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Assessment of food hazards in local restaurants in Chiang Rai, Thailand

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Abstract

The aims of this study are: 1) to examine food sanitation and safety by assessing food hazards, and 2) to recommend guidelines for the reduction of food hazards in local restaurants in Chiang Rai province in northern Thailand. Forty-four local restaurants were included in the target group of this study. The methodology consists of the assessment of physical hazards using a check-list. To assess the chemical hazards, five types of test-kits including a borax, a formalin, a salicylic acid, a sodium hydrosulfite, and a pesticide or MJPK test-kit were used. Moreover, biological hazards were assessed using the most probable number or MPN method. The results show that there were not any physical or chemical hazards in their food. By contrast, *E.coli* was detected at twenty restaurants in Chiang Rai. Therefore, Good Manufacturing Practices (GMPs) should be widely promoted to encourage a high level of food sanitation and safety in order to decrease several food hazards, especially biological contamination. Furthermore, non-smoking areas should be designated and fire-prevention equipment should be installed in these restaurants.

Keywords**:** *food hazards, food safety, food sanitation, food sanitation and safety, Good Manufacturing Practices, GMPs*

1. Introduction

Since the growth of tourism in Asia and the Pacific is second in the world ranking of the world tourism organization (World Tourism Organization and Global Tourism Economy Research Centre, 2017). There has been a continuous increase in restaurants which are a major factor in the development of tourism. According to the International Hotel and Restaurant Association (2016), there are 10 million restaurants in the world. In addition, the report of the Agriculture and Agri-Food Canada (2015) stated that China which is located in the Asia and Pacific area has the highest value of the food-service markets worldwide with around more than $560 billion (USD). Thailand, which has many natural, cultural, and historical attractions, is one of the top destinations in Asia for international tourism and international tourism receipts (World Tourism Organization and Global Tourism Economy Research Centre, 2017; Tourism Authority of Thailand, 2018). Therefore, Thai restaurants can be established widely to support the growth of tourism in this country. As can be seen, the important statistics analyzed by the Ministry of Tourism and Sport (2016, cited in Department of Business Development, 2017), showed that there were 437 Thai restaurants in 2016 which accounted for an increase of 3.37%. Additionally, Thai cuisine offered in Thai restaurants is the favorite food of tourists around the world, especially in the US due to a strong ethnic influence (Sriwattana, Resurreccion, Haruthaithanasan, & Chompreeda, 2002, pp:139-150). In fact, Thai restaurants are defined as all of the services associated with ready-to-eat food, including: 1) cafés and bars; 2) 100% home delivery or takeaways; 3) fast food; 4) street stalls; 5) self-service cafeterias; and 6) full-service restaurants (Department of Business Development, 2017). The food products in restaurants are associated with five factors, including cultural and religious factors, socio-demographic factors, motivational factors, personality, and past experience (Sengel et al., 2015). *Local restaurants* are one of the factors related to tourism which drives the economic development of Thailand. As can be seen from the study of Gale (1977, cited in Brain, 2012), 65% of the income distribution of the community is created from the buying of local products or local food. Moreover, the local restaurants in Chiang Rai province in northern Thailand offer popular food which derives from the *Lanna Kingdom* (Chiang Rai Bulletin, 2014), for example, round tables known as Khantoke, Khanom Jeen Nam Ngiao or noodle curry-soup,

Khao Soi or Northern noodle curry, and Nam Prik Noom or chili-drips. Additionally, some of the ingredients grown in Chiang Rai province, such as strawberries, herbs, and local vegetables are used in modern food (i.e. bakeries and breweries, papaya salad, ready-to-eat and seafood restaurants) that attract many tourists to satisfy their hunger and experience the local food culture (Sengel et al., 2015). Although the local restaurants in Chiang Rai province have been widely established to support the heavy consumption of food and the growth of tourism, there is a risk of unsafe food being served in local restaurants. Moreover, foodborne disease caused by harmful food contaminants in local restaurants is a major problem which can seriously affect the level of tourists' confidence. According to the World Health Organization (WHO) (2018), more than 200 diseases ranging from diarrhea to cancer can be caused by several types of unsafe food contaminants which include harmful bacteria, viruses, parasites, or chemical substances. Moreover, nearly 10% of the world population falls ill after eating unsafe food and half a million people die every year as a result of foodborne disease (World Health Organization, 2018). Additionally, an estimated number of 128,000 hospitalizations occur in the U.S. which is caused by eating contaminated food (Scallan, 2011 cited in Marchado, & Cutter, 2017, pp. 264-269). The study of Osaili, Al-Nabulsi, and Krasneh (2018, pp.167-176) reported that there were 600 million illnesses and half a million deaths in 2010 from foodborne diseases in the Middle East and North Africa. However, in Thailand "clean food with a good taste", which is a safety guarantee of the standard of local restaurants, has demonstrated that nearly 90% of all Thai food and local restaurants are not affected by contaminated food (Department of Health, 2017). Nevertheless, there were 108,153 hospitalizations in Thailand in 2016. In addition, the report of the Bureau of Epidemiology, Department of Disease Control (2017) indicated that there were three deaths from foodborne diseases. It is therefore clear that there is a risk of food contamination which is caused by physical, chemical, and biological contaminants as demonstrated by the local restaurants in Chiang Rai province. Hence, the assessment of food hazards in local restaurants is an important factor that can save lives and which can affect the health of people and tourists living in Chiang Rai province. Furthermore, food safety in local restaurants is one of the factors used to indicate customer satisfaction with the local restaurant services (Liu & Lee, 2018, pp.29-35). Therefore, it is important to assess the food hazards, including the physical, chemical, and biological hazards which may occur. This will not only prevent foodborne diseases from causing harmful pathogens, chemical substances, and physical residuals, but it will also promote the quality of food in local restaurants and tourist satisfaction which will contribute to the development of the cultural tourist economy in this area.

2. Objectives

The objectives of the study are: 1) to examine food sanitation and safety by assessing food hazards assessment; and 2) to recommend the guidelines for the reduction of food hazards in the local restaurants in Chiang Rai province, Thailand.

3. Materials and methods

In this study, there are 78 sites of local restaurants in Chiang Rai province located in the north of Thailand as can be seen in Figure 1 (Kunakorabordin, Muakkul, Sena, & Sriprasert, 2006). This population was then calculated using the Taro Yamane formula at a confidence level of 90% (Check & Schutt, 2012; Phoochinda, 2015). From this calculation, 44 sites of local restaurants in Chiang Rai province were selected for randomized sampling of which 14 sites were ready-to-eat restaurants, 10 were noodle restaurants, 10 were traditional Lanna restaurants, 5 were bakery and beverage restaurants, 3 were papaya salad restaurants and 2 were of seafood restaurants. After the randomized sampling selection, three types of food hazard assessments were carried out including: 1) a physical hazard assessment; 2) a chemical hazard assessment; and 3) a biological hazard assessment. Firstly, a check-list in the form of a questionnaire of physical hazards was developed by the Department of Health, Ministry of Public Health (2014). These questionnaires were divided into four parts with a total of 30 questions. In the first part, there were 8 questions called the "preparing and dining area" concerning clean and proper areas for food preparation, providing a non-smoking zone, the distance of food preparation from the floor, proper lighting, rodent and pest control, fire prevention and safety equipment, frequency of utensil cleaning and the separation of used utensils from

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other equipment used in food preparation. In the second part, there were 8 questions associated with "food utensils and equipment" which included questions about proper food storage, natural gas tank safety locks, the distance of utensils after washing and cleaning from the floor, the proper position of ready-to-eat facilities, the separation of cutting boards and knives for food preparation, proper rodent and vector traps, the provision of hot water for disinfection of food utensils, and the proper position of glasses for drinking water. In the third part, called "raw materials for food", there were 9 questions including the cleanliness and quality of ice and drinking water, the process of food cleaning before cooking, the separation and storage of raw materials, the proper temperatures for cooking food, the re-heating of ready-to-eat food, proper ice pincer or related equipment, proper ready-to-eat food containers, the process of utensil cleaning, and the proper container for food waste. In the fourth part, called "personal hygiene", 5 questions were included associated with wearing jewelry, the clothes worn by the chef, hand washing, tasting, and the covering of wounds. Thus, there were a total score of 30 points for the physical hazards. The cut-off points for analyzing the physical hazards on this check-list were: 1) the risk of contamination from physical hazards was at a low level for which the total score was less than 50% or less than 15 points; and 2) the risk of contamination from physical hazards was at a high level for which the total score was 50% of the highest possible percentage of the total score or 15 points (Department of Health, Ministry of Public Health, 2014; Osaili et al, 2018).

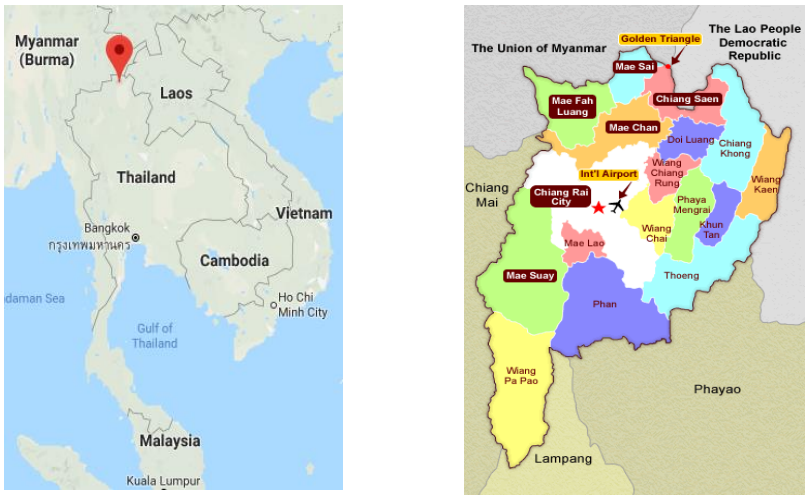

Figure 1 The location of this study

Moreover, the assessment of the chemical hazards was then tested using the test-kits provided by the Department of Medical Science. The parameters for testing the chemical hazards of contamination of foods are related to the established criteria for healthy foods in Thailand which 1) *borax* found in samples of pork ball, ground pork, fish-tofu, etc., and a red color showed on the cucumber paper if the borax was contaminated in the sample; 2) *formalin* found in samples such as seafood, vegetables, animal entrails and a red or pink color showed if the samples were contaminated by formalin; 3) *salicylic acid* in samples of sour pork, pickled fruit, curry paste, etc., and if there was contamination with salicylic acid, a dark or violet color showed on the sample; 4) *sodium hydrosulfite* including samples of bean sprouts, pickled bamboo shoots, etc., and a dark or gray color showed if there was contamination by sodium hydrosulfite in the sample; and 5) *pesticides* found in cabbage, Chinese Kale, long beans, several kinds of vegetables and fruits, etc., and if these were contaminated with pesticides at a high level, the samples showed a pinky-orange color when the MJPK test-kits were used (Department of Health, Ministry of Public Health, 2000).

The assessment of biological hazards was then tested after the physical and the chemical

hazard assessment. Samples from the chefs' hands, food and drinking water containers, and samples of drinking water or ice were included to analyze the biological hazards. This analysis was based on the most probable number or MPN method, and the metallic green sheen on EMB agar which demonstrates *E. coli* contamination was used for the biological analysis to confirm the results of the MPN method (Cappuccino & Sherman, 2008; U.S. Food and Drug Administration, 2018). Samples of raw food and food equipment from this study are illustrated in Table 1. Moreover, the mean difference of fecal coliform bacteria were analyzed by the *SPSS* program at 0.05 level of significance to compare the differential average of fecal coliform bacterial numbers for each type of local restaurant located in Chiang Rai province.

Table 1 Food and food equipment sampling

Type of sampling	Number of sampling	Sampling technique
Hand of Chef	Select one hand that is usually used for food preparation for one man per local restaurant	Swab Technique
Food Container and Utensil (e.g. spoon, chopsticks)	More than 4 pieces per one bottle of Peptone solution per local restaurant	Swab Technique (on the bottom of the food container around 2x2 inch for the food container) (the area of this swab for any utensil is 2x2 inch)
Ice	More than 100 g	Aseptic Technique and the collection of samples in a sterile bag or sterile box
Drinking Water	More than 100 ml	Aseptic Technique and the collection of samples in a sterile bottle

Source: Department of Medical Science, Ministry of Public Health, 2008.

After the assessment of physical, biological and chemical hazards in the sample sites, the results of these assessments were analyzed to describe the food sanitation and safety and the risk of food contamination and hazards in this area. The recommendations are related to the principles of food sanitation and safety as demonstrated by the results of previous assessments (World Health Organization, 2006; Knechtges, 2012; McSwane, Rue, & Linton, 2005; Pranee, 2015; Gupta, Dudeja, & Minhas, 2017). Hence, the conceptual framework of this study is demonstrated in Figure 2.

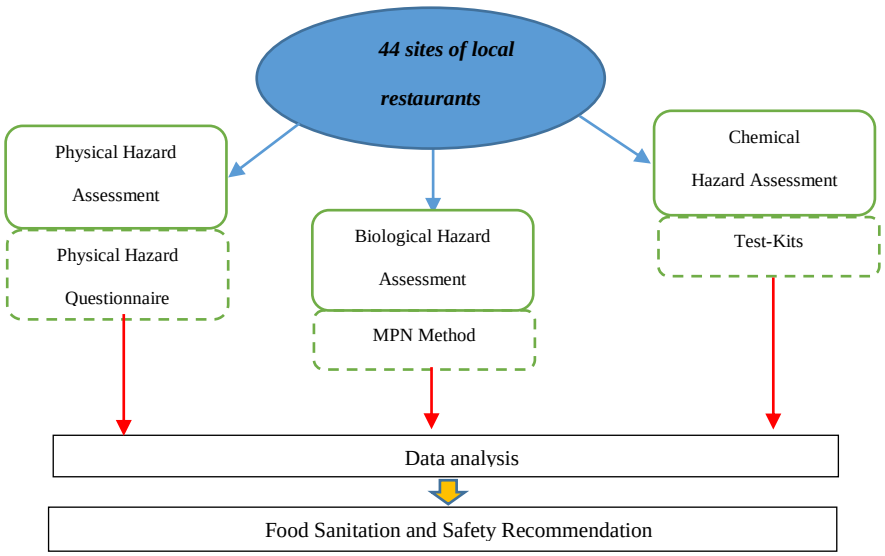

Figure 2 Conceptual framework

4. Results

4.1 Assessment of physical hazards in the local restaurants

With regard to the physical hazard assessment, all of the local restaurants in this study were at a low level of physical contamination with a score of more than 50% of the total points for this questionnaire. However, some of the criteria in this assessment were not met by some of the local restaurants as follows: 1) 68.3% of the local restaurants lacked a designated non-smoking area; 2) most of the local restaurants or around 70.4% lacked fire prevention or safety equipment; 3) rodent and vector traps were not installed in 84.1% of the local restaurants; 4) they lack hot water for disinfection of food utensils at a level of 70.5%; 5) 22% of the chefs working in the local restaurants wear jewelry while cooking food, and; 6) only 6 local restaurants or 13.6% do not keep raw materials in separate areas. Moreover, 7 local restaurants or 15.9% lack proper containers for food waste.

4.2 Assessment of chemical hazards in local restaurants

This study did not detect any chemical hazards in the food samples from the local restaurants in this area using the chemical test kit which included borax, formalin, salicylic acid, sodium hydrogensulfite, and pesticide. After the physical and chemical hazard assessments, it can be assumed that the physical and chemical contamination to food in the local restaurants is only a minor problem with regard food sanitation and safety. In fact, physical hazards commonly result from accidental contamination and poor food-handling practices that can occur at various points in the food chain from harvest to consumer. Chemical hazards in food are usually classified as either naturally occurring, such as in chemicals which contain toxins produced by natural plants, seafood, and biological organisms or man-made chemicals, including substances that are added, intentionally or accidentally, during the preparation of food.

4.3 Assessment of biological hazards in the local restaurants

With regard to biological hazard assessment, the MPN method was applied to predict the biological contamination of raw materials in storage, during food preparation and cooking, and the serving of food to customers in order to establish the total amounts of coliform bacteria and fecal bacteria. Total coliform bacteria are common in the environment, while fecal coliform bacteria, which originates in the intestines of warm-blood animals including humans, are a sub-group of the total coliform bacteria. If we find fecal coliform bacteria in food or drinking water, it can indicate that the food or drinking water has been contaminated with human or animal feces or urine associated with poor levels of sanitation in the preparation of food. From the fecal coliform bacteria analysis illustrated in Figure 3, it was found that 18 (40%) of the local restaurants had fecal coliform bacteria in the samples of drinking water and ice at the level of less than 3 mpn/100 ml. With regard to the detection of fecal coliform bacteria in samples from the hands of the chefs, it was found that 20 of the local restaurants (nearly 46%) were found to have the bacteria at the level of 3-50 mpn/100 ml. At 23 of the local restaurants (nearly 53%) fecal coliform bacteria were found in samples from food containers and utensils at a level of less than 3 mpn/100ml. According to the average number of fecal coliform bacteria from the samples on the hands of chefs which were divided into the several different types of local restaurants and analyzed by the *SPSS* program, it was found that the different types of local restaurants had different levels of the average amount of fecal coliform bacteria in the samples from the hands of chefs at 0.05 of level of significance. The average numbers of fecal coliform bacteria detected in the samples from the hands of chefs in noodle restaurants, ready-to-eat restaurants, papaya salad restaurants, bakery and beverage restaurants, traditional Lanna restaurants, and seafood restaurants were 39.02, 17.95, 71.99, 963.52, 24.65, and 47.99 mpn/100 ml, respectively. Meanwhile, the different types of local restaurants did not show different levels of the average number of fecal coliform bacteria in samples of drinking water or ice and food containers and utensils. This analysis suggests that biological contamination in the form of fecal coliform bacteria can be found in the local restaurants of this study. In addition, the detection of *E. coli* which is the pathogen bacteria originating from feces or urine was found in a sample from a hand of chefs, a food container and utensil, and some ice or drinking water.

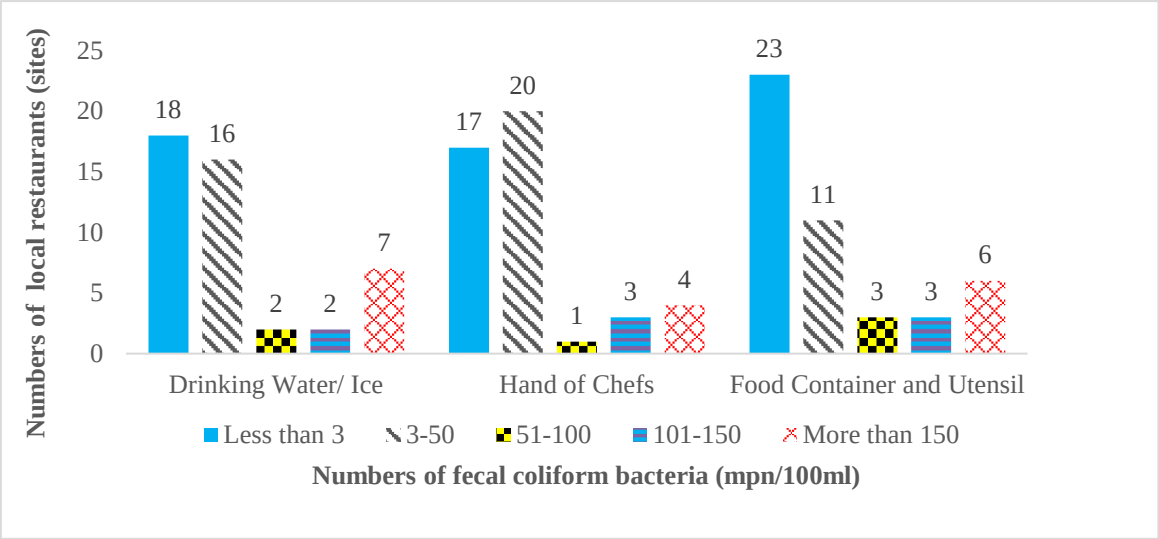

Figure 3 Numbers of fecal coliform bacteria detected in separate types of samples

