FEASIBILITY ANALYSIS OF A FOOD SAFETY STANDARD FOR A LOCAL DESSERT COMPANY IN CHIANG RAI, THAILAND : A CASE STUDY OF STICKY RICE IN COCONUT SHELL

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Abstract

The aim of this study is to determine the feasibility of a food safety standard for a sticky rice dessert in coconut shell in Chiang Rai, Thailand. A single company was used for purposive sampling. The methodology consists of an assessment of the details of the production process and also a physical and environmental assessment. To assess the risks of biological contamination, the most probable number or the MPN method were used to determine the cleanliness of the production process and the water quality. The results demonstrate that there is a lack of training in personal hygiene and an inadequate wastewater treatment system with a single entrance and exit. Therefore, to minimize the wastewater pollutants from this process, the company should implement a basic treatment process, such as the use of grease traps. The company should construct both a one-way entry and a one-way exit as to reduce the likelihood of cross-contamination. Furthermore, to ensure a high standard of food safety practice in their production process, their staff should also receive training in food sanitation and safety

Keywords: Safety Standard for Food, Hygienic assessment, Sticky rice in coconut shell, Thai dessert

Introduction

The market for Thai desserts is an important sector and the demand is constantly increasing. For instance, desserts made in a western style are popular among Korean ladies under the age of 30. (Byung-Kwan CHO, 2020). Additionally, it is recommended that tourists should eat at popular tourist attractions and check all the various ingredients and cooking styles of a particular culture (Yongguang Zou and Qionglei Yu, 2022). Desserts have four benefits according to Pondan (2018), including; 1) Nutritional richness: desserts are not only sweet and tasty, but they are also filled with vitamins, fiber, and antioxidants that our bodies require. These minerals are found in the common ingredients of desserts, such as milk and eggs; 2) Mood Booster: the high carbohydrate content of desserts helps in the body and brain production of serotonin and tryptophan, which elevates mood; 3) Weight Control: For individuals on a diet, sugary meals should be avoided and only vegetables consumed. However, self-destructive diets, including very low-calorie diets (VLCDs), extreme low-carbohydrate diets like the ketogenic diet, frequently result in overeating and a larger caloric content than desserts; and 4) Be more active: many individuals feel guilty after eating dessert,

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because they put on weight. To burn calories, they typically walk around or exercise. Some people choose to consume sweet meals just after working out. The studies of Pondan (2018); Yongguang Zou and Qionglei Yu (2022) suggest that eating sweet foods can lead to

Thailand has long been referred to as "the kitchen of the world", due to its abundant natural resources, highly qualified workforce. Approximately 23% of the country's GDP was mainly composed of food production (Thailand Board of Investment, 2016). Even though the COVID-19 pandemic accelerated the rise of several food trends in Thailand, the trends seen in 2021 will mostly continue in 2022. According to the U.S. Department of Agriculture, 2022, the demand for Thai cuisine and restaurants will expand by an average of 3.7 % yearly over the following three years (2022-2024), and private consumption among the high-income consumer group will rise by 3.6 % in 2022. Additionally, according to the statistics from KrungSri Research (2021), the Thai ready-to-eat food market increased by an average of 7.4% each year from 2016 to 2020. Based on this information, it can be inferred that the value of Thailand's food products has risen in relation to the COVID-19 outbreak. As a result, several desserts in Thailand have been popular among both domestic consumers and foreign tourists, namely, mango and sticky rice, banana in sticky rice, and sticky rice in bamboo. Such Thai desserts are popular as gifts for a variety of occasions, such as New Year's Day, birthdays, weddings, retirement days, etc. (Jantira Phooma *et al*., 2013). In Chiang Rai Province located in the north of Thailand, there are 11 sites for the sale of local desserts as reported by the Department of Agriculture Extension (2017), which certifies the best quality products for OTOP (One Tambon One Product). However, this report points out that only 4 sites or 39% on the list have received the food safety standard from the Thailand Food and Drug Administration (Thailand FDA). Therefore, some of the local dessert companies cannot sell their products out of the production area due to the lack of t quality control people to ensure certain standards (Thailand Food and Drug Administration, 2015). Moreover, some consumers may face a risk of eating poor quality food which could affect their health. This can be caused by the poor quality of local desserts or leaking from the food packaging of local desserts (Ping Shao *et al*., 2021). Based on these findings, a company that sells sticky rice in coconut in Chiang Rai province, as seen in Figure 1, needs to enhance the quality of its production process to increase customer satisfaction and prevent customers' complaints about the product's poor quality. Moreover, the owner of this company lacks the knowledge necessary to monitor the relevant factors for food safety, such as water quality, drinking water quality, and workplace lighting. The Department of Health, 2022, issues certification for good practices in food processing and for environmental concerns. Hence, it is important to analyze the feasibility of a food safety standard for a sticky rice in coconut product. This will not only prevent harmful pathogens, chemicals, and physical contaminants from foodborne diseases, but it will also improve the quality of the Thai dessert. Additionally, it may improve the local economy, enhance the appreciation of visitors, and encourage the development of the region's tourism industry. The purpose of this research is to determine the feasibility of such a food safety standard for a sticky rice in coconut shell dessert company in Chiang Rai, Thailand.

