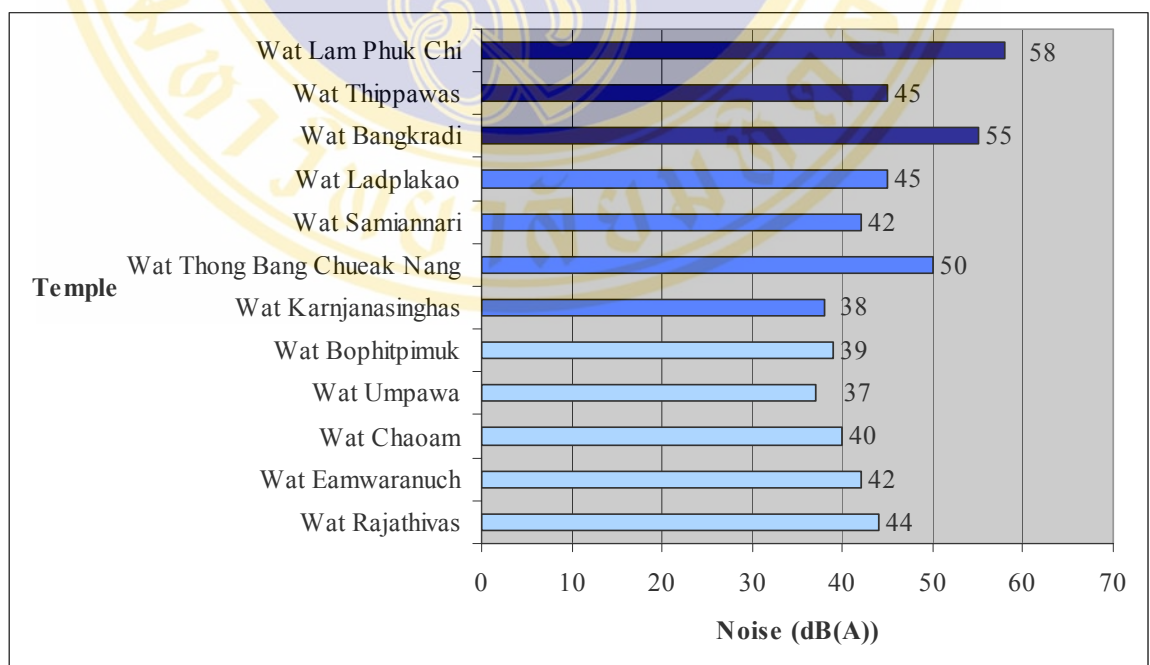


Figure 10 Noise level inside KUTIs.

4.2 Type of water consumption

In this study, water consumption was divided into *used water* (cleansing water in toilet, food utensil washing water, and cloth cleansing water) and *drinking water* (bottled water and water in other containers). Buddhist monks were interviewed for their water consumption behaviors by using questionnaires. Furthermore, both used water and drinking water were evaluated the bacteriological quality in terms of total coliform bacteria and fecal coliform bacteria contaminations.

4.2.1 Bacteriological qualities of studied water

From questionnaire, water supply from Metropolitan Waterworks Authority (MWA) was a major source of water consumption for all BMR temples. It was used for bathing, cloth washing, and utensil washing (85.0%) as well as drinking (22.9%).

For used water, not only the studied monks used water supply for many activities but also they used the other water such rain water (8.1%), canal water (4.1%), and shallow well water (2.0%). Especially the suburb monks, 18.0% and 14.0% of them used rain water and canal water, respectively. Most of Buddhist monks stated that the appearance of water supply was clean; therefore they were directly used from the water pipe (44.1%) and no treatment before use (69.3%). On the other hands, some of Buddhist monks (30.7%) in inner city treating it by filtration (75.7%) and chemical addition (10.0%) before use. Although most of the studied monks directly used the water from tap, they had the varieties containers to keep the used water, such as concrete tank, aluminum tank, large earthen jar, and plastic tank. 15.6% of inner city Buddhist monks kept the used water in concrete tank, whereas, 18.5% of urban fringe Buddhist monks and 16.4% of suburb Buddhist monks kept the water in aluminum tank. Regarding to container cleaning frequency, only 12.3% of the studied monks cleaned it every day. Around 43% and 18.5% of them cleaned the water container once a week and never, respectively. Almost studied monks (73.7%) had no problem with water supply quality. There was approximately 20.4% faced with insufficient water quantity, contaminated water, and expensive water price.

Most of studied monks drank seven to eight glasses of water or around two liters per day. Major source of drinking water was bottled water (56.9%), water supply (22.9%), gallon water (10.9%), and rain water (4.5%). Particularly, 24.1% of suburb

monks drank rain water. Although most of the studied monks (79.6%) agreed with the water cleanliness, they still improved the drinking water quality by boiled in hot water pot (54.1%) and filtration (44.9%). Inner city Buddhist monks 51.5% filtered the drinking water before use while 69.6% of urban fringe monks and 63.7% of suburb monks boiled it. Therefore, the monks kept those treated drinking water into varieties containers. Although 32.8% of the studied monk cleaned the container every day but the rest of 27.8% did it only once a week. The familiar container was plastic bottle in which 35% of the studied monks used it for kept the drinking water. Hot water pot, aluminium tank and large earthen jar were also used in many studied temples. Almost the studied monk (87.7%) was regularly drank water together with ice. However, only 22.9% of them complained about the drinking water quality problem, insufficient quantity, and high cost.

There were 60 water samples which sampling from the studied temples. 36 samples were used water and 24 samples were drinking water. It was 15, 12, and 9 samples of used water in inner city, urban fringe, and suburb, respectively. Additionally, 10, 8, and 6 samples were a number of drinking water in inner city, urban fringe, and suburb, respectively. The analyzed results of bacteriological quality of those sampled water were shown in Table 5.

Table 5 Bacteriological quality of studied water

Temple	Type of used water						Type of drinking water			
	Cleansing water in toilet		Food utensil washing water		Cloth cleansing water		Water in Container		Bottled water	
	TC	FC	TC	FC	TC	FC	TC	FC	TC	FC
Inner city										
Wat Rajathivas	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Wat Eamwaranuch	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Wat Chaoam	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Wat Ampawa	64*	28*	<2	<2	<2	<2	220*	<2	<2	<2
Wat Bophitpimuk	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Urban fringe										
Wat Karnjanasinghas	<2	<2	<2	<2	<2	<2	300*	<2	<2	<2
Wat Thong Bang Chueak Nang	<2	<2	<2	<2	≥1600*	110*	38*	<2	<2	<2
Wat Samiannari	<2	<2	<2	<2	≥1600*	60*	<2	<2	<2	<2
Wat Ladplakao	≥1600*	4*	<2	<2	80*	6.2*	<2	<2	<2	<2
Suburb										
Wat Bangkradi	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Wat Thippawas	≥1600*	81*	<2	<2	<2	<2	8*	<2	<2	<2
Wat Lam Phuk Chi	240*	7.4*	<2	<2	<2	<2	7*	<2	<2	<2

Remark : TC = Total coliform bacteria (MPN/100 mL)

FC = Fecal coliform bacteria (MPN/100 mL)

* = unaccepted permission level from Public Health promulgate Vol.6 B.E. 2524 and Department of Medical Science and Department Health, Ministry of Public Health: Total coliform and fecal coliform bacteria < 2.2 MPN/100 mL in water supply, Total coliform bacteria <2.2 MPN/100 mL and fecal coliform bacteria non detected in bottled water (<2.2 MPN/100 mL)(78).

The results in Table 5 pointed out that some samples of both used water, and drinking water were contaminated with total coliform bacteria and fecal coliform bacteria. Used water had high contamination. The bacterial contamination was ranged between lower than 2 MPN/100mL and higher than 1600 MPN/100mL. Most of total and fecal coliform bacteria contaminations were found from cleansing water in toilet (33.3%) and cloth cleansing water (25.0%). On the other hands, the bacterial contamination of food utensil washing water was less than 2 MPN/100 mL in every zone. Besides this, the used water of 5 temples or 7 samples had bacterial contamination higher than 2.2 MPN/100 mL in terms of total coliform bacteria and fecal coliform bacteria. It was 4 samples of cleansing water in toilet which came from one temple of inner city (Wat Ampawa) and urban fringe (Wat Ladplakao) as well as

two temples in suburb (Wat Thippawas and Wat Lam Phuk Chi). The other 3 samples were cloth cleansing water which from the urban fringe temples (Wat Thong Bang Chueak Nang, Wat Samiannari, and Wat Ladplakao). Therefore, the urban fringe temples had the highest bacterial contamination (4 samples or 33.3% of the 12 total water samples) in terms of total and fecal coliform bacteria. The results of their number of acceptable quality were presented in Table 6.

Table 6 The summary of bacteriological quality of used water which classified in terms of total and fecal coliform bacteria in each zone (n = 36)

Temple Zone	Total coliform bacteria (MPN/100 mL)				Fecal coliform bacteria (MPN/100 mL)			
	Accepted		Unaccepted		Accepted		Unaccepted	
	n	%	n	%	n	%	n	%
Inner city	14	93.3	1	6.7	14	93.3	1	6.7
Urban fringe	8	66.7	4	33.3	8	66.7	4	33.3
Suburb	7	77.8	2	22.2	7	77.8	2	22.2
Total	29	80.6	7	19.4	29	80.6	7	19.4

The drinking water had lower bacterial contamination. In addition, there was found only the total coliform bacterial contamination which ranged between lower than 2 MPN/100mL and 300 MPN/100mL and none contamination for fecal coliform bacteria. Table 7 showed the acceptable number of the drinking water in container and bottle. It pointed out that 5 samples (20.8%, n = 24) were contaminated with total coliform bacteria in the unacceptable ranges. All contaminated samples were water samples in containers (1 of inner city temple (Wat Ampawa), 2 of urban fringe temple (Wat Karnjanasinghas and Wat Thong Bang Chueak Nang), and 2 of suburb temple (Wat Thippawas and Wat Lam Phuk Chi)). Besides this, the result showed that none of the bottled water samples were contaminated with total coliform and fecal coliform bacteria. Therefore, the order of unaccepted drinking quality from bacterial contamination was the suburb temples (2 samples or 33.3%, n = 6), the urban fringe

temples (2 samples or 25.0%, $n = 8$), and the inner city temples (1 sample or 10.0%, $n = 10$), respectively.

Table 7 The summary of bacteriological of drinking water which classified in terms of total and fecal coliform bacteria in each zone ($n = 24$)

Temple Zone	Total coliform bacteria (MPN/100 mL)				Fecal coliform bacteria (MPN/100 mL)			
	Accepted		Unaccepted		Accepted		Unaccepted	
	n	%	n	%	N	%	n	%
Inner city	9	90.0	1	10.0	10	100.0	0	0
Urban fringe	6	75.0	2	25.0	8	100.0	0	0
Suburb	4	66.7	2	33.3	6	100.0	0	0
Total	19	79.2	5	20.8	24	100.0	0	0

4.2.2 The difference between bacteriological qualities of each type of used water

Although there were variety levels of bacterial contamination in the used water, the different was not high. Thus, there was no statistical significant different between bacteriological qualities in each type of used water samples. This result was present in Table 8.

Table 8 The difference between bacteriological qualities in each type of used water which classified in terms of total and fecal coliform bacteria

Type of used water	Total coliform bacteria (MPN/100 mL)			p- value	Fecal coliform bacteria (MPN/100 mL)		Total	p- value
	Accepted	Unaccepted	Total		Accepted	Unaccepted		
	No.	No.			No.	No.		
Cleansing water in toilet	8 (66.7%)	4 (33.3%)	12 (100.0%)		8 (66.7%)	4 (33.3%)	12 (100.0%)	
Food utensil washing water	12 (100.0%)	0 (0%)	12 (100.0%)		12 (100.0%)	0 (0%)	12 (100.0%)	
Cloth cleansing water	9 (75.0%)	3 (25.0%)	12 (100.0%)		9 (75.0%)	3 (25.0%)	12 (100.0%)	
Total	29 (80.6%)	7 (19.4%)	36 (100.0%)	0.10	29 (80.6%)	7 (19.4%)	36 (100.0%)	0.10

Significant at p-value ≤ 0.05

4.2.3 Residual chlorine concentration of water supply and its relationship with bacteriological qualities in terms of total and fecal coliform bacteria

The residual chlorine concentration was measured from water supply samples in all studied BMR temples. Table 9 showed that the entire samples (100.0%) had residual concentration higher than 0.2 ppm. The highest detection was 0.6 ppm at Wat Rajathivas in inner city. Beside this, 0.5 ppm of residue chlorine could be found in urban fringe temple (Wat Karnjanasinghas) and suburb temple (Wat Bangkradi and Wat Thippawas) as well.

Table 9 Residual chlorine concentration of water supply

Temples	Residual chlorine concentration (ppm)
Inner city	
Wat Rajathivas	0.6
Wat Eamwaranuch	0.2
Wat Chaoam	0.2
Wat Ampawa	0.3
Wat Bophitpimuk	0.2
Urban fringe	
Wat Karnjanasinghas	0.5
Wat Thong Bang Chueak Nang	0.2
Wat Samiannari	0.2
Wat Ladplakao	0.2
Suburb	
Wat Bangkradi	0.5
Wat Thippawas	0.5
Wat Lam Phuk Chi	0.2

Remark : accepted permission level of residual chlorine concentration in water supply > 0.2 ppm (91).

Since water supply was the major source of used water for all studied temples, therefore it was sampled for analyzing the concentration of residual chlorine together with bacteriological quality. The studied water supply samples were come from an outlet piping for food utensil washing. The relationship of those two parameters of studied water supply was showed in Table 10.

The analyzed result of 12 water supply samples did not found the unacceptable range of both total and fecal coliform bacterial contamination whatever different residual chlorine concentration was. Thus, there was relationship between residual chlorine concentration of water supply and bacteriological contamination.

Table 10 The relationship between bacteriological qualities of water supply which classified in terms of total and fecal coliform bacteria and residual chlorine concentration in 12 water samples

Residual chlorine concentration (ppm)	Bacteriological quality (MPN/100 mL)		Total
	<2.2	≥2.2	
Less than 0.2	0	0	0
0.2 and over	12	0	12
Total	12	0	12

4.3 Type of food for monks

4.3.1 Bacteriological qualities of type of ready-to-eat food for monk

From questionnaires, most of studied monks acquired food from different ways such offering food on the alms round in the morning, supporter's giving at temple, invitation getting, self-cooking, and market or shop buying. 65.7% of the studied monks ever received spoilage foods. It was come from food offering in the alms round in the morning (84.2%) and Buddhist people's offering (11.4%). Generally, the average of spoilage food finding frequency was estimated 3 times per month except the inner city and urban fringe temples. They were often met around 30 times per month. 40% of suburb Buddhist monks ever met the spoilage food but those monks of the inner city and urban fringe found in higher percentage of 87.7 and 55.3, respectively.

Most of studied monks kept their food in plastic bag and other containers before eating. For breakfast meal, 22.9%, 21.4%, 19.7% and 18.7% of Buddhist monks put the container on table, floor, covered table and covered floor, respectively. After this meal, 42.1% of them donated the left foods to whomever wants and 11.3% disposed as rubbish and/or fed pets. On opposite, the other half of studied monks (43.4%) kept it for forenoon meal with the same method as that of the morning. It was found that 62.7% of the studied monks had lunch which was kept in container without

re-warming and only 33% of them warmed foods before eating. Finally, around half of studied monks (52.4%) acted the same pattern as the morning for removing the remained food.

In this research, the ready-to-eat food for monk was sampled and analyzed for bacteriological quality in terms of total coliform bacteria and fecal coliform bacteria contamination. A total of 108 ready-to-eat food samples were divided into 54 breakfast (before 7.30 a.m.) ready-to-eat food samples and 54 forenoon (11.00 – 12.00 a.m.) ready-to-eat food samples. There were five types of studied food which were clear soup, curry, fried vegetable, dressed salad and dessert.

The ready-to-eat food for monk had bacterial contamination in different degree (Table 11). Total coliform and fecal coliform bacteria contamination were ranged from lower than 3 to more than 1,100 MPN/g. When comparing the difference of bacteriological qualities between breakfast and forenoon of ready-to-eat food, the forenoon meal always had higher contamination than that of the breakfast meal (Table 16). In case of total coliform bacteria, the highest degree of bacterial contamination was clear soup for breakfast meal and fried vegetable for forenoon meal. The lowest degree of bacterial contamination was curry (Table 14 and 15). Besides this, not only the breakfast ready-to-eat foods in urban fringe temples had high contamination (38.9%, n=54) but also that of the forenoon foods had increasingly contamination (50%, n=54) (see Table 12 and 13). Furthermore, breakfast ready-to-eat food contamination in Table 12 showed that fecal coliform bacteria contamination (35.2% or 19 unaccepted samples) was higher than total coliform bacteria contamination (24.1% or 13 unaccepted samples). Similarly, fecal coliform bacteria contamination (55.6% or 30 unaccepted samples) was higher than total coliform bacteria contamination (40.7% or 22 unaccepted samples) in forenoon ready-to-eat food (Table 13). The order of fecal coliform bacteria contamination was urban fringe temple, suburb temple, and inner city temple, respectively.

Table 11 Bacteriological quality of type of ready-to-eat foods for monk

Temple	Type of foods											
	Clear soup				Curry				Fried vegetable			
	Breakfast			Lunch			Breakfast			Breakfast		
	TC	FC	TC	FC	TC	FC	TC	FC	TC	FC	TC	FC
Inner city												
Wat Rajadivas	<3	<3	<3	<3	>1100*	260*	<3	<3	43	3.6*	<3	<3
Wat Eamwaranuch	>1100*	11*	>1100*	21*	<3	<3	<3	<3	23	<3	-	<3
Wat Chaoam	1100*	15*	>1100*	20*	<3	<3	>1100*	>1100*	>1100*	>1100*	<3	<3
Wat Ampawa	20	<3	1100*	<3	<3	<3	<3	<3	<3	<3	>1100*	9.2*
Wat Bophitpimuk	290	3	290*	>1100*	<3	<3	>1100*	>1100*	>1100*	>1100*	<3	<3
Urban fringe												
Wat Kamjanasinghas	1100*	9.2*	>1100*	>1100*	>1100*	1100*	43	43*	>1100*	>1100*	9.2	<3
Wat Thong Bang Chueak Nang	>1100*	>1100	>1100*	>1100*	>1100*	3.6*	>1100*	6.2*	>1100*	>1100*	>1100*	210
Wat Samiannari	<3	<3	<3	<3	93	240	3.6	<3	9.2	3.6*	-	<3
Wat Ladplakao	1100*	21*	>1100*	120*	<3	14	<3	3.6*	21	9.2*	-	<3
Suburb												
Wat Bangkradi	3.6	<3	210*	<3	19	9.4*	>1100*	210*	>1100*	210*	-	-
Wat Thippawas	<3	<3	<3	<3	<3	93	>1100*	11*	>1100*	44*	-	<3
Wat Lam Phuk Chi	<3	<3	<3	<3	<3	<3	3.6	<3	240	<3	460*	>1100*

Remark : TC = Total coliform bacteria (MPN/g)

FC = Fecal coliform bacteria (MPN/g)

- = No sample

* = unaccepted permission level from Public Health promulgate Vol.6 B.E. 2524 and Department of Medical Science and Department Health,

Ministry of Public Health; Total coliform bacteria < 500 MPN/g

Fecal coliform bacteria < 3 MPN/g (78).

Table 12 The summary of bacteriological contamination of breakfast ready-to-eat food which classified in terms of total and fecal coliform bacteria in each zone(n = 54)

Temple Zone	Total coliform bacteria (MPN/g)				Fecal coliform bacteria (MPN/g)			
	Accepted		Unaccepted		Accepted		Unaccepted	
	n	%	n	%	n	%	n	%
Inner city	19	79.2	5	20.8	19	79.2	5	20.8
Urban fringe	11	61.1	7	38.9	8	44.4	10	55.6
Suburb	11	91.1	1	8.3	8	66.7	4	33.3
Total	41	75.9	13	24.1	35	64.8	19	35.2

Table 13 The summary of bacteriological contamination of forenoon ready-to-eat food which classified in terms of total and fecal coliform bacteria in each zone(n = 54)

Temple Zone	Total coliform bacteria (MPN/g)				Fecal coliform bacteria (MPN/g)			
	Accepted		Unaccepted		Accepted		Unaccepted	
	n	%	n	%	n	%	n	%
Inner city	15	62.5	9	37.5	14	58.3	10	41.7
Urban fringe	9	50.0	9	50.0	3	16.7	15	83.3
Suburb	8	66.7	4	33.3	7	58.3	5	41.7
Total	32	59.3	22	40.7	24	44.4	30	55.6

4.3.2 The difference between bacteriological qualities in each type of ready-to-eat food and meals

From the results, there was no significant difference between bacteriological qualities in terms of total coliform bacteria and fecal coliform bacteria in each type of ready-to-eat food samples. Similarly, there was no significant difference between bacteriological qualities in terms of total coliform bacteria in each meal. This result

was presented in Table 14, 15, and 16. However, there was significant difference between bacteriological qualities in terms of fecal coliform and meals. This result was presented in Table 16.

Table 14 The difference bacteriological qualities in breakfast ready-to-eat food which classified in terms of total and fecal coliform bacteria (n = 54)

Type of foods	Total coliform bacteria		p-value	Fecal coliform bacteria		p-value
	(MPN/g)			(MPN/g)		
	Accepted	Unaccepted		Accepted	Unaccepted	
Clear soup	7(58.3%)	5(41.7%)		7(58.3%)	5(41.7%)	
Curry	11(91.7%)	1(8.3%)		9(75.0%)	3(25.0%)	
Fried vegetable	8(66.7%)	4(33.3%)		5(41.7%)	7(58.3%)	
Dressed salad	5(71.4%)	2(28.6%)		4(57.1%)	3(52.9%)	
Dessert	9(81.8%)	2(18.2%)		10(90.9%)	1(9.1%)	
Total	40(74.1%)	14(25.9%)	0.38	35(64.8%)	19(35.2%)	0.13
Significant at p-value ≤ 0.05						

Table 15 The difference bacteriological qualities in forenoon ready-to-eat food which classified in terms of total and fecal coliform bacteria (n = 54)

Type of foods	Total coliform bacteria		p-value	Fecal coliform bacteria		p-value
	(MPN/g)			(MPN/g)		
	Accepted	Unaccepted		Accepted	Unaccepted	
Clear soup	6 (50.0%)	6 (50.0%)		6 (50.0%)	6 (50.0%)	
Curry	10 (83.3%)	2 (16.7%)		6 (50.0%)	6 (50.0%)	
Fried vegetable	6 (50.0%)	6 (50.0%)		3 (25.0%)	9 (75.0%)	
Dressed salad	4 (57.1%)	3 (42.9%)		3 (42.9%)	4 (57.1%)	
Dessert	7 (63.6%)	4 (36.4%)		6 (54.5%)	5 (45.5%)	
Total	33(61.1%)	21 (38.9%)	0.43	24 (44.4%)	30 (55.6%)	0.63
Significant at p-value ≤ 0.05						

Table 16 The difference bacteriological qualities in meals which classified in terms of total and fecal coliform bacteria (n=108)

Type of meals	Total coliform bacteria (MPN/g)		p-value	Fecal coliform bacteria (MPN/g)		p-value
	Accepted	Unaccepted		Accepted	Unaccepted	
Breakfast	40(74.1%)	14 (25.9%)		35(64.8%)	19(35.2%)	
Forenoon	33(61.1%)	21(38.9%)		24(44.4%)	30(55.6%)	
Total	73(67.6%)	35(32.4%)	0.22	59(54.6%)	49(45.4%)	0.05

Significant at p-value ≤ 0.05

4.3.3 Bacteriological contamination of contact surface of food utensils

From the questionnaire pointed out that most of Buddhist monks (80.3%) had separated private glass. Around 12.6% shared glass together in which the high percent was from the inner city temple. Before eating, 81.5% of the monks washed hands; whereas the 10.3% did not practice. Besides this, 91% of the monks immediately washed utensils with chemical solution and sponge after eating. Furthermore, more than half of them (64.3%) used sun drying method for their utensils before stored while approximately 30.5% rubbed it with cloth and suddenly kept on the shelves.

The contact surface of food utensils had been examined by using swab method. It was then analyzed for bacteriological contamination in terms of total bacteria (CFU/in²). There were 48 examined utensil samples which divided into 4 types as; dish, bowl, spoon, and glass. The analyzed results were shown in Table 17.

The studied contact surface of food utensil had various levels of bacterial contamination. It was ranged between less than 10 CFU/in² to 65×10^3 CFU/in². When considering the contamination by type of utensils, the highest contamination (less than 10 to 65×10^3 CFU/in²) was spoon. It was from Wat Bophitpimuk in inner city and Wat Bangkradi in suburb. On the other hand, the glass had the lowest contamination (less than 10 to 4.4×10^3 CFU/in²). There were 7 contaminated glass samples (58.33%) that had bacterial count less than 10 CFU/in². However, 2 glass samples (16.67%) from Wat Eamwaranuch in inner city and Wat Lam phuk chi in suburb had high bacterial

count 4.4×10^3 CFU/in² and 1.0×10^3 CFU/in², respectively. Furthermore, when comparing the contamination level in each zone, Table 18 showed that the suburb temples had bacterial contamination (41.7%) higher than that of the inner city (25.0%) and urban fringe temples (18.3%).

Table 17 Bacteriological quality of type of contact surface of food utensils

Temple	Total bacteria(CFU/in ²)			
	Type of utensils			
	Dish	Bowl	Spoon	Glass
Inner city				
Wat Rajathivas	570	60	3.2×10^3 *	<10
Wat Eamwaranuch	<10	<10	90	4.4×10^3 *
Wat Chaoam	500	200	510	300
Wat Ampawa	<10	<20	<20	840
Wat Bophitpimuk	8×10^3 *	7.3×10^3 *	65×10^3 *	200
Urban fringe				
Wat Karnjanasinghas	4.9×10^3 *	3.8×10^3 *	<10	<10
Wat Thong Bang Chueak Nang	<20	16×10^3 *	<10	<10
Wat Samiannari	<10	<10	130	<10
Wat Ladplakao	<20	45	35	<10
Suburb				
Wat Bangkradi	760	<20	65×10^3 *	<10
Wat Thippawas	140	30	7.2×10^3 *	<10
Wat Lam Phuk Chi	3.2×10^3 *	2.1×10^3 *	1.5×10^3 *	1.0×10^3

Remark: * = unaccepted permission level from Public Health promulgate Vol.6 B.E. 2524 and Department of Medical Science and Department Health, Ministry of Public Health: Total bacteria < 10^3 CFU/in² (78).

Table 18 The summary of bacteriological contamination of contact surface of food utensils which classified in terms of total bacteria in each zone (n = 48)

Temple Zone	Total bacteria (CFU/in ²)			
	Accepted		Unaccepted	
	n	%	n	%
Inner city	15	75.0	5	25.0
Urban fringe	13	81.3	3	18.3
Suburb	7	58.3	5	41.7
Total	35	72.9	13	27.1

4.3.4 The difference between bacteriological contamination in each type contact surface of food utensils

There was no significant different between bacteriological contamination among each type of contact surface of food utensils samples. This result was present in Table 19.

Table 19 The difference of bacteriological contamination in each type of contact surface of food utensils which classified in terms of total bacteria

Type of food utensils	Total bacteria (CFU/in ²)		Total	p-value
	Accepted	Unaccepted		
Dish	9 (75.0%)	3 (25.0%)	12 (100.0%)	
Bowl	8 (66.7%)	4 (33.3%)	12 (100.0%)	
Spoon	7 (58.3%)	5 (41.7%)	12 (100.0%)	
Glass	11 (91.7%)	1 (8.3%)	12 (100.0%)	
Total	35 (72.9%)	13 (27.1%)	48 (100.0%)	0.30

Significant at p-value ≤ 0.05

CHAPTER V

DISCUSSIONS

5.1 Housing sanitation of Bangkok Metropolitan Region temples

5.1.1 The outdoor environment

Most of Thai temples and their constructions in BMR have a long history and been established for more than many hundred years. For example, Wat Eamwaranuch in the inner city was originally built in the Ayutthaya period. The temple which been established latest in this study, 28 years, is Wat Lam Phuk Chi in suburb area. Therefore there was quite different among infrastructure design and development of each temple.

Thai temple compound may find the number and type of buildings contained within the walls, and their functions a bit confusing. There was, however, a definite function and significance in each building, which made up a temple complex. The buildings in a Thai temple complex not only served sacerdotal functions in the cycle of Buddhist ceremonies and holy days but also served as the residence for the monks of the temple, and temple space served for educational and community service functions as well (13). The term Wat referred to a group of religious buildings generally enclosed by a wall with several gateways. According to artistic importance, the principal religious buildings in Thailand are: the Phra Chedi, the Bot, the Vihara, the Phra Prang, the Mondop and the Prasat. The other structures architecturally not very important are: the KUTI, Ho Trai, Sala Kan Parien, ordinary Salas and the Ho Rakhang. A Wat may contain just some of these structures or all of them. The most essential is the Bot, also called Ubosot. In general, with the exception of the Bot or of the Vihara, whose plan is conceived as a single unity within its enclosing gallery, the rest of the monuments are added little by little without special consideration of the general planning (14). Besides this, the construction of such a building, and indeed all buildings in a temple complex, is a collective social effort. Most temples, especially

common temples were subsidize by wealthy sponsors or by collective effort of communities (13,63) had to much spend time in construction. As these result, there were varieties of design of the monk's dormitory and location of temple settlements.

For KUTIs, it is the lodgings for the monks in Sanghawatt area. It is the living quarters of the monastic community (63). In Pali language, KUTI means a small hut or cottage. It would have been originated from Sasana Satharn during Lord Buddha's life. Imagine that the KUTI was built under the shady trees in a peaceful environment. Even nowadays, from the studied results found that KUTIs could be a small room for one or several monks where was made of wood and/or concrete. Some other temples had large dormitory like buildings with several rooms housing for thirty to fifty monks. There were many factors influenced the different of KUTIs building such as number of Buddhist monks, revenue, donation and monastery's planning of each temple.

The studied results found that number of Buddhist monks in inner city temples was quite dense (6,341 Buddhist monks), especially in the royal temple; namely Wat Bowonniwet and Wat Sungwejwisayaram. For urban fringe temples, a number of Buddhist monks were less than those in the inner city. There were 4,689 Buddhist monks in urban fringe. Generally, there was 27-72 Buddhist monks per temple in this zone except the old temples, namely Wat Chang Lek and Wat Samiannari, which had higher number of Buddhist monk. In case of suburb temples, there were the least number of Buddhist monks. They were approximately 832 Buddhist monks.

The main revenue of most temples was gained from donation, land renting for car park and others. The inner temples were getting more income since there were some government subsidies for royal temple and/or more requirements for land renting. The modification and restoration of the old constructions was a major infrastructure development for the old temple while construction of new settlement such KUTI and Ubosot is for the new temple. For the new construction, such as KUTI, Ubosot and Me-ru, it could be found in only Wat Bangkradi and Wat Thippawas's planning project. The land area of the studied BMR temples was approximately around 10-31 Rai (16,000-49,600 m²). However, it was quite dense and limit for development of more constructions. Most of the KUTIs which was built for a long

time had to develop by only some renovation. Therefore, in this research found most studied KUTIs were reformed with concrete and wood. Regarding to the temples which had lower income, their KUTIs were found in the original form of wood.

The solid waste management of all studied temples was serviced from Department of Public Cleansing of each district in Bangkok Metropolitan Administration (BMA). This department was under BMA, the local government, had responsible for waste management in all Bangkok area. It included planning, and controlling of public cleaning, disposing waste and night soil, and arranging public toilets and mobile toilets. Each district office had to provide waste container and collect the wastes from households, temples, markets, commercial, and public areas to the landfill sites. There were two colors of plastic waste container; yellow and green. The green is for moist waste while a yellow is for dry waste.

Waste collection in Bangkok used both direct and indirect collection systems. Household waste is a direct collection system. The District offices' crews collect waste directly from households, apartments, business areas and public places. Collection time and date were not scheduled. It depended on traffic, waste quantity, location and number of collection crew each day. Generally, it was carried out every day or every second day. Waste was collected during the early morning from waste containers, kept into a truck and then transported to the nearest transfer plant. Garbage from each transfer plant was send to the landfill sites twice a week by the contracted company (64, 65, 66).

The solid waste service of the Section of Public Cleansing in each district was rather good. Most of Buddhist monk had medium satisfy level in terms of frequency of collection, solid waste residue, type and amount of waste container as well as location of them. However, there were some constrains factor effecting the quality of services such waste quantity, location of temple and traffic conditions. The service could easier perform for the temple that located nearby the main road and/or generated low waste quantity. The problem of left waste was usually occurs in the temple where waste production rate was quite high and/or unable increasing the collection frequency. The temples in inner city, for example, were located in the dense communities with traffic problems thus it was quite difficult to neither using the bigger waste carrier or increase

collection frequency. Waste was then kept in every second day by hauling of the crews.

It was quite difficult to estimate waste generation rate since activities of each temple are different. However, the figure of waste collection fee of each temple could explain something. It was roughly calculated from the volume of waste collection. The fee was ranging between 300 to 1,000 baht per month. The interview results indicated that the inner city and urban fringe temples had to pay more fees than the suburb temples. An observation showed that most BMR people put their food in the plastic bag and/or foam box then giving to the monk. This behavior gives impact on more waste generation. Beside this, number of monk is also the important factor influencing waste production. Number of Buddhist monk in the inner city (6,341 Buddhist monks) and urban fringe (4,689 Buddhist monks) were higher than that of suburb temples (832 Buddhist monks). These are some reasons explaining the higher waste collection fee in the inner city and urban fringe temples than in suburb temples.

Although most monks reflected the medium satisfy level of solid waste management, nevertheless, the observations found problem of unsanitary solid waste conditions. There were noticeable rubbish and animal feces scattered around temples. Many of pets (dogs, cats and birds) in temples were the major cause of problem. Animal feces may be infested with microscopic parasitic organisms or others that could be transmitted and caused many diseases to Buddhist monk and people in relationship. For example, a single gram of dog feces contained an average of 23 million fecal coliform bacteria, some of which could cause disease in humans (67). Therefore, in order to prevent these animal transmitted diseases and other related problems, it was a need to proper take care all pets in the temple and maintain hygienic temple conditions such daily clean and get rid all feces and wastes before scatter and spread to the environment. For the rubbish, the survey found that most rubbish was usually put together in one container and left food was given to pets on the ground. These caused unsanitary conditions of temple. Temples should separate waste by type; wet or dry rubbish, and put in the specific waste container; yellow and green bin. Mixing of wet and dry rubbish and improper management were the major cause of problem. It also contributed a breeding site for insects and vectors (rats, flies and cockroaches). Although there was a service of BMA for spraying pesticides and

collecting special wastes, most Buddhist monk did not use it. It was believed inconvenient and charged some fees. In order to get rid of this insect and vector problem, the study results therefore were shown that they prefer to use insecticide by themselves and very rare case used the environmental friendly method. The chemical residues and its environmental contamination might be other co-incident problem from poor solid waste management.

When considering the compound of a monastery, it was discovered that most Buddhist monk had satisfaction with the number of buildings and the rest area of the temples at a moderate level. Charoenkit S. (68) did a study on the desirable characteristic of Buddhist temples by comparing the desirable characteristics and activities of Buddhist temples with the actual situations of the temples of Thai society in 1997. It explained that desirable temples were condition of quiet, peaceful, and garden-like. In addition, the space in temple should be carefully arranged for maximum utilization. It also pointed that Bangkok's temple had sufficient building to accommodate activities. This finding supported the satisfaction of the rest area at a moderate level of this study. However, half of the studied monk had moderate satisfaction with the number of buildings in temple. It implied that there are some problems with limited space in KUTIs and temple areas due to the increasing number of monks.

The studied results expressed that most monk had to face with air pollution in the form of suspended dust. They had to solve this problem by daily cleaning. Swept and clean with wet cloth was used for KUTIs cleaning while pour water on the floor and use fence was for the outside area. This problem was more occurred for the temple in inner city and urban fringe than that of the suburb. Maximum amount of suspended dust, 0.4570 mg/m^3 of air, was found from Wat Karnjanasinghas and a similar high quantity of 0.4519 mg/m^3 of air was also found from Wat Samiannari which located in the same urban fringe area. The reasons for having high amount of dust were due to those places were situated nearby main roads which had dense traffics. In addition, there was a building under construction of those two temples. These were main activities for increasing the ambient dust. This situation was confirmed by many monitoring data of ambient air quality from Pollution Control Department and others (8). For example, the ambient air quality in Bangkok Metropolis is monitored in the

areas which locate more than 50 meters from major roads. In these areas, Pollution Control Department, Ministry of Natural Resources and Environment had set up 10 monitoring stations. It was found that Total Suspended Particulate (TSP) range at 24 hours average was 0.01-0.31 mg/m³ which was within its standard values (74). On contrary, there was lesser amount of dust, 0.2155 mg/m³ of air, in suburb temples especially Wat Thippawas which located far away from the roadside. Its KUTI had special design and located surround refectory. Moreover, there was a small canal behind the group of building which serve as a flooding control during raining season. These reasons could help decreasing the ambient dust. However, the overall figure of suspended dust in ambient air was still pleasure when comparing to the previous amount from last 30 years. Sakulphraham P. (1975) (69) reported the average dust in ambient air of plantation zone in Bangkok area was 0.2558-0.5196 mg/m³ of air while this experimental result found average dust 0.2208-0.3379 mg/m³ of air. It meant that the buffering capacity from plantation of temple could purify the clean air and prevent all dirt from surrounding environment.

Besides this, the air quality was studied in terms of bacteriological contamination. All suspended dust sample had been analyzed for total bacterial count. The average bacterial contamination was high in the temple of inner city and urban fringe area while that of suburb was less found. The contamination was not related to amount of dust. The ambient air of Wat Bophitpimuk in the inner city and Wat Thong Bang Chueak Nang in urban fringe had lower amount of dust but there was maximum contamination. On the other hand, Wat Karnjanasinghas in urban fringe, which had maximum amount of dust, was lowest contaminated. It could indicate the different causes of problem. As mention earlier, the construction and traffic were the reasons for contributing higher dust but they did not a main cause of bacterial contamination. The observation results could explain well. It might come from a consequence problem of solid waste management. Dried feces of all pets (dogs, cats and birds) could be scattered together with dust and polluted the air quality. Moreover, the contaminated dust could cause water and/or food borne diseases as well.

It was observed from the laboratory analysis that there was plenty of fungi contamination. Some of them could inhibit bacterial growth in the culture media and

might give an interpretation error. However, it could be staged that the studied ambient air had both bacterial and fungal contamination.

5.1.2 The indoor environment

The studied results from in-depth interview showed that major expenditure of most temples in all zones was electricity and water supply costs. The electricity cost was ranged around 10,000-140,000 baht/month while that of water supply was 5,000-10,000 baht/month. The inner city temples paid highest 20,000-140,000 baht/month. It was lower the urban fringe (10,000-40,000 baht/month) and suburb (15,000-40,000 baht/month). These costs were referred to the use of facilities together with temple activities. The questionnaires reflected that all KUTIs had similar facilities. They were electric fan, telephone, hot water pot, television, refrigerator, and computer. It was quite difference for the ancient days and/or rural temple where most of KUTIs is a small hut and empty because monks were not supposed to make anything in their room except meditating and sleeping (70). However, it was exception for the city temples in this case since the electrical facilities, especially the computer and television, were used for supporting monk's education. This electrical expenditure thus was high follow by the increasing number of studying monk in the temple. The other important factor was temple activities as temple fair. There were many Buddhism activities in each month; thus temples had to spend more electricity. These results became a financial problem for many temples especially that of the inner city. Besides this, the amount of water consumption was also increased in the similar direction. Water supply is now the source of used water and drinking water for all temples. This was due to the convenient use and acceptable qualities. All temples thus had to carry these burdens of expenditures.

The average indoor sound level from all KUTIs was around 45 dB(A) and not over than the standard criterion of the national environmental board (1997) (71). At the same time, it was not exceeded the nuisance noise level for residential area in building, 45 dB(A), of WHO (72). However, there were only the temples in suburb area that had the average sound level exceeded the standard requirement. Major source of nuisance noise was come from schools and traffics. Although the average sound level for this study was not rather high, it also contributed some problems. Most monks had to study and did Buddhism activities which required almost silent

environment. This noise disturbed monk's activities and made sleeplessness problem. If there was no measurement for reducing noise level, many problems would occur and influence to monk's life quality at the end. Suksavage A. (73) did a study on stress coping among Buddhist monks in Bangkok Metropolitan. It found that almost one quarter of studied monk could not practice *Dhamma* in peace and quietness because of the disturbing sounds and smells. Fortunately, the nuisance noise which highly occurred during morning period did not be annoyance with most monks. This was due to there was few activity in the morning such as eating and cleaning thus it did not require quite surrounding. The noise was caused more impacts for studying activities. Monk had to close door or window in order to reduce the noise. This prevention could reduce a bit sound problem but it created other problems. Ventilation and lighting was effected. Monk had to open fan and lamp all the times. It was resulted to a stress problem to monk and an increasing of temple electricity expenditure as the whole.

Besides this, there was a problem of odor nuisance. Wet rubbish had much water constituent. Therefore, it could be easier to decompose and transmit nuisance odor. As soon as it was mixed together, it could be a vector breeding site and food source. Insect – vector transmitted disease can be reduced by separating rubbish, covering waste container and properly disposing waste. Moreover, cleanliness within and around temple areas could significantly reduce the risk of disease transmission. If monks could follow these, it could not only decrease odor nuisance and vector breeding site but also improve better life quality and well *Dhamma* practices.

KUTI's indoor lighting during daytime had been measured in the condition of natural and fluorescence lighting of intensity in KUTIs. The natural daylight was quite low (7-79 lux) and suitable for serving only walking and relaxing activities (75). The artificial light source could help a bit increasing light intensity. Thus, 60% of the surveyed KUTIs had the increasing light intensity not over than 37%. When considering the major monk activities, practicing *Dhamma* and studying, the average lighting intensities, 38 and 79 lux for natural and fluorescence lighting in KUTIs, found in this study was not enough for doing such activities. It was lower than a standard requirement of occupational environment promulgated by Ministry of Industry (2003) (75). Light intensity for walking and relaxing should not less than 20 Lux and 50 Lux, respectively. On opposite, for fine work activity such reading and

writing, the acceptable light intensity should be greater than 400 Lux (75). The lighting intensities inside KUTIs were inadequate for performing the demand of visual tasks. In this case, monk was not recommended to do an extremely visual task. If necessary, they should find another place which had more natural light intensity or arrange more artificial light. Increasing natural light is also important for home cleanliness: if a house is dark, it is more difficult to see dust and dirt and thus more difficult to clean properly (76). There were five temples, namely Wat Lam Phuk Chi, Wat Thong Bang Chueak Nang, Wat Ampawa, Wat Chaoam, and Wat Eamwaranuch, had natural lighting intensity lower than 20 Lux. Of these results, three temples were in the inner city, one in the urban fringe, and one in the suburb. It clearly shown that most Buddhist monks in inner city had to face with the lower lighting intensity problem. Because of the disturbing noise and dust, they had to close windows inside KUTIs all the times. Thus, the lighting intensity of those five KUTIs was less than the other KUTIs. It was necessary to turn fluorescence lamp on while they did activities in day time. Furthermore, there was a closed correlation between light intensity and noise level. A KUTI which had higher noise level always had lower natural light intensity. Thus the difference between the natural and artificial lighting intensity was rather high. On contrary, some KUTIs did not have much increasing light intensity even using more lamps. This was due to the maintenance problem. Monk paid more concern with the housekeeping and maintenance. It will create livelier environment.

5.2 Type of water consumption

5.2.1 Bacteriological qualities of studied water

Used water of all temples was water supply from Metropolitan Waterworks Authority (MWA). The MWA produces water supply based on the demand of public in BMA, Nonthaburi and Samut Prakarn provinces. Raw water sources of MWA are the upstream of Choa Phraya River and Mae Klong River. The treated water is generally complies with the recommended standard quality of the World Health Organization (WHO) at all times (8,65). However, as Bangkok is low land area and has problem of land subsidence, there is always a need to replace the older pipes in

order to ensure water quality at the household equivalent to those of at the treatment plant outlet (8). Thus water quality might be lowered during this maintenance period. Furthermore, Ruangdumrong J. (77) did a study which compared bacteriological quality of treated water from surface and ground sources. It was found that water quality from the surface sources had lower in both MPN and standard plate count. By the same reason, total residual chlorine of water sample from the ground source was lower than that from the surface source.

There were 7 samples of used water which their qualities were in the unaccepted permission level in terms of total coliform bacteria and fecal coliform bacteria from Public Health promulgate Vol. 6, B.E. 2524 and Department of Medical Sciences and Department of Health, Ministry of Public Health (78). It was 4 samples of cleansing water in toilet (1 sample of inner city temple (Wat Ampawa), 1 sample of urban fringe temple (Wat Ladplakao) and 2 samples of suburb temple (Wat Thippawas and Wat Ladplakao) and 3 samples of cloth cleansing water of urban fringe temples (Wat Thong Bang Chueak Nang and Wat Lam Phuk Chi)). In most cases, running water is not continuously supplied for hand and dish washing, cooking or drinking. It leads the temples to store water under vulnerable conditions which subject to re-contamination. Cloth cleansing water samples were kept in containers (large earthen jar and concrete tank) without lid cover. Ahmed S.A., Hoque B.A. and Mahmud A. (79) found that the internal surfaces at the bottom of the containers were found to be heavily contaminated. Proper cleaning of containers was essential to ensure safe storage of water. They also found that the bacterial counts from aluminum pitchers were markedly lower than those from earthen pitchers. Therefore, the material of which a container was made many materials also plays a role in bacterial growth. The porous surface of an earthen pitcher may provide a conducive environment for bacterial growth and adhesion. On the other hand, aluminum material may inhibitive for bacterial growth. Moreover, there was a chance for both dust and dried feces of pets fell into the used water containers. In general terms, the greatest microbial risks are associated with ingestion of water that is contaminated with human or animal (including bird) feces. Feces can be a source of pathogenic bacteria, viruses, protozoa and helminthes (42). Besides this, the contamination of cleansing water in toilet was similar to cloth cleansing water. Not only the containers were uncovered but also the

water was kept in a small container nearby wash closet. It might be easily contaminated with human excreta during defecation and bottom cleaning. Contaminated fingers would also come in contact with storage water during monks dip up water. Additionally, most of Buddhist monks (43%) cleaned the container only once a week and 18.5% never did. Beside this, the residual chlorine, which serves as disinfectant, would disappear from volatile process if water had been storage for more than 1-2 days (8). As these reasons, bacterial contamination in terms of total coliform bacteria and fecal coliform bacteria could be detected in those samples if there was contamination. Agard L. & Alexander C. (80) pointed out that storage vessels or containers used in various household played some role in the contamination of water. The impact of storage vessels on water quality was previously demonstrated by others (81, 82, 83). Thus the need for proper and regular cleaning of storage vessels should be emphasized. Frequency cleaning of storage vessels could significant reduce the level of coliform contaminated water (80).

The rest of used water samples were in the acceptable permission level in terms of total coliform bacteria and fecal coliform bacteria from Public Health promulgate Vol. 6, B.E. 2524 and Department of Medical Sciences and Department of Health, Ministry of Public Health (78). These samples were obtained from tap water which was water supply. Consequently, it could be summarized that the relatively high prevalence of coliform bacteria in many types of used water was a result of unclean storage vessels as well as the rather low mean residual free chlorine level. Although there was no statistical difference from the observation of bacteriological contamination among cleansing water in toilet, food utensil washing water, and cloth cleansing water, the results showed the higher risk to monk's health. A larger number of samples might possibly be an evidence for such results.

In case of drinking water, there were only 5 contaminated samples in terms of total coliform bacteria which in the unaccepted permission level from Public Health promulgate Vol.6, B.E. 2524 and Department of Medical Science and Department of Health, Ministry of Public Health (78). Those contaminated samples were water samples in containers (1 of inner city temple (Wat Ampawa), 2 of urban fringe temple (Wat Karnjanasinghas and Wat Thong Bang Chueak Nang), and 2 of suburb temple (Wat Thippawas and Wat Lam Phuk Chi). Besides this, the result showed that none of

the bottled water samples were contaminated. There were several factors responsible for high contamination of total coliform bacteria in drinking water which was stored in the container. Although most monk using boiling method for treat microbial contamination in the drinking water, the re-contamination would still easily occur during a process of storage whereas that of bottled water was not. The analyzed result of bacterial contamination in bottled water was quite similar to a study of Chongpiyawarang S. (102). It indicated that the total coliform bacteria and fecal coliform bacteria were not found in water supply samples and bottled water whereas cooler water was found contamination. Some of the contaminated drinking water samples was kept in a big container which was repeated use for several times and quite difficult to clean. Improperly maintenance of water treatment devices was being other source of contamination. It was the directed as a similar result from Nsanze H. and Babarind Z. (34). It showed 20 liters bottles were higher microbial contamination than 1.5 liters and storage of bottled water at ambient temperature could cause the multiplication of contamination. However, there was low contamination in drinking water since 79.2% of water sample in container and 100.0% of bottled water sample were met the standard in terms of total coliform bacteria. The bottled water which was treated by standard manufacture processes such ozone, reverse osmosis, or ultraviolet technology could ensure its quality. The analyzed result of fecal coliform bacteria was also accepted in permission level from Public Health promulgate Vol.6, B.E. 2524 and Department of Medical Science and Department of Health, Ministry of Public Health (78). Fecal coliform bacteria are a group of bacteria that are passed through the fecal excrement of humans, livestock and wildlife. The presence of coliforms in water is therefore suggestive of fecal contamination (85). Any fecal coliform in drinking water is of immediate concern as many diseases can be spread through fecal transmission. The risk of illness dictates that the water must be boiled to kill the organisms before it is safe to drink (86, 87). However, the common preference for bottled water seems aesthetically based: better taste and less odor, especially from chlorine. There is also a perception of greater safety, with an assumed lower concentration of microorganisms and chemical pollutants (88). It was a main reason for doing more treatment of uncontaminated water supply before drinking in most temples.

5.2.2 Residual chlorine concentration and bacteriological qualities water supply

Chlorination of water is known to be lethal to coliform bacteria, and their detection in treated water supplies indicates inadequate treatment or post process contamination (85, 89, 90). Chlorine kills bacteria, including disease-causing organisms and the nuisance organisms, iron bacteria. Residual chlorine measurement should be done on the distribution system at the areas farthest from the source of the water-treatment plant. This ensures that the entire distribution system is receiving enough chlorine. If the residual is low, the disinfection of the water system cannot be assumed to be complete and disease-causing bacteria (pathogens) may still be present in the water distributed lines (36, 37). Un-chlorinated water or water in which the residual chlorine has disappeared has been reported to support a high rate of contamination (85, 89, 90). Besides this, if breakpoint chlorination is being practiced to obtain free chlorine, the residual should be at least 0.2 to 0.5 ppm (37).

In this study, the residual chlorine concentration in water samples was between 0.2 to 0.6 ppm. It was 100% of studied temples which had the residual chlorine concentration in the acceptable permission level of WHO (1993) (91). When comparing microbiological quality with the residual chlorine concentration, these two parameters had very closely relationship. Whenever water had residual chlorine concentration in an accepted permission level, the microbiological quality was also in an accepted permission level. Thus microbial water quality is extensively monitored by measuring residual chlorine as an indicator of microbiological quality (88). As these results, it could be summarized that residual chlorine concentration was directly related to bacteriological qualities. A study in a Saudi Arabian referred that the use of chlorinated water was reported to be associated with a 4% reduction in occurrence of diarrhea disease (90). Disinfection of water with chlorine was then become widely used. Besides this, residual chlorine concentration was varied in each studied temples. This difference may be explained in part by the fact that contamination of piped water is known to occur during distribution, and a decrease in residual chlorine also can be a contributing factor. Likewise, possible pipe leakage due to corrosion resulted in the release of free chlorine and the deposition of chlorine on the interior of the pipe may also plays a role in this decreased in residual chlorine concentration (92). Agard L. &

Alexander C. (80) reported relationship of prevalences of coliform and *E.coli* and residual chlorine levels from various sources. They found a progressive increase in the prevalences of total coliforms, thermotolerant coliforms, and *E.coli* as the level of residual chlorine decreased. In order to ensure water supply quality, monk should frequently inspect water supply distribution lines in temple and observe any change of water quality from a smelling of chlorine.

5.3 Type of food for monks

5.3.1 Bacteriological quality of type of ready-to-eat food for monks

One of very important thing for human-being is food. The benefit of food consumption is for grow and healthy live in the world. On opposite, there were some risks from food consumption especially the contaminated food.

From the questionnaire, most of Buddhist monks got food from food offering on their alms by Buddhist. 84.2% of them usually got the spoilage food three times per month. Exceptionally, monk in urban fringe and inner city temples got it everyday. This situation pointed that the change of life style of Buddhist, especially in urban society, had impact to many activities. Most Buddhists in rural society has to cook food for monk by themselves in the early morning. Conversely, because of rush hour, a lot of ready-to-eat food in plastic bags that was prepared by street seller was favor for Buddhist in urban society. This was a main reason why spoilage food in urban fringe and inner city was much found than that of the suburb. Spoilage food is affected by several common factors, from the quality of raw materials to food handling and storage practices. Some bacteria grow in an aerobic environments, in other words they need oxygen to survive, and others in an anaerobic environment, such as the deadly botulinum bacteria, where an absence of oxygen is needed. This poses a canning risk for low acid items such as mushrooms or green beans. Thus there is a chance for both types of bacterial or other microbes to contaminate and caused health problems to monks.

Generally, after Buddhist monk got offering foods in the early morning, they had it as breakfast and kept some of it for forenoon meal. The behavior of keeping lunch food at ambient temperature for more than 2 hours without reheating is quite

dangerous. Frank L. Bryan (52) did a study on hazard and critical control points of vending operations at bus station in Pakistan. It found that the major factor that contributed to outbreaks of food borne diseases in developed countries is holding food at ambient temperature for several times. Besides this, a preliminary study of food safety practices and presumptive food-borne disease of Apiwathnasorn C. et al (95) found that prolonged holding of the foods at ambient temperature was found to be associated with high bacterial counts. In addition, more Muslim people experienced symptoms related to food poisoning during Ramadan period than at other times (95). Food hygiene practices concerning either daily food procurement or preparation need more attention especially the duration of holding food, personal hygiene, time-temperature control of cooking and reheating. Furthermore, Umoh V.J and Odoba M.B (51) studied the safety and evaluation of street foods sold in Nigeria. They found that unsanitary handling of street food is major contribution to contamination in food. Ready-to-eat foods in unsanitary locations are susceptible to contamination by flies and dust-laden microorganism. Most of foods were generally prepared in bulk (84.4%) and displayed for a whole day (more than 6 hours) for sale at ambient temperature without re-warming.

From the laboratory analyzed results found 35 samples had total coliform bacteria in an unaccepted permission level from Public Health promulgate Vol.6 B.E. 2524 and Department of Medical Science and Department Health, Ministry of Public Health (78). They were clear soup (41.7%, n=5), fried vegetable (33.3%, n=4), dressed salad (28.6%, n=2), dessert (18.2%, n=2), and curry (8.3%, n=1) of breakfast meal. Similarly, there were 50.0% clear soup (n=6), 50.0% fried vegetable (n=6), 42.9% dressed salad (n=3), 36.4% dessert (n=4), and 16.7% curry (n=2) of the forenoon meal. Coliform is a family of bacteria commonly in soils, plants and animals (87). The most widely used indicator bacteria are of the total coliform and fecal coliform (96). Total coliform is the collective name used for all coliform groups (87). Therefore, the possible reason for contamination of clear soup, fried vegetable, and dressed salad may from several types of vegetable that has typical coliform contamination. These vegetables might be cooked with insufficient heat to kill bacteria. At the same time, the contamination of dressed salad may be also from raw vegetable. Generally, spore forming bacteria are found in foods like vegetables. Raw vegetable had high bacteria

because of soil and fertilizer contamination, wash-water, and washing method (97, 98). Most of dressed salad was cooked by raw vegetable and less heat. The contamination came from raw vegetable because of the step of transportation, food preparation, and holding to sale. Unsanitary washing could not decrease a number of bacteria in raw vegetable. If vegetables are not washed thoroughly, bacterial contamination is carried through to the final product (79). Therefore, it was highly bacterial contaminated. The results were similar to Lertkanavanichkul M. et. al. (99) study whose found fried vegetable and dressed salad was the highest contamination with total coliform bacteria. It caused from unsanitary process, improper keeping food, and personal hygiene. Kaneko and Ken-Ichi (100) studied bacterial contamination of ready-to-eat foods and fresh products in retail shops and food factories. The coliform values in the raw vegetables cut for salad were the most heavily contaminated among the six kinds of ready-to-eat foods examined (salad, cooked salad, cooked rice, boiled noodles, bean curd, and cooked Japanese foods). For desserts, they could be contaminated by keeping for long time in container such as foam box or plastic bag at ambient temperature. Furthermore, most of them has major ingredient as coconut milk which was easily to spoil. The step of pressing coconut meat to get milk had to use raw water. Thus, it was possible for microorganisms to grow and multiply in dessert. Finally, the least percentage of bacterial contaminant was curry. Curry was generally heat for long time and added with many type of spices. As this result, the bacteria were retarded to growth. It was similar finding with Swangjit J. (50) that the least bacterial contaminant was in curry sample. Besides this, utensil may also represent an important cause of offering food contamination to monks, since the same utensils are used to process ready-to-eat food and raw material without any in-between cleaning which promoting the cross-contamination of foods. For example, raw meats should never be cut on the same cutting board as vegetables that will be consumed raw, cross contamination is hazard and can pass on food-borne illnesses.

In case of fecal contamination, there were 49 unaccepted samples which had contamination higher than the permission level from Public Health promulgate Vol.6 B.E. 2524 and Department of Medical Science and Department Health, Ministry of

Public Health (78). They were divided into 19 samples (35.2%) of morning meal and 30 samples (55.6%) of forenoon meal. The order of unaccepted sample was fried vegetable, clear soup, dressed salad, curry, and dessert, respectively. Fecal coliform by themselves are usually not pathogenic; they are indicator organisms, which means they may indicate the presence of other pathogenic bacteria. In fact, fecal contamination was public health risk indicator (101). Pathogens are typically present in such small amounts it is impractical monitor them directly (102). Fecal coliform bacteria are present in large numbers in the feces and intestinal tracts of humans and other warm-blooded animals, and can enter water bodies from human and animal waste. This could occur either through inadequate hand washing when handling food, or through inadequate cooking. Therefore, this result of contamination could indicate the sanitary practices of cooker. Cooker did not wash and dry their hand after going to toilet. It made contamination passed by hands to food. Therefore, the washing of hands with sanitizing soap is extremely important to stop not only the passing on of bacteria but also viruses.

5.3.2 The difference between bacteriological qualities in each type of ready-to-eat food and meals

There was no statistical difference from the observation of bacteriological contamination, total coliform and fecal coliform bacteria, in each type of ready-to-eat food samples and total coliform bacteria in each meal. However, the results showed the high risk to the monk's health. There was significant difference between bacteriological qualities in terms of fecal coliform and meals. The number of unaccepted samples of fecal coliform bacteria contamination was increased from 19 samples or 35.2% in breakfast meal to 30 samples or 55.6% in forenoon meal. There was highly change of unaccepted number in dessert samples. Only 1 unaccepted dessert sample (9.1%) in breakfast meal was then increased to 5 unaccepted samples (45.5%) in forenoon meal. The rest of unaccepted samples; clear soup, curry, fried vegetable, and dressed salad, had its increment around 1-3 samples from breakfast to forenoon meal. The survey indicated all of ready-to-eat food that got from food offering were kept together in plastic bag or container and hold at ambient temperature for more than 2 hours. It was similar to a preliminary study of food safety practices and presumptive foodborne disease of Apiwathnasorn C. et al (95). It was found that

prolonged holding of the foods at ambient temperature was found to be associated with the high counts. In just a few hours at breeding temperatures and with the right conditions, bacteria can go from a few to a few billion. Basically, the bacteria multiply very fast in warm, moist conditions. That is why temperatures below 4°C and above 60°C are best to hold foods at because bacteria find these environments inhospitable, and the freezer can shut most bacteria down completely. Temperatures 71°C and above will kill most bacteria, but if sufficient time has been given for the food to 'spoil' bacteria may have produced toxins that will not be inactivated by heat. That is why most food items have a maximum limit of a total of 4 hours at room temperature. Bacteria does not do well in a high acid environment or a high sugar/salt environment so vinaigrettes and other high acid items can keep longer at room temperature, but a lot is based on the amount of acidity. Salt and sugar mixtures plus a lack of moisture can make certain foods safe at room temperature like crisp cooked bacon. The salt and sugar bind up the moisture not allowing the bacteria an environment to grow in. Therefore, it is recommended for sanitary keeping food and re-warming every time before meals.

5.3.3 Bacteriological contamination of type of contact surface of food utensils

From results found 27% (n=13) contact surface of food utensils had more total bacteria than a permission level. Spoon was the highest contaminated whereas glass was the least contaminated. There were several factors for utensils contamination such as cleaning process, cleaning skill, quantity of utensils, utensil model, and method of storage. The importance of proper cleaning can be appreciated when one realizes that contaminated equipment (equipment and utensils which are not clean) is another major cause of food-borne disease outbreaks. No cleaning task in the food establishment is as important as the cleaning of food contact surfaces of equipment and utensils. Food contact surfaces of equipment and utensils are those surfaces with which food normally comes into contact. Effective cleaning of food contact surfaces of equipment and utensils serve two primary purposes. That was to reduce chances for contaminating safe food during processing, preparation, storage and service by physically removing soil, bacteria and other microorganisms and to minimize the chances of transmitting disease organisms to the consumer by achieving

bacteriological safe eating utensils. Furthermore, public and personal food utensils had different contamination. The high contamination was a sample from the kitchen center of studied temples such as Wat Bophitpimuk and Wat Lam Phuk Chi. Reversely, that of the less contamination from Wat Chaoam, Wat Ampawa, Wat Samiannari, and Wat Ladplakao, were personal food utensils. The causation of contamination might be different method of cleaning and storage. Most of public food utensils were cleaned by assigned Buddhist. There were a plenty of them in each batch which resulted in poor cleaning quality. On contrary, the personal food utensils which was cleaned by the owner and received more attention might have better cleanliness. Beside this, the observation from all studied temples indicated that a contamination might come from a cleaning place since most of utensils were cleaned on the floor. From theoretical basis, sanitary washing of contact surface of food utensils should starting with dish-washing detergent then rinse well under running water one or twice times in two water basins. This operation must also be elevated to at least 60 cm. above ground to prevent a splashing of dirt into utensil-washing water (93, 94). Furthermore, detergent, cleaner, chemical and abrasive was used to remove the remaining soil from equipment and utensils. These are physical and chemical removing processes. The soil and bacteria, as well as cleaning compounds, are suspended in the wash water (40). If there were many utensils, the suspended dirt in wash water; soil and bacteria, was also more. The order of utensil washing is also important. Less contaminated utensil such glasses should be the first order of washing. It should follow by bowl, dish, and spoon. Then rinsing to remove most of the suspended soil, bacteria and cleaning compounds from the equipment and utensils. Although the equipment and utensils look visibly clean at this point, some of them are still contaminated with many bacteria. From the theoretical basis, utensils must be dried in an open container with good air circulation and on the elevated level at least 60 cm. above ground (93, 94) in order to prevent re-contamination from air, insect and vectors. The use of cloths or towels for drying, polishing or any other purpose could re-contaminate equipment and utensils with bacteria (40). Chongpiyawarang S. (84) pointed that there was cross-contamination from dish drying cloths and half of sample had more total bacterial count than permission. Thus only acceptable method of drying equipment and utensils is air drying. Moreover, proper storage and handling of cleaned equipment and utensils is

very important to prevent re-contamination prior to use. Cleaned equipment and utensils must be stored on clean containers and handled to minimize contamination of food contact surfaces (40). The survey found most of contaminated spoon, bowl, and dish samples were kept in unsanitary condition. The basket of utensil was on the floor which prone to contamination than those of placed on the shelf. Glass samples that were kept in a crate had lower contamination than that used in public places. The unsanitary condition of temple and unhygienic behaviors had strongly effect to bacterial contamination of contact surface of food utensils and food at the last.

Although there was no statistical difference from the different type of contact surface of food utensil and bacteriological contamination, the results showed high risk of food contamination and monk's health. It would be great to observe more number of samples to be an evidence for such results.

CHAPTER VI

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This cross-sectional study was to assess the environmental health conditions and its qualities in 30 sampled temples which be a representative of Bangkok Metropolitan Region (BMR) temples. The studied temples were distributed in three zones of BMR which was inner city, urban fringe, and suburb. The sample size of Buddhist monks in this research who was interviewed were 417 Buddhist monks while environmental samples were received from 12 temples. The environmental health conditions were divided into housing sanitation, water consumption, and food for monks. Housing sanitation was composed of the outdoor environment (structure of housing, solid waste management, and ambient air quality) and the indoor environment (facilities, lighting, and noise). Water consumption consisted of used water and drinking water. Additionally, there were food utensils and ready-to-eat food in study food for monk. All data was inquired by using the questionnaire, inspection form and environmental analysis instruments. The ambient air quality was assessed by total suspended dust volume in cubic meter of sampled air and its bacteriological quality. Food utensils were examined for total bacterial contamination in contact surfaces of food utensils. Water supply had been determined for bacterial quality and residual chlorine concentration. Drinking water and ready-to-eat food were analyzed for total coliform and fecal coliform bacteria. The number of environmental sample in each individual temple was 10 foods, 3 used water, 2 drinking water, 4 utensils, and 1 ambient air. The overall laboratory analyzed samples in this research were 240.

For housing environment, most KUTIs were constructed with concrete and wood. They had long history of organizing and progression. All structures were both unplanned design and construction. Regarding to the compound of a temple, more than half of the studied monks had medium satisfaction with number of buildings and the rest area of the temples.

In case of solid waste management, most temples were serviced from Department of Public Cleansing of each district in Bangkok Metropolitan Administration (BMA). Most of Buddhist monks had medium satisfaction with collection frequency of service, residual solid waste, type and amount of waste container as well as location of them. Besides this, the survey found problem of unsanitary management and housekeeping of solid waste. The rubbish and animal feces were main causes of waste scattering around temple and being a breeding site for insects and vectors (rats, flies and cockroaches).

For ambient air quality, most of the monks must were faced with medium dust quantity on the ground of temple or KUTI. They poured some water on the ground and used shield materials for dust prevention. The highest dust was found at Wat Karnjanasinghas in urban fringe area whereas the lowest was Wat Thippawas in the suburb. The average weight of suspended dust in each zone was ranged in this order; urban fringe, inner city and suburb. On the other hands, the inner city, urban fringe and suburb was ranged in order of average of total bacteria count per weight of suspended dust.

There were many facilities inside KUTIs such as electric fan, telephone, hot water pot, television, refrigerator, and computer.

In case of lighting, the average natural and fluorescence lighting of intensity in KUTI was around 38 and 79 lux, respectively. There were five studied KUTIs that had light intensity less than 20 lux.

The average noise inside KUTI was around 45 dB (A). The highest average noise level was from Wat Lam Phuk Chi in suburb. The major nuisance noise problem was found in the morning time which was coming from school and traffic.

Water supply from Metropolitan Waterworks Authority (MWA) was a major source of water consumption for all BMR temples. The laboratory result found that used water had high contamination. Most of total and fecal coliform bacteria contaminations were found from cleansing water in toilet and cloth cleansing water. On the other hands, the bacterial contamination of food utensil washing water was less than 2 MPN/100 mL in every zone. The urban fringe temples had the highest bacterial contamination in term of total and fecal coliform bacteria. Although there were variety levels of bacterial contamination in the used water, the different was not high. Thus,

there was no statistical significant different between bacteriological qualities in each type of used water samples. Furthermore, the residual chlorine concentration was measured from water supply samples in all studied BMR temples. The entire samples (100.0%) had residual concentration higher than 0.2 ppm. Therefore, the analyzed result of 12 water supply samples did not found the unacceptable range of both total and fecal coliform bacterial contamination.

The drinking water had lower bacterial contamination. They were found only the total coliform bacterial contamination and none of them was contaminated with fecal coliform bacteria. All contaminated samples were water samples in containers.

Most of studied monks acquired food from different ways such food offering on the alms round in the morning, supporter's giving at temple, invitation getting, self-cooking, and market or shop buying. More than half of the studied monks ever received spoilage foods. The laboratory analysis found bacterial contamination of the ready-to-eat food for monk in different degrees. When comparing the difference of bacteriological qualities between breakfast and forenoon of ready-to-eat food, the forenoon meal always had higher contamination than that of the breakfast meal. The highest degree of bacterial contamination was clear soup for breakfast meal and fried vegetable for forenoon meal. The lowest degree of bacterial contamination was curry. Furthermore, both breakfast and forenoon meal of ready-to-eat food contamination found fecal coliform bacteria contamination higher than total coliform bacteria contamination. However, there was no statistical significant difference between bacteriological qualities in term of total coliform bacteria and fecal coliform bacteria in each type of ready-to-eat food samples. Similarly, there was no significant difference between bacteriological qualities in term of total coliform bacteria in each meal. Reversely, there was significant difference ($p < 0.05$ at significant level of 0.05) between bacteriological qualities in term of fecal coliform and meals.

The studied food utensils had various levels of bacterial contamination. When considering the contamination by type of food utensils, the highest contamination was spoon whereas glass had the lowest contamination. Furthermore, when comparing the contamination level in each zone, the suburb temples had bacterial contamination higher than that of the inner city and urban fringe temples. However, there was no

statistical significant difference between bacteriological contaminations among each type of food utensils samples.

In conclusion, the research demonstrates that the environment of temple area is related to a large number of controlled factors of our study, each of which can affect one another as these variables are in dynamic system. In other words, a particular problem can be attributed to many different factors. Therefore, in order to analyze these problems, we need to come up with cause cycle and eliminate these causes of problems. Concurrently, a virtue cycle is indispensable to the course of action so as to prevent an occurrence of these problems in the future. For instance, one might concern that turning the area, on which the temple currently allow businesses to capitalize, to be cushion area can seriously result in a decline in its revenue. However, as for a virtue cycle, this change is considered to be an environmental investment that can eventually yield a fruitful result to the community as well as society. To be more specific, having the buffer zone can help the temple protect its people from contracting diseases. This is equivalent to mitigate environmental effects deteriorating the healthy life of monks in the temple. Thus, the monks can perform their tasks such as ethically educating people without any such hindrance as illness that is rooted in poor environment. Further, as people appreciate and have faith in monks as well as the temple, they tend to visit this sacred and sanctimonious place more frequently. As a result, the temple will be able to generate more revenue. By the same token, it is reasonable to argue that deep-rooted social problems such as various types of crimes will be dramatically reduced, since people are more aware of social responsibilities owing to these ethically and morally educated people. Therefore, not only the community but also society will benefit from this a virtue cycle.

All in all, this scenario of enhancing the quality of life of both monks and people in the proximity of a temple area can be attained by good collaboration from virtually all members of the community. Monks, ordinary people, non-profit organization, corporations, government, and so on, would have to assist performing this type of environmental improvement.

6.2 Recommendations

6.2.1 Specific recommendations for application

According to the results of study, the Buddhist monk's environmental health conditions needs to improve as following:

1. KUTIs should be regularly cleaned to prevent the dust collection. Plantation around temple and nearby KUTIs is recommended since it will serves as a buffer zone for environmental pollutants.
2. The maintenance of fluorescent lamp and other facilities related to lighting is required to increase light intensity and ensure lighting quality in KUTI.
3. Detail inspection of ventilation, lighting, and noise conditions of all KUTIs should be done. It will give alternatives for minimize nuisance problem together with increase a better environmental health condition.
4. There is a need for pet policy in order to control pet population and reduce consequence problems.
5. Merit person should recognize the quality of food offering to the monk to minimize the food borne problem.
6. The monks should be kept or stored in the sanitary condition after received food to prevent contamination and inhibit microbial growth.
7. In case of the monks kept food for more than two hours in ambient temperature, a process of food reheating is necessary for destroying food microbes.

6.2.2 General recommendations for application

1. General solid waste in temple should be separated and recycled to reduce disposal cost, distribution of diseases and others.
2. Left food should be properly eliminated and prepared in the sanitary place for feeding pets.
3. Water supply container should be maintained in a sanitary condition and frequently cleaning to prevent contamination of storage water.
4. The water supply distribution lines should be routine checked to observe problem of leakage and cross contamination.
5. Only sanitary bottle or container is recommended to use for store drinking water. They have to pass a process of selection and cleaning before use at all times.

6. Sanitary washing of food utensils should start with dish-washing detergent then rinse well under running water one or twice times in two water basins. This operation must also be elevated to at least 60 cm. above ground to prevent a splashing of dirt into utensil-washing water.

7. Cleaned and sanitized utensils and equipments should be stored at least six inches above the floor in a clean, dry location in a way that protect them from contamination by splash, dust and other means.

8. Utensils should be air-dried before being stored or shall be stored in a self-draining position.

9. Glasses and cups should be stored inverted. Other stored utensils shall be covered or inverted wherever practical.

6.2.3 Recommendations for further study

1. A similar study should be repeated for temple, monks and novice monks who live in other provinces which have different socio-economic structure then a comparison of findings can be made.

2. The in-dept study of environment related health problem should be performed to find out linkages web of causation.

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APPEXDIX A

QUESTIONNAIRES FOR BUDDHIST MONKS

แบบสอบถามเพื่อศึกษาสภาพสิ่งแวดล้อมทางกายภาพ

ชื่อวัด..... ที่ตั้งเลขที่..... หมู่ที่..... ชุมชน..... เขต/ตำบล..... ถนน..... อำเภอ..... จังหวัด..... ชื่อผู้ให้สัมภาษณ์..... ตำแหน่ง..... อายุ..... ปี ชื่อผู้สัมภาษณ์..... วันที่สัมภาษณ์.....	เลขที่.....
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หมวดที่ 1. น้ำดื่ม – น้ำใช้

1. ปริมาณการดื่มน้ำประมาณ..... แก้ว/วัน (.....ลิตร/ วัน)
2. ระบุตัวอย่างกิจกรรมที่ท่านใช้น้ำประจำในปริมาณมากมา 3 อันดับ
 อันดับที่ 1 อันดับที่ 2 อันดับที่ 3.....
3. แหล่งน้ำดื่ม – น้ำใช้ (ตอบได้มากกว่า 1 ข้อ)

น้ำดื่ม	น้ำใช้
() บ่อขุด	() บ่อขุด
() น้ำประปา	() น้ำประปา
() น้ำฝน	() น้ำฝน
() น้ำบรรจุขวดพลาสติกใส	() น้ำคลอง/แม่น้ำ
() น้ำบรรจุขวดพลาสติกขาวขุ่น	() อื่น ๆ (ระบุ.....)
() น้ำบรรจุถัง	
() อื่น ๆ (ระบุ.....)	

4. การปรับปรุงคุณภาพน้ำก่อนดื่มหรือใช้

น้ำดื่ม		น้ำใช้	
☐ ปรับปรุง ↓ โดย ☐ ต้มเดือด ☐ กรอง ☐ ใช้สารเคมี	☐ ไม่ปรับปรุง	☐ ปรับปรุง ↓ โดย ☐ กรอง ☐ ใช้สารเคมี	☐ ไม่ปรับปรุง
ลักษณะของน้ำใช้		ลักษณะของน้ำดื่ม	
☐ สะอาด ☐ พอใช้ ☐ สกปรก ระบุ.....		☐ สะอาด ☐ พอใช้ ☐ สกปรก ระบุ.....	
รายละเอียดวิธีการปรับปรุงคุณภาพน้ำ (ตอบได้มากกว่า 1 ข้อ) ☐ โดยการกรอง เครื่องกรองชนิด..... ยี่ห้อ..... ☐ โดยวิธีการต้ม ☐ ต้มจนเดือด 100 °C ใช้วิธี ☐ ใช้กาต้มน้ำ ☐ ต้มไม่เดือดถึง 100 °C ☐ ใช้กระติกน้ำร้อน ☐ ใช้สารเคมี ระบุสารเคมีที่ใช้.....			

5. ภาชนะจัดเก็บ (ตอบได้มากกว่า 1 ข้อ)

น้ำดื่ม	น้ำใช้
☐ ถังเก็บน้ำคอนกรีต ☐ ถังน้ำมีฝาปิดถาวร ☐ ถังน้ำมีฝาปิด ☐ ถังน้ำไม่มีฝาปิด ☐ แทงค์น้ำโลหะ ☐ ได้จากท่อประปาโดยตรง ☐ ขวดพลาสติก ☐ ขวดแก้ว ☐ กระติกน้ำร้อน ☐ กาน้ำชา ☐ อื่นๆ (ระบุ.....)	☐ ถังเก็บน้ำคอนกรีต ☐ ถังน้ำมีฝาปิดถาวร ☐ ถังน้ำมีฝาปิด ☐ ถังน้ำไม่มีฝาปิด ☐ แทงค์น้ำโลหะ ☐ ได้จากท่อประปาโดยตรง ☐ ถังพลาสติก ☐ อื่นๆ (ระบุ.....)

6. ท่านเปลี่ยนน้ำและ/หรือทำความสะอาดภาชนะจัดเก็บบ่อยแค่ไหน

น้ำดื่ม	น้ำใช้
() ทุกวัน	() ทุกวัน
() วันเว้นวัน	() วันเว้นวัน
() สัปดาห์ละครั้ง	() สัปดาห์ละครั้ง
() ไม่เคยเลย	() ไม่เคยเลย
() อื่นๆ (ระบุ.....)	() อื่นๆ (ระบุ.....)

7. ท่านล้างน้ำแข็งหรือไม่

() ไม่ล้าง

() ล้าง

ระบุสถานที่ซื้อ.....

8. ในระหว่างวันท่านจมน้ำโดยใช้

() แก้วน้ำส่วนตัว

() แก้วน้ำส่วนรวม

() กระจกน้ำหรือกาน้ำส่วนตัว

() อื่นๆ.....

9. ปัญหาที่พบเกี่ยวกับการใช้น้ำ (น้ำดื่ม - น้ำใช้) ในเขตวัด

น้ำดื่ม

น้ำใช้

() ไม่มี

() ไม่มี

() น้ำไม่เพียงพอ

() น้ำไม่เพียงพอ

() สกปรก

() สกปรก

() ราคาแพง

() ราคาแพง

() อื่นๆ.....

() อื่นๆ.....

11. ข้อเสนอแนะของผู้ใช้

.....

หมวดที่ 2 ที่พักอาศัย

1. ในเวลากลางวัน ท่านต้องเปิดไฟหรือไม่

() เปิด เนื่องจาก.....

() ไม่เปิด เนื่องจาก.....

โดยท่านได้รับแสงสว่างจาก

() ดวงอาทิตย์

() ตะเกียง

() หลอดไฟฟ้า ชนิดของหลอดไฟ..... กำลังไฟ.....วัตต์

จำนวน.....หลอด/ ห้อง

() อื่นๆ.....

2. กิจกรรมที่ท่านปฏิบัติขณะอยู่ในกฎ (ตอบได้มากกว่า 1 ข้อ)

กิจกรรม	ช่วงเวลา		
() อ่านหนังสือ	เช้า	กลางวัน	เย็น
() ทำความสะอาด	เช้า	กลางวัน	เย็น
() ทำงานฝีมือทั่วไป เช่น.....	เช้า	กลางวัน	เย็น
() รับแขกหรือสนทนา	เช้า	กลางวัน	เย็น
() เขียนหนังสือ	เช้า	กลางวัน	เย็น
() พักผ่อน	เช้า	กลางวัน	เย็น
() ทำงานฝีมือประณีต เช่น.....	เช้า	กลางวัน	เย็น
() รับประทานอาหาร	เช้า	กลางวัน	เย็น
() อื่น ๆ (ระบุ.....)	เช้า	กลางวัน	เย็น

3. ท่านคิดว่าบริเวณกฎของท่านมีเหตุรำคาญหรือไม่

() ไม่มี

() มี ระบุ (ตอบได้มากกว่า 1 ข้อ)

() เสียงดังรบกวน

มีเวลาใดมากที่สุด

() เช้า () กลางวัน

() เย็น () กลางคืน

เสียงดังรบกวนดังกล่าวเกิดปัญหาใดต่อท่าน

() นอนไม่หลับ

() พุดโทรศัพท์, ดูทีวี, สนทนา

() ปวดหัว

() อื่นๆ (ระบุ.....)

แหล่งของเสียงรบกวนมาจาก

() โรงเรียน

() จราจร

() ก่อสร้าง

() อื่นๆ (ระบุ.....)

วิธีที่ท่านใช้ป้องกันการเกิดเสียงรบกวน

() ไม่มี

() มี ระบุ.....

มาตรการที่ท่านต้องการให้หน่วยงานที่รับผิดชอบ
เข้ามาแก้ไข

- () กำหนดเขตจราจร
() กำหนดเวลาทำงาน, เครื่องจักรทำงาน
() ข้อเสนอแนะอื่นๆ.....

- () แสงกระพริบ
() แสงจ้าเกินไป
() แสงมีดสลับ
() มีความสั่นสะเทือน จาก.....
() มีกลิ่นเหม็น จาก.....
() มีฝุ่นละออง จาก.....
() มีเขม่าควัน จาก.....
() เกิดพิษหรือสารเคมีต่างๆ เช่น.....
() อื่นๆ (ระบุ.....)

4. ท่านทำความสะอาดกฎ

- () ทุกวัน () วันเว้นวัน () สัปดาห์ละครั้ง () อื่นๆ (ระบุ.....)