In the section on *E.coli* analysis according to the MPN method, around 20 sites or nearly 46% of samples detected *E. coli* contamination as can be seen in Tables 2 and 3. From these tables, most of the papaya salad and Bakery and beverage restaurants detected *E.coli* at 60 to 75% whereby there were 2 sites of papaya salad restaurants with *E. coli* contaminants in samples of drinking water or ice; meanwhile in 2 sites of bakery and beverage restaurants *E. coli* contaminants were detected in samples from the chef's hands and food containers. Secondly, numbers of *E. coli* contamination in noodle restaurants and traditional Lanna restaurants were found in half of the sample sizes (50.0%) whereas in all of the noodle restaurants *E.coli* contaminants were found on the chefs' hands, some of the drinking water or ice samples. For ready-to-eat food restaurants, 33.3% of samples size or only 5 sites of these restaurants *E.coli* contamination, especially in some of the drinking water or ice samples demonstrated as 3 sites or 60% of samples detection were detected. On the other hand, *E. coli* contamination was not detected in seafood restaurants from this study. To sum up, it was found that some types of foodborne and waterborne diseases may have occurred from biological contamination associated with the detection of fecal coliform bacteria and *E.Coli* in foods, drinking water, hands of the chefs, and several kinds of food utensils as a result of the lack of personal hygiene and following the principles of GMP (Shaw, 2013).

Table 2 Number of *E.coli* contamination

Type of local food restaurant	Total sample size	Number of sites contaminated with *E.coli*	Percentage of *E.coli* contamination
Noodle restaurants	10	5	50.0%
Ready-to-eat food restaurants	15	5	33.3%
Papaya salad restaurants	3	2	66.7%
Bakery and beverage restaurants	4	3	75.0%
Traditional Lanna restaurants	10	5	50.0%
Seafood restaurants	2	0	0.0%
Total	***44***	***20***	***45.4%***

Table 3 Number and type of samples contaminated with *E.coli*

Type of local food restaurant	Number of a sample contaminated with *E .coli*	Type of samples contaminated with *E.coli* (percentage)*		
		Drinking Water / Ice	Hand of chefs	Food container
Noodle restaurants	5	2 (40.0)	5 (100.0)	2 (40.0)
Ready-to-eat food restaurants	5	3 (60.0)	1 (20.0)	3 (60.0)
Papaya salad restaurants	2	2 (100.0)	1 (50.0)	1 (50.0)
Bakery and beverage restaurants	3	0 (0.0)	2 (66.7)	2 (66.7)
Traditional Lanna restaurants	5	3 (60.0)	1 (20.0)	1 (20.0)
Seafood restaurants	0	0 (0.0)	0 (0.0)	0 (0.0)
Total	***20***	***10 (50.0)***	***10 (50.0)***	***9 (45.0)***

Note: *****is defined as all of restaurants can detect *E.coli* contamination in all types of samples

4.4 Recommendations for food sanitation and safety

The results of the assessments of food hazards indicate that the most serious biological problem is caused by the detection of fecal coliform bacteria and *E.coli* in several types of local restaurants because they lack a knowledge of the basic principles of Good Manufacturing Practices (GMPs). These practices can be used to reduce biological contamination during food processing, especially with regard to food containers and utensils, chefs' hands, and drinking water or ice. The rules of GMPs recommend the following (The World Health Organization, 2006): 1) dining and food preparation areas should always be clean; 2) food preparation should be carried out at least 60 centimeters from the floor; 3) food seasoning should be guaranteed by food safety standards; 4) raw meat, seafood and poultry should be stored in the refrigerator below cooked or ready-to-eat foods to avoid cross-contamination and they should be kept at a temperature lower than 5 degrees Celsius; 5) ready-to-eat foods should be kept in food cupboards and the distance from the floor should be at least 60 centimeters; 6) ice should be kept in clean containers and clean ice pincers should be used to reduce cross-contamination from hands; 7) proper detergents should be used for cleaning any utensils and the distance from the floor should be at least 60 centimeters; 8) separate cutting boards for raw materials and ready-to-eat food should be used; 9) hands should be washed with proper soap before handling any food; 10) basins for washing hands and soap should be provided in the toilets in the local restaurants; 11) chefs should wear gloves, cover their hair and wear clean aprons during the preparation of food and cooking; and 12) if any employee suffers from the symptoms of Hepatitis A, Hepatitis B, Typhoid, or Tuberculosis, he or she must not work until certified as healthy by a licensed physician, assistant physician or practicing nurse. In addition, there are several recommendations for the physical improvements of restaurants as follow: 1) they should provide a designated non-smoking area and fire-prevention equipment to prevent accidents caused by smoking or cooking; 2) they should install vector traps and provide suitable garbage bins to prevent contamination from any vectors; and 3) they should have the equipment to provide warm water for the disinfection of utensils.

