



Research article

Evaluation of food safety knowledge, attitude, and self-reported practices of trained and newly recruited untrained workers of two baking industries in Dhaka, Bangladesh

Md. Fahad Jubayer^{a,*}, Md. Shahidullah Kayshar^a, Md. Sajjad Hossain^b, Md. Nasir Uddin^c, Md. Al-Emran^c, Syeda Sabrina Akter^a^a Department of Food Engineering & Technology, Sylhet Agricultural University, Sylhet 3100, Bangladesh^b Department of Chemical and Food Process Engineering, Rajshahi University of Engineering and Technology, Rajshahi, Bangladesh^c Department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

ARTICLE INFO

Keywords:

Food science
Food safety
Baking
Food handlers
HACCP
KAP
Food industry

ABSTRACT

In Bangladesh, with the mounting esteem of bakery products, food safety issues in bakery industries are a paramount concern nowadays. In this regard, this current study was performed to evaluate food safety knowledge, attitude, and self-reported practices of two groups (160 trained and 55 new untrained) of workers from two popular baking industries in Dhaka, Bangladesh. A self-administrated questionnaire was used to acquire the data during the study. On food safety knowledge, attitude, and self-reported practices, trained workers' scores (33.01 ± 0.09 , 14.86 ± 0.03 , 10.66 ± 0.25 , respectively) were significantly higher than the scores (9.82 ± 0.23 , 10.44 ± 0.26 , 5.91 ± 0.33 , respectively) of newly appointed untrained workers. The quality assurance department displayed better knowledge, attitude, and self-reported practices scores than the rest of the departments of the industries. However, compared to knowledge and attitude, the self-reported practice was not up to a satisfactory level. According to the study, training can be proved effective for improving knowledge and attitude but does not always translate those into self-reported practice and behaviors. The results also reinforce the importance of conducting training for untrained workers and suggest further behavior-based food safety training for all employees.

1. Introduction

The food processing industry in Bangladesh is witnessing rapid growth and is representing one of the major potential sectors in terms of contribution to value addition and employment, in comparison with other industrial segments. All food processing industries account for 2% of national gross domestic product (GDP) (Islam, 2016). Because of the growing demand for bakery products, a sizeable number of bakery industries have been expanding over the last decade (Sakib, 2018). Over the course of time, these bakeries have become a prevalent and significant part of the international food market as well as in Bangladesh (Kotsianis et al., 2002; Farjana and Rayhan, 2014). Although the bakery sector in Bangladesh has the potentiality in market penetration because of its nature, several challenges have been encountered by the bakery industry. Among them, lack of backward linkage with the local supplier meaning unavailability of raw materials in the proper place in proper

time; lack of adroit and trained human resources and on the top of that, lack of knowledge and practice related to food safety issues and so on, are faced by the bakery enterprises.

Food contamination and food adulteration have grown to be a severe public health issue; thus, food safety is an unwavering public health concern nowadays. Contaminated and unsafe foods are a reason for many life-threatening diseases, from diarrhea to variants of cancer (Motarjemi et al., 1993). Every year, worldwide, millions of people fall ill and die as a result of consuming unsafe food (WHO, 2009). Nearly 420,000 deaths occur every year in the world, while almost one in ten people fall ill after eating contaminated food (WHO, 2017). Foodborne diseases and food contamination can be caused by improper handling practices and, in the long run, impair the health of consumers (Todd et al., 2007). Food handlers possess a significant role in ensuring food safety in different stages of food production, processing, and storage (WHO, 1989).

* Corresponding author.

E-mail address: fahadbau21@hotmail.com (Md.F. Jubayer).<https://doi.org/10.1016/j.heliyon.2020.e05021>

Received 13 April 2020; Received in revised form 6 June 2020; Accepted 18 September 2020

2405-8440/© 2020 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Foodborne disease is a growing problem in Bangladesh as large numbers of consumers are suffering from different health issues by consuming contaminated foods (Noor and Feroz, 2016). Most of the manufactured and processed foods are unsafe for consumption for adulteration and mishandling as it plays a significant role in the occurrence of foodborne illness (Egan et al., 2007). As a result of poor food handling practices of workers and their illness, a significant number of foodborne illnesses occur, and these two are among the root causes of foodborne disease outbreaks (McIntyre et al., 2013).

The food safety knowledge, attitudes, and practices (KAP) of food industry personnel in Bangladesh are of great concern. In a food processing industry, the equipment used could be a source of severe contamination, as found in some studies (Aguado et al., 2001; Autio et al., 1999; Vogel et al., 2001; Tompkin, 2002). Along with this, poor knowledge of food safety and hygiene can lead the workers to mishandle the food, thus resulting in unsafe food. For long term benefits, training should be provided to the food handlers so that food safety can be increased and ensured. Food safety training can be proved effective in improving the status of sanitation, microbiological quality, and practices (Cotterchio et al., 1998; Cohen et al., 2001; McElroy and Cutter, 2004). To evaluate the food safety knowledge, attitudes, and practices as well as hygienic-sanitary quality, an extensively used model is known as knowledge, attitudes, and practices (KAP) (Zanin et al., 2017; Baş et al., 2006; da Cunha et al., 2014). Several studies were conducted to evaluate the KAP of food handlers in different sectors to understand their behavior and relate them to foodborne disease (Angelillo et al., 2000; Ansari-Lari et al., 2010; Bas et al., 2006; McIntyre et al., 2013; Soares et al., 2012).