5. ภายในกฎของท่านมีสิ่งอำนวยความสะดวกสบายหรือไม่

() ไม่มี	() มี ระบุ (ตอบได้มากกว่า 1 ข้อ)
	() โทรศัพท์ () กระจกน้ำร้อน () น้ำประปา () ที่เก็บและรวบรวมขยะ () ห้องน้ำ () ห้องอาบน้ำ () เตาไมโครเวฟ () อื่น ๆ ระบุ..... () ตู้เย็น () ตู้กับข้าว () เตาอุ่นอาหาร () พัดลม () เครื่องปรับอากาศ () ที่วี () หม้อหุงข้าว

6. ภายในกฎของท่านมีแมลงและ/หรือ สัตว์นำโรคหรือไม่ (ตอบได้มากกว่า 1 ข้อ)

- () ไม่มี (ข้ามไปตอบคำถามหมวดที่ 3) () มี (ตอบคำถามข้อ 7 ต่อไป)
- ได้แก่ () ยุง
() แมลงสาบ
() หนู
() แมลงวัน
() สัตว์เลี้ยง ระบุ.....
() อื่น ๆ

7. การกำจัด

() ไม่กำจัด	() กำจัด โดย
	() กำจัดที่แหล่งกำเนิด () ใช้สารเคมีกำจัด ชนิด (ตอบได้มากกว่า 1 ข้อ) () ฟ่น () เป็นแท่งหรือขดจุด () เป็นแผ่นวางบนแผ่นเหล็กซึ่งใช้ไฟฟ้าเป็นตัวให้ความร้อน () ผงโรย () แบบแท่งขีด

หมวดที่ 3 อากาศ

1. กิจกรรมหรือสภาพแวดล้อมที่เกี่ยวข้องกับปัญหามลพิษทางอากาศในวัด (ใช้เหตุการณ์ที่ผ่านมาในรอบ 1 เดือน และขณะสำรวจ) (ตอบได้มากกว่า 1 ข้อ)

() มีการเผาขยะ	ระยะห่างจากวัดประมาณ.....เมตร	() ไม่มี
() มีการเผาเศษไม้ใบไม้	ระยะห่างจากวัดประมาณ.....เมตร	() ไม่มี
() มีแหล่งทิ้งขยะ/เศษขยะอยู่ใกล้บริเวณวัด	ระยะห่างจากวัดประมาณ.....เมตร	() ไม่มี
() มีการก่อสร้างใกล้บริเวณวัด	ระยะห่างจากวัดประมาณ.....เมตร	() ไม่มี
() มีการใช้เตาหุงต้มในวัด	ระยะห่างจากวัดประมาณ.....เมตร	() ไม่มี
() เตาไฟฟ้า () เตาแก๊ส () เตาถ่าน/ฟืน () อื่นๆ		
() ทานธูปบู่หรี		() ไม่สูบ
() สูบทุกวัน () สูบนานๆครั้ง () อื่นๆ ระบุ.....		
() การจราจรบนถนนใกล้วัด	ระยะห่างจากวัดประมาณ.....เมตร	() ไม่มี
() หนาแน่น () ปานกลาง () น้อย		
() มีถนนสายใหญ่/สายหลักใกล้วัด (เช่น ทางด่วน) ระบุชื่อ.....	ระยะห่างจากวัดประมาณ.....เมตร	() ไม่มี
() ญาติสายตรงของท่าน (เช่น โยมพ่อ โยมแม่ สีกา เป็นต้น) มีปัญหาเกี่ยวกับโรคทางเดินหายใจ ระบุชื่อโรค.....		() ไม่มี
() พระภิกษุหรือบุคคลที่อยู่ร่วมภายในกุฏิของท่านมีปัญหาเกี่ยวกับโรคทางเดินหายใจ ระบุชื่อโรค.....		() ไม่มี
() ท่านมีปัญหาเกี่ยวกับโรคทางเดินหายใจ ระบุชื่อโรค.....		() ไม่มี

2. ปัญหาเหตุรำคาญทางด้านฝุ่น

2.1 ฝุ่นตามพื้นผิวภายในวัด (เช่น พื้นในอาคาร ที่นอน) () มาก (กวาดบ่อยมากในแต่ละวัน ทั้งไว้ 1 ชม. จะเกิดขึ้นใหม่) () ปานกลาง (ทิ้งไว้ ½ - 1 วัน จะเกิดขึ้นใหม่) () น้อย (เกิดน้อยมากใน 1 วัน)	() ไม่มี
2.2 ฝุ่นเกาะติดตามเครื่องนุ่งห่มที่ตากกลางแจ้ง () มาก (ตากไว้ 1 ชม. จะเกิดขึ้น) () ปานกลาง (ตากไว้ ½ - 1 วัน จะเกิดขึ้น) () น้อย (ตากไว้ 1 วัน จะเกิดขึ้นเล็กน้อย)	() ไม่มี
2.3 ปัญหาเรื่องกลิ่นในวัด (เช่น กลิ่นขยะ, กลิ่นน้ำเสียกักขัง เป็นต้น) () มาก (มีกลิ่นเหม็นตลอดเวลา 1 ชม. และรุนแรง) () ปานกลาง (มีกลิ่นเหม็นเป็นพักๆ ในช่วง ½ - 1 วัน) () น้อย (พบกลิ่นเหม็นบ้างแต่นานๆ ครั้งในช่วง 1 วัน) ระบุแหล่งของกลิ่นในวัด.....	() ไม่มี

3. การป้องกันกำจัดฝุ่น

3.1 การทำความสะอาด

ระบุบริเวณที่ทำความสะอาด ซึ่งหากมีหลายพื้นที่ให้ยกตัวอย่างบริเวณที่มีปริมาณฝุ่นมากมา 3 อันดับ

อันดับที่ 1..... ทำวันละ..... ครั้ง

อันดับที่ 2..... ทำวันละ..... ครั้ง

อันดับที่ 3..... ทำวันละ..... ครั้ง

3.2 วิธีทำความสะอาด (ตอบได้มากกว่า 1 ข้อ)

() กวาด () เครื่องดูดฝุ่น () เช็ด - ถู () อื่นๆ ระบุ.....

3.3 วิธีป้องกันฝุ่น

() ใช้น้ำรด () ใช้วัสดุกัน ระบุ..... () อื่นๆ ระบุ.....

หมวดที่ 4 การจัดการของเสีย (ขยะมูลฝอย)

1. การกำจัดขยะ

☐ กำจัดเอง เหตุผลในการกำจัดเอง (ตอบได้มากกว่า 1 ข้อ) ☐ ขยะมีไม่มาก ☐ ค่าบริการในการจัดเก็บแพงเกินไป ☐ ไม่มีรถของทางราชการมาจัดเก็บ	โดย ☐ เฝ้า ☐ ทิ้งลงในคลองสาธารณะ ☐ อื่นๆ ระบุ..... ☐ มีรถมาเก็บแต่เก็บไม่หมด ☐ ที่ทิ้งขยะอยู่ไกล ☐ อื่นๆ ระบุ.....
☐ ไม่กำจัดเอง (ตอบได้มากกว่า 1 ข้อ) ขนย้ายโดยวิธี	☐ ขนย้ายไปรวมกันที่ที่พักของชุมชน โดยเฉพาะ ☐ ขนย้ายไปรวมกันที่ถังขยะสาธารณะทั่วไป ☐ ขนย้ายไปรวมกองไว้ใกล้คลองสาธารณะ ☐ ขนย้ายไปรวมกองไว้ที่พื้นที่ที่ไม่ใช่ที่ทิ้งขยะ ☐ อื่นๆ ระบุ.....

2. ท่านพอใจความถี่ในการจัดเก็บและรวบรวมขยะของหน่วยราชการหรือไม่

☐ พอใจ ☐ ไม่พอใจ ระบุสาเหตุและข้อเสนอแนะ.....

3. การนำขยะไปกำจัด (ครั้ง / สัปดาห์)

☐ กำจัดขยะเอง.....ครั้ง/สัปดาห์
☐ เทศบาลหรือหน่วยงานราชการมาจัดเก็บ.....ครั้ง/สัปดาห์
 ระบุเวลาในการจัดเก็บ.....

4. การตกค้างขยะภายในวัดในแต่ละวัน

☐ มี ☐ ไม่มี

5. จำนวนถังขยะในบริเวณวัดเหมาะสมหรือไม่

☐ เหมาะสม ☐ น้อยเกินไป ☐ มากเกินไป

6. ที่ตั้งของถังขยะวางไว้ในบริเวณที่เหมาะสมหรือไม่

☐ เหมาะสม ☐ ไม่เหมาะสม ระบุสาเหตุและข้อเสนอแนะ.....

หมวดที่ 5 อาหารภายในวัด

1. กรุณาบอกที่มาของอาหารปรุงแล้วที่ท่านนับเป็นประจำมา 3 อันดับ

อันดับที่ 1 อันดับที่ 2 อันดับที่ 3

2. ก่อนรับประทานอาหารท่านมักจะ

☐ ล้างมือ ☐ อาบน้ำ ☐ รับประทานทันที ☐ อื่นๆ.....

3. หลังจากที่ท่านได้รับอาหารที่ปรุงแล้ว ท่านมักจะ

มือเช้า	มือกลางวัน
☐ จันทน์ที่โดยไม่มีการอุ่นอาหาร ☐ จันทน์ที่พร้อมทั้งมีการอุ่นอาหารก่อน ☐ เก็บไว้ก่อนแล้วจึงนำมาฉันโดยไม่มีการอุ่นอาหาร ☐ เก็บไว้ก่อนและมีการนำอาหารมาอุ่นก่อนฉัน ☐ อื่นๆ	☐ จันทน์ที่โดยไม่มีการอุ่นอาหาร ☐ จันทน์ที่พร้อมทั้งมีการอุ่นอาหารก่อน ☐ เก็บไว้ก่อนแล้วจึงนำมาฉันโดยไม่มีการอุ่นอาหาร ☐ เก็บไว้ก่อนและมีการนำอาหารมาอุ่นก่อนฉัน ☐ อื่นๆ

3. การเก็บอาหารก่อนฉันและหลังฉัน

มือเช้า	มือกลางวัน
ก่อนฉัน ☐ จันทน์ที่ ☐ ใส่ภาชนะแล้ววางไว้บนพื้นเฉยๆ ☐ ใส่ภาชนะแล้ววางไว้บนโต๊ะเฉยๆ ☐ ใส่ภาชนะแล้ววางไว้บนพื้นมีที่ปิด ☐ ใส่ภาชนะแล้ววางไว้บนโต๊ะมีที่ปิด ☐ ใส่ภาชนะและเก็บในตู้กับข้าว ☐ อื่นๆ ระบุ.....	ก่อนฉัน ☐ ใส่ภาชนะแล้ววางไว้บนพื้นเฉยๆ ☐ ใส่ภาชนะแล้ววางไว้บนโต๊ะเฉยๆ ☐ ใส่ภาชนะแล้ววางไว้บนพื้นมีที่ปิด ☐ ใส่ภาชนะแล้ววางไว้บนโต๊ะมีที่ปิด ☐ ใส่ภาชนะและเก็บในตู้กับข้าว ☐ อื่นๆ ระบุ.....
หลังฉัน ☐ ให้ญาติโยม ☐ ใส่ภาชนะแล้ววางไว้บนพื้นเฉยๆ ☐ ใส่ภาชนะแล้ววางไว้บนโต๊ะเฉยๆ ☐ ใส่ภาชนะแล้ววางไว้บนพื้นมีที่ปิด ☐ ใส่ภาชนะแล้ววางไว้บนโต๊ะมีที่ปิด ☐ ใส่ในตู้กับข้าว ☐ อื่นๆ ระบุ.....	หลังฉัน ☐ ให้ญาติโยม ☐ ใส่ภาชนะแล้ววางไว้บนพื้นเฉยๆ ☐ ใส่ภาชนะแล้ววางไว้บนโต๊ะเฉยๆ ☐ ใส่ภาชนะแล้ววางไว้บนพื้นมีที่ปิด ☐ ใส่ภาชนะแล้ววางไว้บนโต๊ะมีที่ปิด ☐ ใส่ในตู้กับข้าว ☐ อื่นๆ ระบุ.....

4. ท่านกำจัดเศษอาหาร โดย

- ☐ เลี้ยงสัตว์ (เช่น สุนัข แมว)
☐ มีการรวบรวมและกำจัดอย่างถูกสุขลักษณะ (เช่น ใส่ถุงพลาสติกมัดแน่น และ/หรือ รวบรวมไว้ ในถังขยะที่มีดิด เพื่อให้หน่วยงานราชการนำไปกำจัดต่อไป)
☐ ไม่มีการกำจัด เพราะ.....
☐ อื่นๆ ระบุ.....

5. การล้างภาชนะอุปกรณ์ที่สัมผัสอาหาร

- () ล้างทันที () เก็บไว้ก่อน

6. การจัดเก็บภาชนะหลังทำความสะอาดแล้ว

- () ปล่อยให้แห้งในที่ที่สะอาดและถูกสุขลักษณะ () เช็ดให้แห้งด้วยผ้า
() เก็บทันที () อื่นๆ.....

7. ภายในรอบ 1 เดือนที่ผ่านมา ท่านเคยมีอาการท้องเสียหรือไม่

- () เคย เนื่องจาก (ตอบคำถามข้อ 8 ต่อไป) () ไม่เคย (ตอบคำถามข้อ 9 ต่อไป)
() อาหารที่รับประทานไม่สะอาด
() อาหารสุกๆ ดิบๆ
() เครียด
() ไม่ทราบสาเหตุ
() อื่นๆ ระบุ.....

8. จากข้อ 7. ท่านคิดว่าอาหารที่ทำให้ท่านท้องเสียมาจาก

- () อาหารจากร้านค้า บริเวณ..... () อาหารที่นำมาถวาย
() อาหารที่ใส่บาตร () อื่นๆ ระบุ.....

หมวดที่ 6 พื้นที่รอบวัด

1. ท่านคิดว่าภายในวัดมีจำนวนอาคารเหมาะสมหรือไม่

- () เหมาะสม () มากเกินไป () น้อยเกินไป

2. ท่านคิดว่าภายในวัดมีสถานที่พักผ่อนหย่อนใจเหมาะสมหรือไม่

- () เหมาะสม () มากเกินไป () น้อยเกินไป

3. ข้อคิดเห็นและข้อเสนอแนะของผู้ได้รับการสัมภาษณ์

.....
.....

APPENDIX B
MODIFIED METHODS FOR
FOOD AND DRUG ADMINISTRATION (FDA)
BACTERIOLOGICAL ANALYTICAL MANUAL

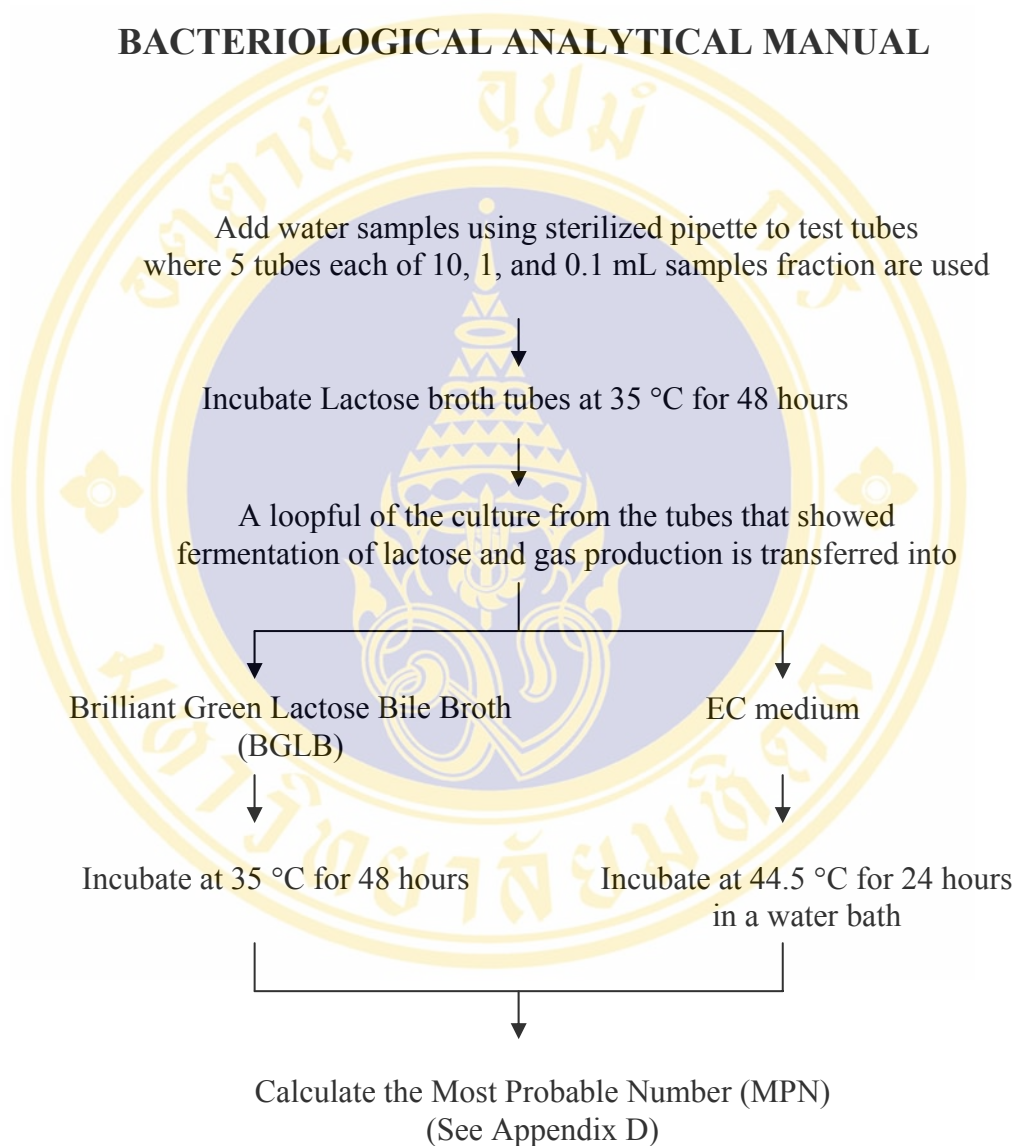


Figure B Most Probable Number technique for the enumeration of total coliform bacteria and fecal coliform bacteria where five tubes per dilution are used (10 mL, 1 mL, and 0.1 mL) for water samples.

APPENDIX C

MODIFIED METHODS FOR FOOD AND DRUG ADMINISTRATION (FDA) BACTERIOLOGICAL ANALYTICAL MANUAL

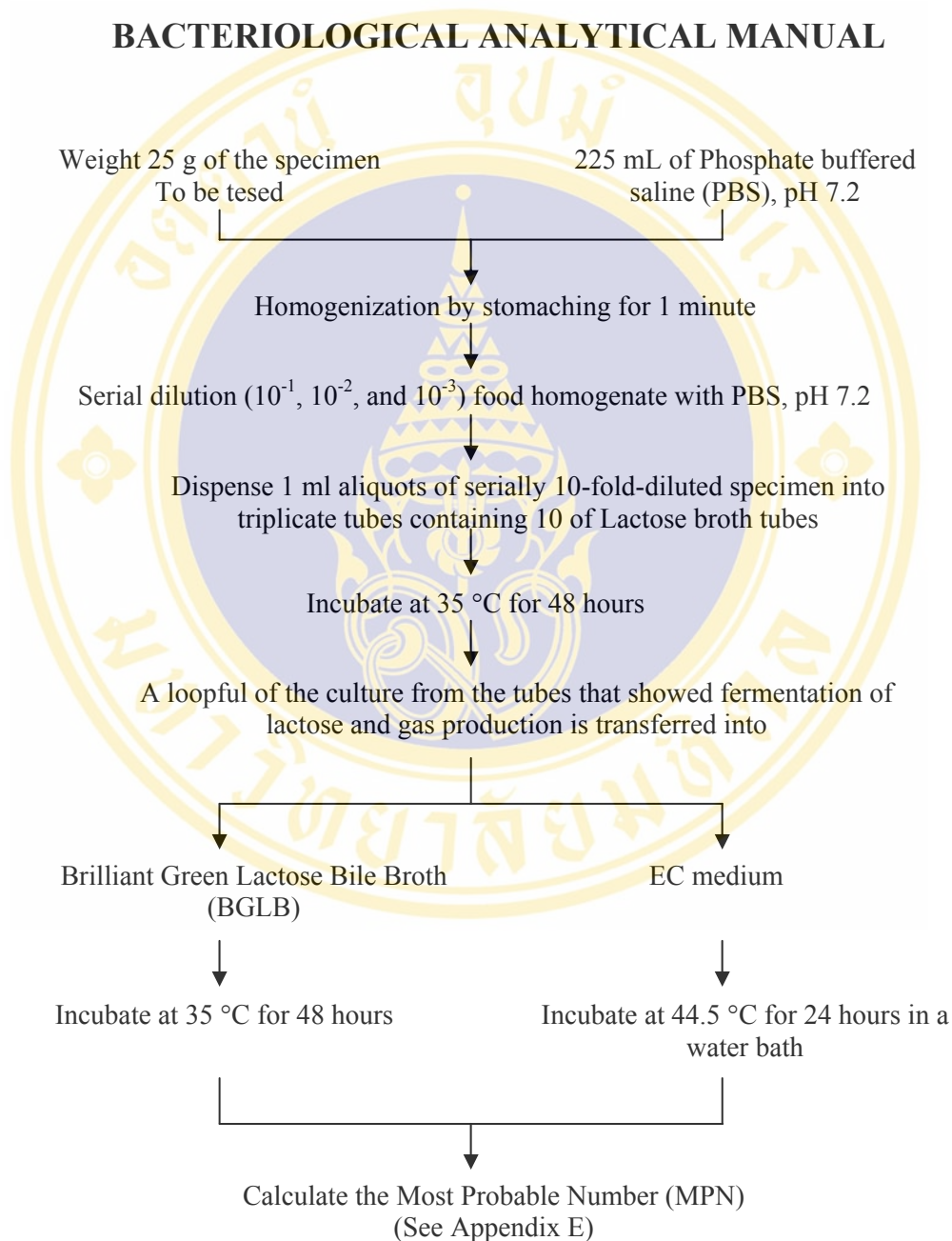


Figure C Most Probable Number technique for the enumeration of total coliform bacteria and fecal coliform bacteria where three tubes per dilution are used (10^{-1} , 10^{-2} , and 10^{-3}) for ready to eat food samples.

APPENDIX D

MPN TABLE FOR WATER AND DRINKING WATER ANALYSIS

MPN index and 95% confidence limits for various combinations of positive results where five tubes per dilution are used (10 mL, 1.0 mL, and 0.1 mL sample portion)

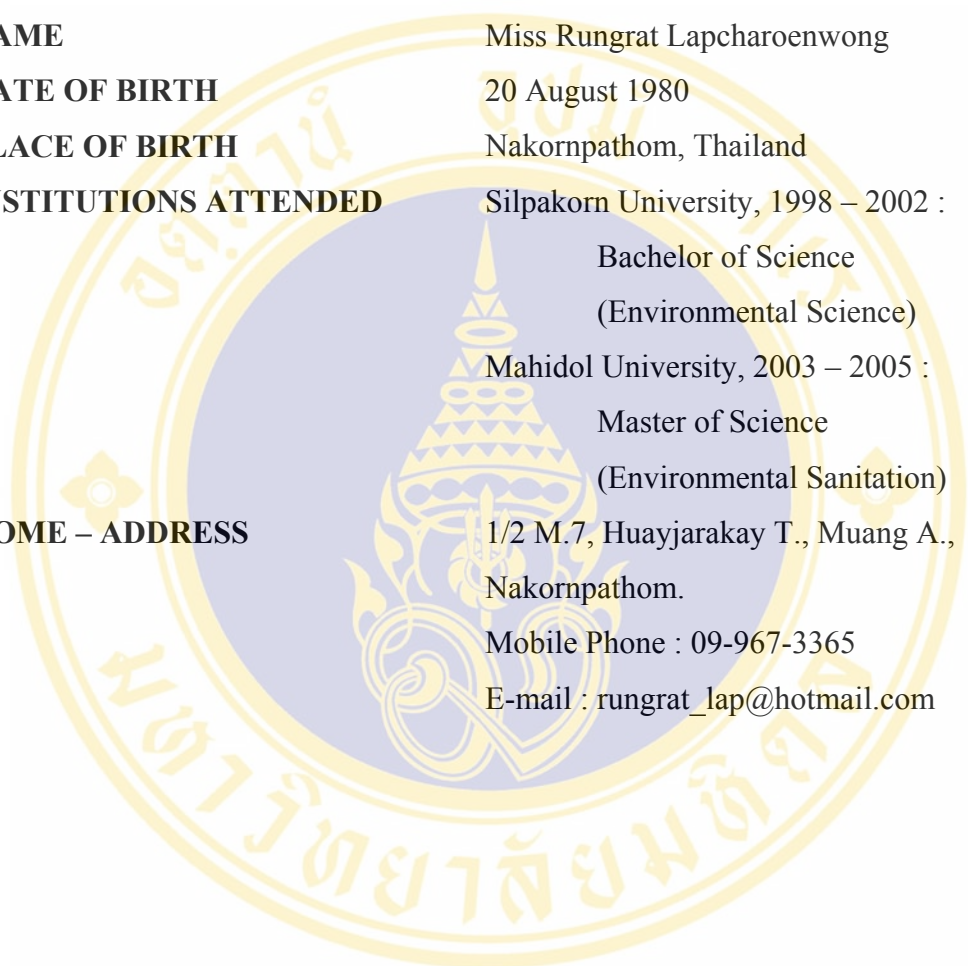
Pos. tubes			MPN/ 100mL	Conf. lim.		Pos. tubes			MPN/ 100mL	Conf. lim.	
10	1.0	0.1		Low	High	10	1.0	0.1		Low	High
0	0	0	<2	1.0	10	4	3	0	27	12	67
0	0	1	2	1.0	10	4	3	1	33	15	77
0	1	0	2	1.0	14	4	4	0	34	16	80
0	2	0	4	--	--	5	0	0	23	9.0	86
1	0	0	2	1.0	14	5	0	1	30	10	110
1	0	1	4	1.0	15	5	0	2	40	20	140
1	1	0	4	1.0	15	5	1	0	30	10	10
1	1	1	6	2.0	18	5	1	1	50	20	150
1	2	0	6	2.0	18	5	1	2	60	30	180
2	0	0	4	1.0	17	5	2	0	50	20	170
2	0	1	4	2.0	20	5	2	1	70	30	210
2	1	0	7	2.0	21	5	2	2	90	40	250
2	1	1	9	3.0	24	5	3	0	80	30	250
2	2	0	9	3.0	25	5	3	1	110	40	300
2	3	0	12	5.0	29	5	3	2	140	60	360
3	0	0	8	3.0	24	5	3	3	170	80	410
3	0	1	11	4.0	29	5	4	0	130	50	390
3	1	0	11	4.0	29	5	4	1	170	70	480
3	1	1	14	6.0	35	5	4	2	220	100	580
3	2	0	14	6.0	35	5	4	3	280	120	690
3	2	1	17	7.0	40	5	4	4	350	160	820
4	0	0	13	5.0	38	5	5	0	240	100	940
4	0	1	17	7.0	45	5	5	1	300	100	1300
4	1	0	17	7.0	46	5	5	2	500	200	2000
4	1	1	21	9.0	55	5	5	3	900	300	2900
4	1	2	26	12	63	5	5	4	1600	600	6300
4	2	0	22	9.0	56	5	5	5	1600	--	--
4	2	1	26	12	65						

APPENDIX E

MPN TABLE FOR FOOD SAMPLE ANALYSIS

For 3 tubes each at 0.1, 0.01, and 0.001 g inocula, the MPNs per gram and 95 percent confidence intervals.

Pos. tubes			MPN/g	Conf. lim.		Pos. tubes			MPN/g	Conf. lim.	
0.10	0.01	0.001		Low	High	0.10	0.01	0.001		Low	High
0	0	0	<3.0	--	9.5	2	2	0	21	4.5	42
0	0	1	3.0	0.15	9.6	2	2	1	28	8.7	94
0	1	0	3.0	0.15	11	2	2	2	35	8.7	94
0	1	1	6.1	1.2	18	2	3	0	29	8.7	94
0	2	0	6.2	1.2	18	2	3	1	36	8.7	94
0	3	0	9.4	3.6	38	3	0	0	23	4.6	94
1	0	0	3.6	0.17	18	3	0	1	38	8.7	110
1	0	1	7.2	1.3	18	3	0	2	64	17	180
1	0	2	11	3.6	38	3	1	0	43	9	180
1	1	0	7.4	1.3	20	3	1	1	75	17	200
1	1	1	11	3.6	38	3	1	2	120	37	420
1	2	0	11	3.6	42	3	1	3	160	40	420
1	2	1	15	4.5	42	3	2	0	93	18	420
1	3	0	16	4.5	42	3	2	1	150	37	420
2	0	0	9.2	1.4	38	3	2	2	210	40	430
2	0	1	14	3.6	42	3	2	3	290	90	1,000
2	0	2	20	4.5	42	3	3	0	240	42	1,000
2	1	0	15	3.7	42	3	3	1	460	90	2,000
2	1	1	20	4.5	42	3	3	2	1100	180	4,100
2	1	2	27	8.7	94	3	3	3	>1100	420	--

BIOGRAPHYThe background of the table features a large, faint, circular seal of Mahidol University. The seal is gold-colored with a blue center. It contains a central emblem of a traditional Thai stupa (chedi) and is surrounded by Thai script in both the upper and lower halves.

NAME	Miss Rungrat Lapcharoenwong
DATE OF BIRTH	20 August 1980
PLACE OF BIRTH	Nakornpathom, Thailand
INSTITUTIONS ATTENDED	Silpakorn University, 1998 – 2002 : Bachelor of Science (Environmental Science) Mahidol University, 2003 – 2005 : Master of Science (Environmental Sanitation)
HOME – ADDRESS	1/2 M.7, Huayjarakay T., Muang A., Nakornpathom. Mobile Phone : 09-967-3365 E-mail : rungrat_lap@hotmail.com