5. Discussion

It can be concluded from this study that all the local food restaurants in Chiang Rai have introduced good practices to prevent physical hazard with the result that they obtained a sufficient score to pass the physical hazard assessment. Some physical hazards were detected from harvesting and food transportation. However, several physical contaminants which could lead to food damage or illness were found to be at an acceptable level, such as wood, plastic, sand and grits (Orolugbagbe, 2015). Moreover, none of the local restaurants in this study were found to have chemical contaminants of raw food, such as borax, formalin, salicylic acid, sodium hydrogensulfite, or pesticides. According to Gupta et al. (2017), the farmers in this region apply the principles of Good Manufacturing Practice (GMP) to produce safe food and prevent contamination. However, although the chemical test-kits are a useful tool to evaluate some chemical substances harmful chemical contaminants in food cannot always be adequately analyzed. In order to investigate other chemical substances and confirm the results in a further study, advanced techniques for chemical contamination analysis, for example,

gas chromatography-mass spectrometry or GCMS, should be used in addition to several test-kits.

With regard to the biological assessment, 20 local restaurants in this study indicated that there was biological contamination by *E.coli*. Several factors may have led to this contamination; for example, a lack of food safety awareness and evaluation, thus the information relating to good practices in food sanitation and safety was not available (Harris, Murphy, Dipietro, & Line, 2017). Moreover, in 10 local restaurants in this study contamination by *E.coli* was found on the chefs' hands, especially at noodle restaurants, because of a lack of proper handwashing after using the toilet and also there was a lack of adequate facilities for using soap and washing materials. These findings corroborate the study of Niode, Bruhn, and Simonne (2011), who stated that some of the chefs in Asian countries only wash their hand for a short duration time of less than 20 seconds, especially when they are busy. Recommendations from the Annex of the Model Food Code cited by Almanza and Ghiselli (2014) are considered as a basic reference which advises the use of soap and running water for at least 15 seconds. Furthermore, in 10 local restaurants *E.coli* was detected in the samples of drinking water and some of the ice which may have resulted from the use of drinking water being taken from an unsuitable water supply tank in the local restaurants. This suggests that there was formation of a biofilm associated with infrequent tank cleaning and disinfection (Praveena, Huyok, & de Burbure, 2018). Furthermore, the process of disinfection using chlorine or ultraviolet radiation in their water sources for drinking water may not be effective if residual chlorine in the water is lower than 0.2 ppm (Ercumen, Gruber, & Colford, 2014). In fact, WHO (2011) indicated that the goal of a water supply should show zero *E. coli* detection per 100 ml of water supply. Also, *E. coli* contamination in a sample of ice can occur when the vector animal (i.e., flies, cockroaches) are attracted to feces. In others words, unsuitable conditions of sewage and human excreta collection, treatment, and disposal can lead to pathogen contamination in the environment causing public health problems (European Commission, n.d.). In addition, contamination of the ice may be caused by a lack of personal hygiene and sanitation practices of the workers in ice factories (Kanbakan, Con, & Ayar, 2004). Moreover, the results from observations showed that some of the ice transporters lacked good practices for sanitation, especially when employees did not wear gloves for handling ice products. This finding is associated with the study of the Government of the Hong Kong Special Administrative Region (2005) which determined the microbiological quality of edible ice manufacturing plants and retail outlets. This study shows that the main causes of *E.coli* contamination in the manufacture of ice include: 1) the lack of cleanliness in the production area; 2) food sanitation and safety rules were not enforced for the ice manufacturing workers; 3) some of the equipments were not properly cleaned; and 4) there was a lack of suitability during the transportation to the retail outlets. Moreover, some of the local restaurants in this study may have forgotten that cleaning ice buckets improperly easily causes cross contamination from other sources.