Food safety and hygiene are crucially important in any baking industry, as they contain certain features that are different from other kinds of food manufacturing industries (Huq et al., 2013). Raw materials of baked goods possess different kinds of the food safety hazard. Aflatoxin B1 (Riba et al., 2010), mycotoxins (Liu et al., 2015), *E. coli*, *Salmonella* spp., *Bacillus cereus*, and several pathogenic microorganisms that have been found in flour (Wu et al., 2017). Raw egg used as emulsifier can be a likely carrier of biological hazards such as *Salmonella* (Foley et al., 2013), *Campylobacter*, *Listeria monocytogenes* (Rivoal et al., 2010). Besides, during the manufacturing, different kind of hazards can be introduced from different processing steps. Since the employees are the first line of defense in ensuring food safety, they must possess ample knowledge on the food safety issue, bear a positive attitude towards it, and practice professionally. Improved knowledge, attitude, and practices can be achieved through proper training. Better food safety requires scientific and technical skills, as well as the development of well-organized tools and effective training programs (WHO, 2002). Training at a regular interval is thus considered supportive to prevent food safety hazards by adjusting the practices of food handlers and improving their skills. Assessment of the efficiency of food safety training is a prerequisite of international standards such as ISO 22000:2005 (ISO, 2005). Well-designed and well-planned training programs are supposed to have a positive impact on both individual and organizational performance. To the best of author's queries, until now, there is not a single study on the knowledge, attitude, and practices of food handlers regarding a baking industry. Again, in Bangladesh, no similar investigation is conducted yet in any food industry. As for a baking industry, considering the sensitivity of products to food safety hazards, the importance and status of ongoing training should be explored. This may assist the relevant stakeholders in improving the safety and sanitation measures inside the manufacturing plant. Hence, this current study was conducted in two baking industries in Dhaka, Bangladesh to evaluate the status of knowledge, attitude, and self-reported practices of trained and newly appointed untrained workers, as well as to achieve a comparative analysis of knowledge, attitude, and self-reported practices between the two groups of workers.

2. Materials and methods

2.1. Study place and population

This cross-sectional study was conducted in two renowned baking industries of Dhaka in Bangladesh from August 2018 to December 2018. In total, 318 people were working as permanent workers, and 90 were working as daily basis workers in these industries during the study period. Among them, 160 trained workers and 55 newly appointed untrained workers took part in this study. From each baking industry, 105 and 110 people respectively took part in the study. The study populations were the general floor workers from the production department (n = 151), quality assurance (QA) department (n = 20), maintenance department (n = 13), warehouse and store (n = 16), and human resource management (HRM) department (n = 15). No daily basis workers were mixed up in this survey. The study population was divided into two segments, namely the trained group and the newly appointed untrained group. The newly appointed people were of seven to ten days of employment period in the current industries. The companies have HACCP, HALAL, and ISO 22000:2005 implemented in their plant.

2.2. Characteristics of provided training

Every recruited worker in the industry receives food safety training (2 days long) within one month- those who have prior food safety training also supposed to join the training session. A trained, certified person conducts this training. Monthly hygiene and sanitation training is common for all floor workers. These kinds of regular basis training are conducted by the quality assurance executives and production executives. A basic HACCP, SOP, and ISO related training are compulsory for every employee each year that also led by a trained auditor. Moreover, quality circle activity supervised by the QA manager is carried out every month for 2 h participated by all floor workers.

2.3. Questionnaire

A self-administrated and structured questionnaire was developed for conducting the study, and two versions (English and Bengali) were prepared for convenience. All the respondents participated voluntarily in the ongoing study and sufficient time (60 min) was provided for the completion of the questionnaire. A simple completion instruction was attached to the questionnaire regarding the intention of the study as well as the instructions on how to fill it. According to the signed consent, the participation in this study remained confidential as a consent form was collected with a signature from each respondent before the study. A pilot study was also carried out before the actual work on 30 workers (randomly selected) to find out the question clarity, time requirements, and consistency. Some minor modifications were carried out after the pilot study. The first part of the questionnaire was prepared to gather the demographic characteristics like age, sex, education, marital status, length, and status of current and previous employment. The second part of the questionnaire was developed to access knowledge, attitude, and practices on the food safety of workers. In the knowledge part of the questionnaire, there was a total of 35 close-ended questions that were again arranged into three more sections, namely: product safety and sanitation (15 questions), general food safety (10 questions), and HACCP (10 questions). On the other hand, the attitude and practices section comprised of 15 questions each. Three possible choice options for answering were provided in knowledge (true, false, don't know), attitude (agree, disagree, not sure), and practices (yes, no, sometimes) section. The answering options were selected as such, which can reduce the possibility of choosing the correct answer by chance. Each correct or desired answer was awarded one point each, and the rest of the responses got no point or zero. The score range was 0–35, 0–15, 0–15 in the knowledge, attitude, and practices part, respectively. The scores were converted to 0 to 100 points. The score above 60% was considered as

good score and below that was considered as poor. The total score was calculated by summing up the correct answers.

2.4. Statistical analysis

Scores for food safety knowledge, attitude, and self-reported practices were calculated by assigning correct responses. The KAP scores are presented as mean and standard deviation. