Observed Food Safety and Sanitation Behavior for Chinese Culinary Cooking

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Abstract

The purpose of this study is to develop a Chinese culinary food safety and sanitation behavior scale that can be used in industry auditing, inspection, and training, as well as in school education. This study first observed food safety and sanitation behaviors in the order of cleaning, cutting, and cooking procedures according to the standards of Chinese culinary cooking. According to the observation results, for the cleaning component, alcohol disinfection after cleaning utensils and hands, the utensil cleaning sequence, the placing of cutting boards, the cleanliness of articles and water tanks, and other cross-contamination actions, as well as the complete removal of gills and scales of fish in fish handling, received lower scores. In terms of cutting, cutting sequences for various ingredients, the three-stage egg knocking sequence, the cleaning actions after each action, and the action of cleaning the knife and cutting board again were not performed properly. In the cooking step, the cross-contamination of cutting raw and cooked food, the placing of finished products, plate decorations, and the cross-contamination of not wearing gloves when contacting cooked food and tasting the food were still major problems. Finally, the cleanliness of the working area still needs improvement in all processing.

Keywords: food safety and sanitation, Chinese culinary cooking, observed behavior

Introduction

THE LATEST STATISTICS from the Taiwan Tourism Bureau (2019) show that the number of tourists in Taiwan in 2018 hit 11.07 million, among which 70.73% of inbound travelers arrive for tourism purposes. Overall, the tourism industry has become the main force of Taiwan's economic development. Taiwan has experienced plasticizer incidents, oil incidents, and toxic starch incidents in recent years, making consumers pay more and more attention to food safety; thus, food safety has become an important issue of public concern (Ko, 2015).

Food safety is a comprehensive concept that generally includes food sanitation, food quality, food nutrition, and other related content. It also refers to the potential hazards related to food that possibly cause human diseases (Dong and Ching, 2015). Ko (2013) pointed out that the main causes of food poisoning in Taiwan include cross-contamination of raw and cooked food, insufficient heating of food, preservation of food at normal temperature, and contamination of food by food workers. The occurrence of food poisoning incidents often relates to the lack of relevant knowledge by employees as well as food and beverage personnel. The presence of professional personnel in the food industry can help ensure the implementation of independent sanitation management,

further avoid food safety incidents, and strengthen the capability and quality of the food industry as a whole. How to reduce the occurrence of foodborne diseases can mainly be regulated by strengthening the health education and self-sanitation management of food and beverage staff (Osaili *et al.*, 2012).

According to the Skill Testing Center in the Work Force Development Agency of Taiwan's Ministry of Labor, the number of candidates who applied for the grade C Chinese cooking technician certificate in 2018 hit 38,339, of whom 27,745 became qualified. Grade C covers basic Chinese cooking in Taiwan, and a chef needs to obtain the certification of grade C if he is working in a restaurant. The grade C certificate for Chinese cooking is divided into two components: food sanitation behavior and cooking, and is not issued if the candidate fails either component. Therefore, food sanitation safety is a very important factor for obtaining the certificate of cooking technician (Ministry of Labor, 2019).

Students attach great importance to simulation and learning in a school education environment in terms of how to strengthen food safety and sanitation behaviors when taking this examination. Education and training are indeed very helpful to detect many hazards on-site and can greatly reduce the chances of microbial infection (Soares *et al.*, 2013). In Taiwan, we have two credits for food safety and sanitation for

hospitality-related department at least. ÁKusluvan and Kusluvan (2000) found that their cognitive level of the catering industry improved after experiencing teaching. Teaching and training students to acquire good sanitation habits as well as the training contents can greatly help improve food safety management (Ababio *et al.*, 2016). Fielding and Fielding (1996) noted that the observer can obtain real information in a more natural situation, emphasizing “process” instead of “result,” emphasizing the understanding of “meaning” rather than just the description of phenomena, and analyzing the information obtained through “induction.” This research targets to develop a food safety and sanitation behavior scale and to establish a food safety and sanitation observation behavior scale, which will be helpful for the industry to conduct auditing, inspection, and training and to contribute to school education.

Materials and Methods

Preparation of research tools

The research observation scale was developed in accordance with the sanitation regulations of culinary technicians at the Skill Testing Center of the Work Force Development Agency, mainly for grade C examination on Chinese culinary cooking (Ministry of Labor, 2019). The food safety and sanitation behaviors, including prepreparation, cleaning, cutting, and cooking processes, were the observation points. Five food safety experts were further invited to carry out a review of the on-site sanitation requirement items, and the preliminary indices of the food safety and sanitation behavior scale were extracted. Finally, the observation behavior scale was divided into four components: prepreparation, cleaning, cutting, and cooking. Among them, there were 3 questions for prepreparation, 21 questions for cleaning, 7 questions for cutting, and 14 questions for cooking.

Calculation of the observation behavior score

The students’ self-assessment scale was divided into four scale standards. There is a certain observation time for each behavior. Within the observation time, if 100% of the observed behavior is achieved, then this item is given 3 points; if it is normally (~80% of the behavior) achieved, then this item is given 2 points; if it is an ordinary achievement of the behavior (~50% achieved), then this item is given 1 point; if <50% is realized, then this item is given 0 points. If the behavior is not observed at all, then the item is not scored.

Measurement methods

After the preliminary establishment of the food safety and sanitation behavior evaluation index developed from earlier, the questionnaire was further divided into the food safety and sanitation behavior observation scale and the food safety and sanitation behavior self-assessment scale, emphasizing the understanding of students’ behavior during the Chinese food preparation process. Referring to the methods of food safety and sanitation behavior evaluation tools of Carbone *et al.* (2013), based on Chinese food grade C examination, we set up the food safety and sanitation behavior observation points in the process of preparing dishes for each group of dishes. After the reliability and validity were

confirmed, a formal behavior observation scale and a self-assessment scale were formed. The behavior scale was evaluated by trained teachers or raters for the assessment of actual behavior.

To understand the differences between the student self-assessment scale and the expert behavior observation scale, this study invited 27 students (who were prepared to evaluate the examinations) and 3 Chinese food examination sanitation experts as comparative samples to observe the correctness of the behavior recognized by both parties in the self-performance evaluation of students and the behavior observation scale measured by experts for each item of the scale.

Statistical analysis

Reliability checks cover the stability of data collected with the observational forms and should be completed on at least three separate occasions during an initial data collection phase if possible (Singleton *et al.*, 1993). In this study, two teachers who are supervisor experts for Chinese culinary cooking used the observation assessment tools at the same time and on the same students, based on the same observable behavior. This observer looked at the results of five students. Both rates were knowledgeable about the proper use of instruments and in food safety behavior and skills before implementation. The reliability was calculated as low. The results were 0.84, 0.84, 0.79, 0.76, and 0.79, respectively.

$$\text{Reliability} = \frac{\text{Agreements}}{\text{Agreements} + \text{Disagreements}}$$

The content validity of this study was confirmed by another six supervisors who had the qualification of Chinese food sanitation supervision and evaluation.

This study used the total score of the scale to carry out an average mean difference test to explore the difference in scale assessments between the 27 students and teachers. If the *t*-test result of the item achieved a significance level of 0.05, it indicated that there was discrimination.

Results

Student compliance rate for food and beverage sanitation and safety behavior

The compliance rate of students is based on the analysis of the observation scale data recorded by the supervisors. The purpose is to understand the completion and failure rates of students’ behaviors in various experimental items and to provide direction in teaching for items that should be paid more attention. Table 1 lists the compliance rate of students’ prepreparation. The compliance rate of students was 100% in two items. For the component of clothes and appearance, uniforms must be changed at least once a day, and students can only move in the food processing area after putting on a uniform (Zhang *et al.*, 2015). They are not allowed to wear work clothes into the nonfood processing area. If they need to go to the toilet or classrooms, they must take off their work clothes before they leave. Since this portion includes a cooking course in the school, appropriate clothing appearance is the basic requirement.

TABLE 1. STUDENT COMPLIANCE RATES FOR PREPREPARATION ITEMS

Item	N ^a	Mean ^b	Student compliance rate (%)
A1. Clothing should conform to regulations and do not wear tights and soft shoes.	80	3.00	100
A2. Apart from nonremovable bracelets, there are wristwatches, makeup, ornaments, beards, fingernails, nail polish, etc.	81	2.89	96
A3. If there is any injury to the hand, the wound should be properly bandaged.	80	3.00	100

^aObserved students.^bAverage score for all observed students.

There are 21 items in the cleaning component (Table 2). The lowest score in the cleaning part is only 27% for B13, “The gills or scales of fish are completely removed.” The Chinese culinary cooking test requires the removal of fish scales and internal organs, and as beginners may be relatively unfamiliar with this component, it needs to be strengthened.

Table 3 shows items in the cutting stage in which some students' compliance rates are <50%, including C1, “Follow the cutting sequence (dry goods → processing element → processing meat → vegetables → pork → chicken → eggs → seafood),” for which the accuracy rate is only 48%; and C3, “Clean the cutting board again after each action,” for which the compliance rate is only 23%.

Among the 14 items in the cooking section (Table 4), the compliance rate is 39% for D14, “After the work is finished, the work bench, sink, stove, utensils, equipment and working area shall be thoroughly cleaned,” which is the

only item that does not reach the 50% compliance rate among all of the scoring items. This finding shows that the students' cleaning behavior after the test is the least acceptable and needs much improvement. For the other items, D1, “Cooking oil reaches the smoking point or caught fire, and smoking or burning continues,” and D12, “The sink is not kept clean,” the compliance rates are 55% and 54%, respectively, indicating that fire control and sink cleaning are slightly worse, and there is room for improvement for these two items.

Comparison of students' self-assessment and teachers' observation scale

Table 5 presents the comparison between the students' self-assessment and the teacher's observation scale. The following items have significant differences: B2, tableware is

TABLE 2. STUDENT COMPLIANCE RATES IN THE CLEANING COMPONENT

Item	Observed time (min)	N ^a	Mean ^b	Student compliance rate (%)
B1. Follow the cleaning order for cooking material (porcelain → stainless steel dishes → cookware → cooking utensils → knives → cutting board → dishcloth).	15	81	2.93	98
B2. Wash the tableware thoroughly.	2	81	2.07	69
B3. Using sterilization during cooking processing	2	80	1.29	43
B4. Avoid overlapping and stacking containers.	2	81	2.06	69
B5. Avoid placing cutting boards arbitrarily.	2	77	1.91	64
B6. Dishcloth shall be used according to regulations.	2	81	1.67	56
B7. Food cleaning sequence: dry goods → processed vegetables → processed meat → vegetables (without peeling, peeled, spicy) → pork → chicken → eggs → seafood (fish, shrimp)	15	81	2.11	70
B8. Raw foods are clearly classified.	2	75	2.43	81
B9. Do not use fire before cooking.	2	68	2.82	94
B10. Vegetables are washed before being cut.	2	81	2.93	98
B11. Vegetables with leaves are completely washed.	2	80	1.56	52
B12. Clean eggs thoroughly.	2	54	1.44	48
B13. The gills or scales of fish are completely removed.	2	44	0.82	27
B14. Seafood is not washed with brine.	2	61	2.07	69
B15. Keep the sink clean and sanitation.	15	75	1.16	39
B16. Do not talk during cleaning.	2	81	2.00	67
B17. The floor is free of water stains and stagnant water.	2	81	2.56	85
B18. Avoid cross-contamination in the work area.	2	79	2.63	88
B19. Avoid cross-contamination during the use of sanitary gloves.	2	59	2.51	84
B20. There is no smoking, drinking, chewing betel nut, spitting, etc. during the test.	2	81	3.00	100
B21. When sneezing or blowing your nose, wash hands and then disinfect them with alcohol.	2	79	1.97	66

^aObserved students.^bAverage score for all observed students.