In this study, *E.coli* contamination was found in samples taken from food containers, such as dishes, bowls, glasses, and spoons caused by ineffective cleaning methods. Generally, *cleaning* is the physical removal of soil and food residues from the surface of equipment and utensils. *Sanitizing*, on the other hand, is the treatment that has been used previously to reduce the number of a disease-causing microorganisms to safe levels (McSwane et al., 2005). Additionally, the results from the physical assessments show that some the local restaurants did not use warm water for utensil disinfection. Hence, sanitizers or sanitizing processes can reduce several of the diseases caused by microorganisms which may be present on equipment or utensils even after cleansing. Sanitization is not sterilization because some bacterial spores and a few highly resistant vegetative cells can still generally survive. There are two types of heating sanitizers (77^{o}C for at least 15 minutes or 94^{o}C for at least 5 minutes), and chemical sanitizers use chlorine, iodine, and quaternary ammonium compounds (McSwane et al., 2005). However, chemical cleaners and sanitizers should be selected according to the grades of food they are in contact with and their use should be related to the recommendations displayed on their labels to avoid some of the harmful chemical residuals which contaminate food (Nerin, Aznar, & Carrizo, 2016).

As a result of the contamination found in this study, recommendations should be made to

local restaurants based on the basic GMPs which will decrease the amount of *E.coli* contamination caused by biological contamination that may lead to a risk of foodborne diseases in the future. In other words, some of the chefs in the local restaurants may lack the knowledge and the practices of food sanitation and safety as can be seen in the findings of Reboucas, et al. (2017), who found that nearly 20-40 % of chefs in Brazil made errors in food sanitation practices including the non-use of disposal gloves when handling or distributing food, tasting food with their hands, and usually talking without masks while handling food. If chefs learn to respect hygienic behavior, there is good reason to believe that use of basic GMPs will lead to a high standard of food sanitation and safety which will be at acceptable levels (Harris et al., 2018; Murphy, DiPietro, Kock, & Lee, 2011). Such practices are related to the theory of knowledge, attitude and practice or KAP (World Health Organization, 2008; Abdullah, Yusof, Gani, Mohammad, & Ishak, 2018) which will improve knowledge of food sanitation and safety on the part of chefs by creating an appropriate mindset or *attitude on the part of chefs* thus avoiding the spread of harmful diseases from their food. However, HACCP (Hazard Analysis and Critical Control Point) should be widely promoted in their restaurants to reduce the risks of food contamination and poisoning in establishments that serve food in the future (Osaili et al., 2018).

Although this recommendation concerns the prevention of biological contamination, some of the physical factors should also be improved to prevent any accidents in local restaurants, especially the flames from cooking and the effects of smoking. Therefore, fire-prevention equipment and non-smoking areas should be clearly designated in more of the local restaurants.

6. Conclusion

Nowadays, local restaurants can improve local economic development as a part of the tourism business. Although the taste of the food in these restaurants is very popular with many tourists, there is no guarantee that the levels of food sanitation and safety combined with hygienic practices in the selection of raw food, food preparation and cooking are always adequate. Therefore, food hazard assessments should identify the level of food hazards and recommend suitable methods for improving the quality of food sanitation and safety in the local restaurants in the Chiang Rai area.

This study concludes that the owners of local restaurants can pass the indicators of physical and chemical hazards in their food. However, some biological contamination by *E. coli* was detected in 10 of the local restaurants. Hence, the basic principles of GMPs should be widely recommended to the restaurants affected in order to reduce the risk of foodborne diseases including diarrhea, typhoid, and other symptoms of food poisoning.

Future research should consider the application of hazard analysis and critical control point (HACCP) to identify the actual causes of the problems that are related to food hazards in the local restaurants. However, this study has shown that the risks of food contamination which are physical, chemical, and biological in form, can be improved by following practical guidelines or the standard operation processes (SOPs) to prevent other sources of food contamination and food hazards in the future.

7. Acknowledgments

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