Figure 1. A sticky rice in coconut shell product in Chiang Rai, Thailand

Materials and Methods

To determine if this sticky rice in coconut shell product faces any problems in achieving a food safety accreditation, purposive sampling was used in this study (Robinson, 2014). Furthermore, the Thailand Food and Drug Administration (2016) criteria for food safety were applied in the form of a checklist to assess the sticky rice in coconut production process and environment, which are described below:

1) A Walkthrough Survey of the production process enabled us to examine whether the process was contaminated in any way, including physical

hazards (e.g. staples, sand, soil), chemical hazards (e.g. detergents, fuel oil, pesticides), or biological hazards (e.g. pathogens, strands of hair).

2) The physical and environmental assessment focused on the solid waste management, wastewater treatment, one-way entrance to prevent cross-contamination, toilet facilities, hand washing facilities, and the environment of the area for food production. Additionally, this assessment focused on lighting. In addition, the manual of lighting assessment in the workplace (issued by the Labor Department, The Government of Hong Kong Special Administrative Region of the People's Republic of China (2008); the Kaufman (1981) principle, was used to measure lighting for the food production of this company.

3) The assessment of the water quality in the production process concentrated on the purity of the water supply used in the production of sticky rice in coconut. In accordance with the official regulations for the use of a water supply for food processing, the most probable number (MPN) method was used (Cappuccino and Sherman, 2008; U.S. Food and Drug Administration, 2018). To identify any biological contamination in the water supply, including fecal coliform bacteria and Escherichia coli (E. coli), several types of nutritional broth (Lactose Broth, Brilliant Green Bile Lactose Broth, and EC-Medium Broth) and nutritional agar (Eosin methylene blue Agar) were used to identify any microorganism growth. Moreover, The American Public Health Association, American Water Works Association, and Water Environment Federation (2012), and Friis' method (2019) of wastewater sampling and analysis were employed for the wastewater assessment and the effluent. For this analysis, the BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), TSS (Total Suspended Solid), Fat Oil and Grease (FOG), and pH of the wastewater were some of the characteristics that were investigated.

4) An assessment of the cleanliness of the production process was conducted, which focused on the cleanliness and hygienic conditions of the kitchenware and the food-workers. Furthermore, the cleaning of kitchenware and the cleanliness of the food-workers' hands were carried out in accordance with Public Health Ministerial Regulation B.E. 2561 (2018). According to this regulation, the kitchen needed to have at least 3 pieces and at least one food worker's hand for the swab procedure with SI2 solution. An abundance of coliform bacteria can be verified if the SI2 switches from violet to yellow at room temperature within 24 hours. For this study, 3 samples were collected from kitchenware (including 5 aluminum pots, 5 aluminum bowls, and 5 ladles) and from 6 hands of 3 food workers to test for coliform bacteria contamination using the SI2 solution. Additionally, to detect E. coli contamination in samples of kitchenware and on the food workers' hands, a SI2 liquid positive result in which the color of SI2 shifts from violet to yellow approximately 24 hours was transferred to the EMB agar according to the method recommended by the American Society for Microbiology (2016).

All the results from these four types of assessments were investigated for data analysis and interpretation using content analysis and laboratory analysis techniques. Following the data analysis, a recommendation for sanitary improvement was made to improve the food quality of the manufacturing process in compliance with the requirements of the Public Health Regulations. In addition, the tools of observation used in this study were approved by the Ethics Review Committee for Research Involving Human Research Subjects, Chiang Rai Provincial Health Office (the experimental protocol no. CRPPHO 132/2564).

Results and Discussion

The physical and environmental assessment

The details of the production process of the sticky rice in coconut obtained from the walkthrough survey are shown in Figure 2. There were three key production processes. The first process involved several materials, including sticky rice, beans, taro, sugar, palm oil, coconut milk, and eggs. These were washed without first being cut or prepared. Then, some of the ingredients were shaved into thin slices. Biodegradable waste and wastewater were discharged into the environment as a result of this operation, and some of the biodegradable waste was then used for feeding animals. The next step was the mixing and baking of the ingredients. All the ingredients were combined and packed into a clean coconut shell before being baked in a commercial oven for 30 minutes at 180°C In the final step the sticky rice in coconut was packed, using plastic wrap and aluminum foil to maintain the products' temperature and to avoid cross-contamination. Some of the plastic wrap and aluminum foil were recovered and disposed by the local municipality. However, some of the wastewater from the production process was not collected and treated with the appropriate wastewater treatment using grease taps, before being discharged into the environment. Additionally, this process failed to show the exit and entry gate into a one-way system as shown in Figure 3. As a result, some of the contaminants might come into contact with the food products because they were washed, prepared, baked, and

stored in the same way as the finished products, which is different from the GMP principle whereby a one-way system should be constructed to prevent any mixing of items in the production process. (Shukla, 2017). Furthermore, this area had lighting ranging from 240 to 840 lux, which is above the recommended range of 150 to 300 lux for adequate lighting.

Assessment of water quality in the production process

The wastewater study revealed that the average values for pH, BOD, COD, FOG, and TSS were 5.62, 1,100 mg/L, 1,620 mg/L, 1,180 mg/L, and 0.5 mg/L, respectively. Additionally, the results were more than expected when compared to Thailand's wastewater standard, which specifies maximum values for pH, BOD, COD, FOG, and TSS of 5.5 to 9.0, 20 mg/L, 120 mg/L, 5 mg/L, and 50 mg/L, respectively. However, an analysis of the water supply did not recognize *E.coli* because it did not detect any gas bubbles in the Lactose Broth nor did the presumptive test which is the first stage of the MPN method (see Figure 4). In fact, World Health Organization (WHO) (2011) indicated that the goal of a water supply is to have zero *E. coli* detection per 100 ml of water supply. However, the company concerned did not have a primary unit for treating wastewater, including grease taps. Therefore, wastewater treatment, including grease taps, should be installed to minimize environmental degradation from wastewater contaminants, such as is caused by the ecosystem imbalance in natural rivers and rodent and vector outbreaks which can harm public health.

Assessment of cleanliness in the production process

The cleanliness of the production process and water quality of the company was assessed and the hygienic conditions were found to be satisfactory in the food working area because of good housekeeping. The Thailand Food and Drug Administration approved several products, including drinking water which were used in the preparation of food. Additionally, the company scheduled a thorough cleaning of the refrigerator, food shelves, and hot air oven every Sunday. To prevent cross-contamination from a food worker to the sticky rice in coconut, the food workers followed the principles of personal hygiene by using personal sanitation equipment (such as caps, gloves, facial masks, and towels) to prevent cross-contamination (See Figure 5).

Furthermore, no *E.coli* was found on the EMB agar from the food equipment sample or the food workers' hands. Additionally, this outcome complies with the Ministry of Public Health (2017) regulation on microbiological contamination, which specifies that *E. coli* must not be found on samples of kitchenware or samples on food workers' hands. However, not all food workers receive training in food safety and sanitation from the local government or other relevant sectors.

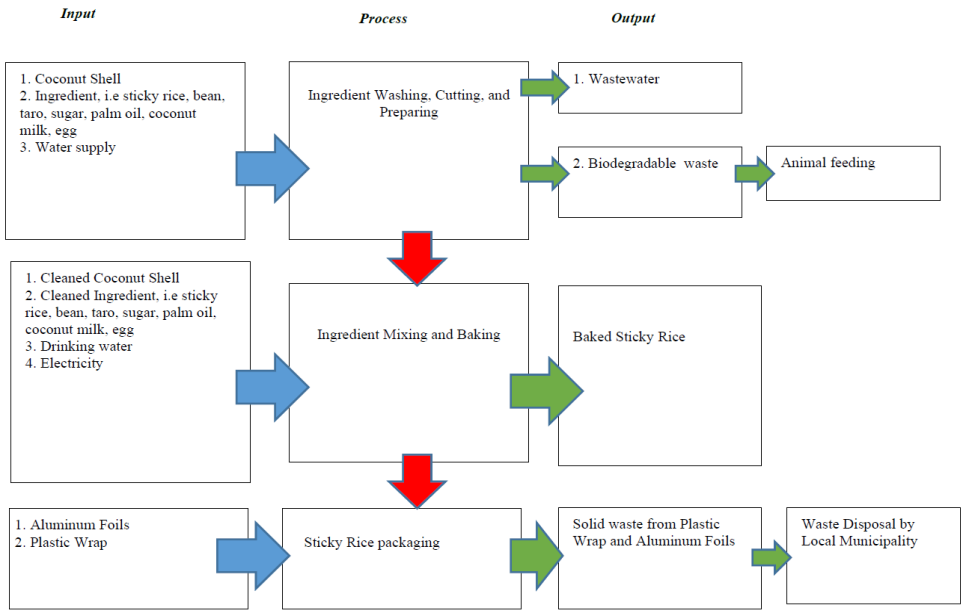

Figure 2. The production process of sticky rice in coconut shell obtained from the walkthrough survey

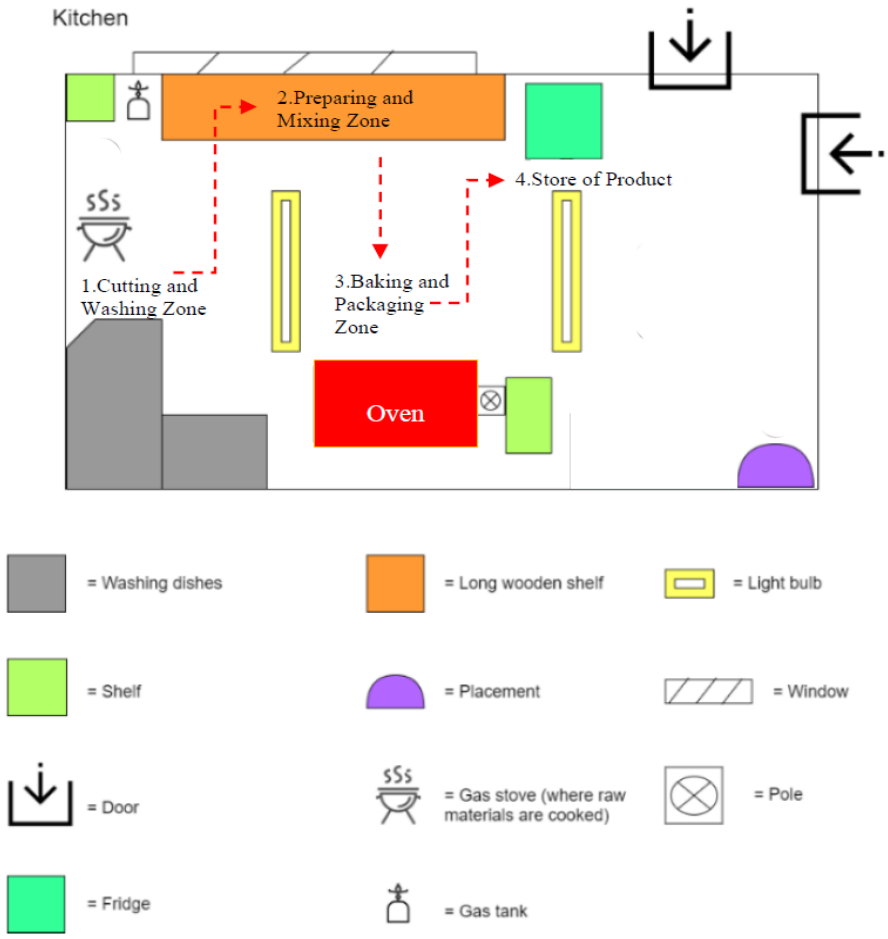

Figure 3. The layout for the production of sticky rice in coconut shell

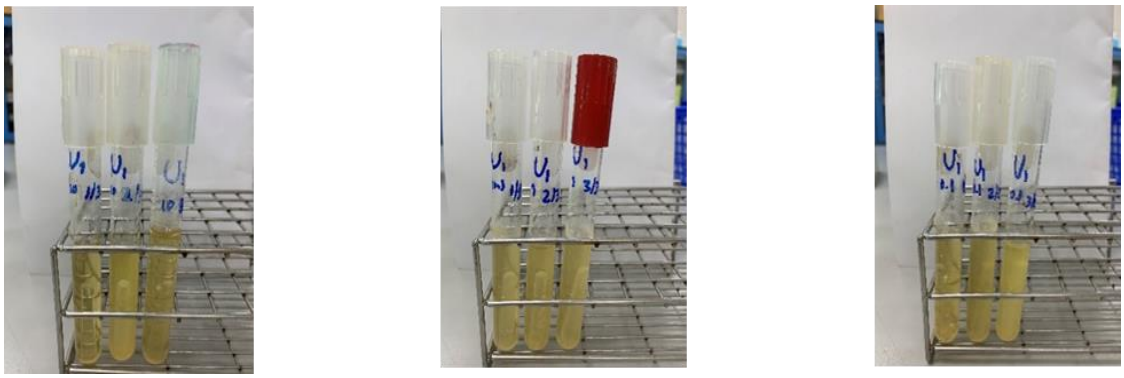

Figure 4. Demonstration of a negative result (no microorganisms were detected) in the presumptive test of the water supply using the MPN method

Figure 5. Personal hygiene in the food production process for sticky rice in coconut shell

Discussion

Regarding the results of the physical and environmental assessment, it was found that the lighting complied with the requirements of Public Health Ministerial Regulation B.E. 2561 (2018), but Light-Emitting Diodes or LED tubes should be installed in the workplace. This is because LEDs use less electricity and can be used more effectively in the food production process because they do not transfer heat to the food product (Jakub Berk *et al*., 2016; Jia-Yong Song *et al*., 2022) which prevents microorganisms growing rapidly in the food product (Wallace *et al*, 2018).

According to the results of the assessment of the water quality in the production process, the wastewater which was released into the environment was not properly treated. In fact, the effluent contained a significant amount of contaminants that are environmentally harmful, such as protein, lipids, and antibiotics. Lee and Stuckey (2022) state that one of the largest sources of pollution worldwide is wastewater from food manufacturing. In this case a large volume of fat, oil, and grease in the wastewater may contain raw materials including taro, palm oil, and coconut that are used in the production of sticky rice in coconut. Wei Han Foo *et al*. (2022) argue that one of the most serious environmental contaminants is oily wastewater, which is extensively produced and discharged into the environment. Massive amounts of this wastewater are deposited worldwide which leads to several negative environmental issues, such as sewer blockages, difficulty with sewage pretreatment at wastewater plants, and pollution of water and soil if oily wastewater is dumped into municipal solid waste landfills. Because of this, the company should install a grease trap as the principal unit of wastewater treatment since it can reduce the quantity of total suspended solids and the concentration of oil and grease in wastewater by up to 84%. (Wong *et al*., 2007). However, if this company can meet the expenditure, numerous types of wastewater treatment technology which reduce fat, oil, and grease are available, such as chemical treatment, anaerobic digestion, membrane filtering, and advanced oxidation (Hena *et al*., 2021 cited in Imran Ahmad *et al*., 2022).

Generally, the workers applied the principle of sanitation for the food equipment, including cleaning, the physical removal of soil and food residues from the surface of equipment and utensils, and sanitizing (McSwane *et al*., 2005). The study of Niode *et al*. (2011), which suggested that some cooks in Asian countries only wash their hands for a brief period of less than 20 seconds, especially when they are busy, was not supported in our findings. Almanza and Ghiselli (2014) suggest washing with soap and running water for at least 15 seconds. However, this study revealed that the food workers were not receiving certification for appropriate food safety and sanitation standards as required by the Public Health Ministerial Regulation B.E. 2561 (2018) for training on food sanitation and safety. To promote awareness of sanitary issues knowledge, attitudes, and practices in food processing, all food workers should participate in training in food sanitation and safety (World Health Organization, 2008; Abdullah *et al*., 2018). Mae Fah Luang University in Thailand has demonstrated that the percentage of *E.coli* contamination was reduced by up to 76% after appropriate training (Vivat *et al*., 2021), and if food workers have a positive attitude toward food sanitation and safety, it may lead to international standard certification (Limon, 2022).

Further studies should investigate raw materials, such as taro, bean, and sticky rice, using advanced chemical instruments, such as High Performance Liquid Chromatography (HPLC) (Wei-Chen Chuang, *et al*., 2016) or High Performance Liquid Chromatography for the type of Triple Quadrupole (HPLC MS/MS) (Yanmei Feng, *et al*., 2022) to determine the chemical contamination of consumers' health, for instance, as caused by paraquat and carbamate (Mohamed, *et al*., 2022).

Conclusion

Nowadays, sticky rice in coconut shell is a popular dessert in Chiang Rai, Thailand, due to new packaging and improvements in the quality of the product. However, some aspects of the food production process, such as solid waste or wastewater, may have a detrimental effect on the environment. Additionally, this company does not keep a record of the environmental and hygienic aspects of its business. In order to improve the quality of their production process in compliance with the national standard (Public Health Ministerial Regulation B.E. 2561), an assessment of the environmental and hygienic factors is necessary.

According to the findings of this study, the company that produces a sticky rice in coconut shell business complies with the necessary indicators of the food production process, its cleanliness and water quality. However, there is a lack of training in personal hygiene, problems with the wastewater treatment, and the one-way entrance and exit. Therefore, to minimize the wastewater pollutants from this process, the company should implement basic treatment, such as a grease tap. Additionally, they should construct a one-way entry and exit, which will reduce the likelihood of cross-contamination. In order to improve their food safety practices, they should also provide their workers with training in food sanitation and safety.

To ensure the quality of the raw material and encourage customer satisfaction with their sticky rice in coconut product, future research should investigate the application of advanced chemical instruments for the treatment of raw materials, such as High Performance of Liquid Chromatography (HPLC) or High Performance of Liquid Chromatography for the type of Triple Quadrupole (HPLC MS/MS).

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