TABLE 3. STUDENT COMPLIANCE RATES IN THE CUTTING COMPONENT

Item	Observed time (min)	N ^a	Mean ^b	Student compliance rate (%)
C1. Follow the cutting order (dry goods → processed vegetables → processed meat → vegetables → pork → chicken → eggs → seafood).	15	80	1.43	48
C2. There is indeed a three-stage egg tapping sequence.	2	34	2.26	75
C3. Clean the cutting board again after each action.	2	79	0.68	23
C4. Nothing is placed on the cutting board.	15	81	2.10	70
C5. The sink and worktop shall be kept clean.	2	81	1.59	53
C6. There is no water stain or vegetable residue on the floor.	2	80	2.09	70
C7. No talking while cutting.	2	80	2.95	98

^aObserved students.^bAverage score for all observed students.

not thoroughly cleaned and tableware wiping is contaminated; B5, (cross-contamination) cutting boards are randomly placed: cutting boards are placed on garbage cans, cutting boards are placed on cutting boards; B15 (cross-contamination) water tank is not kept clean (dishcloth and water tank vegetable residue are put together); and B21, “Those who sneeze or blow their noses do not cover their mouths or directly facing the food or worktable or do not wash their hands after the event (those who covered their mouths needed to wash their hands and then disinfect them with alcohol).” All of these items have lower scores from teachers than from students’ self-evaluations, indicating that these are items that students need to improve more. As seen, students have a higher self-evaluation in cleaning utensils and cross-contamination sanitation; however, they have not met the actual qualification standards.

Discussion

Observation scales should be used for evaluation, and the components with weak sanitation awareness should be additionally strengthened. All equipment needs to be thoroughly cleaned and disinfected to prevent the spread of pathogens (Satow *et al.*, 2009). This study finds that during cleaning, students generally lost scores in the equipment washing sequence and alcohol disinfection after personal hand cleaning, which require better attention on the part of the students. Todd *et al.* (2007) showed in their comprehensive summary of foodborne diseases caused by food handlers that 94% of food poisoning is caused by food handlers who do not have good sanitation habits, mainly due to the staff’s failure to wash their hands when handling food. Jevsnik *et al.* (2013) and Worsfold and Griffith (1997)

TABLE 4. STUDENT COMPLIANCE RATES IN THE COOKING COMPONENT

Item	Observed time (min)	N ^a	Mean ^b	Student compliance rate (%)
D1. No overcooking and smoking while cooking.	15	80	1.65	55
D2. Fire can be controlled while cooking to avoid burning food.	15	80	2.96	99
D3. There is no mixture of cooked food with raw food.	15	73	2.58	86
D4. Wash, dry, and disinfect cooked food’s cutting boards, knives, and hands thoroughly and wear sanitary gloves to cut cooked food.	2	67	2.73	91
D5. For vegetables and fruits after blanching, if they need to be eaten directly and cooling is accelerated, then they shall be treated with cold water cooled by a bacteria reduction treatment.	2	72	2.96	99
D6. There is no risk of cross-contamination of the knives and cutting boards when cutting raw or cooked food.	2	76	2.62	87
D7. Cutting boards are not used as storage boards or backing plates.	2	77	2.83	94
D8. Good protective measures against contamination are available when the finished products are cold dishes.	2	73	2.52	84
D9. Taste food according to a proper hygienic operation strategy, and no dropped food remains untreated.	2	79	1.95	65
D10. There is no cross-contamination between finished products and decorations.	2	79	2.95	98
D11. Wash and disinfect hands or wear gloves when touching cooked food.	2	78	2.68	89
D12. Keep the sink clean.	2	79	1.61	54
D13. Seasoning items can be clearly distinguished.	2	80	2.45	82
D14. After the work is finished, the work bench, sink, stove, utensils, equipment, and working area shall be thoroughly cleaned.	2	80	1.16	39

^aObserved students.^bAverage score for all observed students.

TABLE 5. COMPARISON OF SELF-ASSESSMENT AND TEACHERS' OBSERVATION

Item	Observer (1 student, 2 teacher)		N ^a	Mean ^b	SD	T value
B2. Wash tableware thoroughly.	1	26	2.58	0.643	1.797*	
	2	81	2.07	1.376		
B5. Avoid placing cutting boards arbitrarily.	1	26	3.00	0.000	3.942***	
	2	77	1.91	1.407		
B8. Food ingredients are clearly classified.	1	26	2.85	0.464	1.818**	
	2	75	2.43	1.141		
B15. Keep the sink clean.	1	26	1.96	1.455	2.401*	
	2	75	1.16	1.471		
B21. When sneezing or blowing your nose, you can cover your mouth or directly face food or worktable or do not wash hands afterward.	1	26	2.88	0.588	3.146***	
	2	79	1.97	1.432		
C1. Follow the cutting order (dry goods → processed vegetables → processed meat → vegetables → pork → chicken → eggs → seafood).	1	26	2.31	1.289	2.682**	
	2	80	1.43	1.508		
C3. Clean the cutting board again after each action.	1	26	2.19	1.357	5.177***	
	2	79	0.68	1.266		
C4. Nothing is placed on the cutting board.	1	26	2.85	0.613	2.865***	
	2	81	2.10	1.281		
D1. No smoke point is reached or catching fire during cooking.	1	26	2.69	0.679	3.726***	
	2	80	1.65	1.370		
D9. Taste food according to hygienic operation strategy, and no dropped food is untreated.	1	26	2.73	0.604	2.699***	
	2	79	1.95	1.431		
B15. Keep the sink clean.	1	26	2.27	1.041	2.689**	
	2	79	1.61	1.103		
D13. Seasoning items can be clearly distinguished.	1	26	2.85	0.368	1.713**	
	2	80	2.45	1.157		
D14. After the work is finished, the working table, sink, stove, utensils, equipment, and working area shall be thoroughly cleaned.	1	26	2.65	0.977	5.599***	
	2	80	1.16	1.237		

^aObserved students.^bAverage score for all observed students.* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

observed that 66% of British consumers ignore the steps of washing their hands before preparing food, and 76% do not wash their hands after handling eggs. Since the hands of the cooking staff are the parts that are in greatest direct contact with food when they are working, if they fail to keep their hands clean, then they can easily become the main medium for the spread of germs, resulting in food cross-contamination in the near future (Baş *et al.*, 2006). During the food preparation process, pathogens such as *Campylobacter*, *Salmonella*, *Escherichia coli*, and *Staphylococcus* are easily transferred from contaminated food to the raw food materials to be cooked or onto kitchen rags through hand contact, resulting in extensive cross-contamination (Jevnsnik *et al.*, 2013). Food handlers must thoroughly clean their hands when they arrive at the workplace and before and after handling food, including with an interruption in food handling, before contact with any objects that may be contaminated, or after using the bathroom. Studies also show that maintaining hand sanitation can reduce the incidence of intestinal diseases by 12–40%, thus reducing the incidence of food contamination (Kim *et al.*, 2012). Studies have also found that coughing and sneezing are potential sources of *Staphylococcus aureus* infecting food (Jianu and Chis, 2012).

The sanitation assessment results of Jevnsnik *et al.* (2013) show that the hands of the subjects are most polluted by microorganisms in all selected surfaces, followed by the kitchen food processing work area and cutting board. At-

tention should be paid not only to hand cleaning but also to the cleanliness of the cutting board. It is further learned from de Boer and Hahne (1990) that 25% of consumers use cutting boards that are not cleaned after handling similar items of food in different food preparation operations, resulting in greater possibilities of cross-contamination and food poisoning. As cutting directly affects the safety of eating, cutting boards, knives, shovels, pots, and other tools that come into contact with food in the preparation area must be cleaned with detergent, which can help reduce the chance of bacterial contamination caused by food residue (Tatum, 2011). When using cutting boards, food and beverage operators should avoid mixing cutting boards of different colors (indicating different purposes), wear gloves when handling cooked food, and strictly abide by the rules of hand washing (Barth, 2004). That study also found that students' concepts of cleaning and proper placement of cutting boards after use were insufficient and still need to be strengthened for some students.

Regarding the food cleaning component, cleanliness is considered as an important quality indicator for Central American consumers when purchasing fresh fruits and vegetables (Berdegué *et al.*, 2005). This study found in the egg processing component that students' incomplete cleaning and incorrect egg knocking procedures need to be improved. In the EU Foodborne Disease Report of EFSA (2011), most cases in the EU are related to animal-borne food. The most

common foods are eggs and egg products, of which *Salmonella* is the most commonly detected pathogen. *Salmonella* is a potential food safety problem of eggs. de Boer and Hahne (1990) found that 41% of consumers did not clean food before preparing it. Food that has not been cleaned or completely cleaned is vulnerable to microorganisms and cross-contamination, which can lead to foodborne diseases. Washing meat with clean water and adopting sanitary measures can improve the microorganism quality of meat. Therefore, the cleaning and sequence of food materials are important parts of improving cross-contamination, especially the processing of eggs, egg products, and meat products.

In terms of environment, a messy or tidy working area is also closely related to sanitation. The kitchen food processing area needs to be disinfected many times in advance and immediately after cooking is completed (Ergonul, 2013) to reduce microbial residue and breeding. Mitakakis *et al.* (2004) pointed out that, of the 515 households interviewed, 70.3% had inadequate cleaning of food preparation tables, 46.6% did not wash their hands or did not confirm such actions, and 41.7% and 70.1% had improper processing procedures for fresh and cooked foods, respectively. Thus, it can be seen that general households or consumers have insufficient knowledge of these aspects and cannot prepare food with the proper safety and sanitation knowledge. Jevsniak *et al.* (2013) also showed that the sink area is not always cleaned before food preparation, indicating that students did not score well in the cleaning of the sink and environmental cleaning after the test. As seen, the students' environmental cleaning component still needs to be improved. If the students do not cultivate cleaning habits in their daily lives, then this oversight may affect their family members. Cross-contamination is the physical transfer of harmful microorganisms from people, places, or objects to other objects. In particular, the family kitchen is a key factor for food safety, consumer protection, and prevention of food poisoning (Ergonul, 2013). Therefore, to reduce cross-contamination, the importance of food safety education for family members cannot be ignored. Large amounts of food preparation, food handling, and storage in the home are closely related to cross-contamination; thus, education on unsafe food handling behavior is essential (Howton *et al.*, 2016).

Food sanitation focuses on the establishment of sanitation concepts of employees. By introducing correct sanitation knowledge, a positive attitude of self-management can be formed, and continuous improvement of self-managed sanitation behavior can be implemented. From the training and habit cultivation of food employees, the risk of contamination by food pathogenic bacteria can be indirectly reduced, and a family's food safety and sanitation behaviors can subsequently be guided. Smith *et al.* (2014) pointed out that providing good food safety training for employees helps reduce the occurrence of food poisoning incidents caused by insufficient personal knowledge of food safety and sanitation, improper behaviors, incorrect food temperature, improper storage time, and other sanitation factors. Because food safety certification was not common in the past, the promulgation of good food sanitation standards provides clear sanitation rules for food and beverage staff, which not only can spur the staff to abide by them but also means that law enforcement personnel have laws to uphold. With the guidance of good food sanitation standards, good health habits of food and beverage staff can truly be established, thus ensuring the food safety of those people

eating out. Another study mentioned that people with food safety and sanitation training have significantly higher awareness and execution of sanitation and safety than those without food safety and sanitation training (McIntyre *et al.*, 2013). Professional culinary training courses should focus not only on the cooking of dishes but also on food safety and sanitation. During training, hand cleaning and overall sanitation instructions should be made into manuscripts or slogans, which should be announced many times to the classroom so that students can adhere to them at all times.

Students need to recognize that apart from the improvement of their cooking skills, the most important thing is the change in their sanitation and safety cognition and concepts when they try to obtain food licenses. Sanitary operations and management in the food and beverage industry are closely related to the occurrence of food poisoning incidents. Related companies should standardize and improve any behaviors that cause cross-contamination and further reduce the chance of foodborne diseases. From the viewpoint of consumers or employees, both place great importance on food safety and sanitation; thus, the functions of food safety and sanitation are issues that the food and beverage industry and school education must pay greater attention during the preparation process (Ko and Jiang, 2016; Ko *et al.*, 2016).

The contribution of this research is academic and provides teaching assistance to schoolteachers. The research scale can be used to understand the insufficient parts of students' sanitation and safety awareness, to strengthen teaching emphasis and to provide students with a form of self-examination. In daily practice, the scale can be used to understand the missing items and improve self-study. In practice, the results herein can provide a reference index for setting up the Chinese food cooking license examination training class outside of school; the scale can be used to evaluate the students' learning status and to develop health behavior standard items for food and beverage business operators to educate employees. The questionnaire sample of this study was answered by students from the hospitality departments of two universities. The future study can be expanded to many other schools, then we can better understand students' overall cognition of Chinese culinary food safety and sanitation behaviors. From the results of our questionnaire, teachers of various schools can jointly strengthen the weaker components.

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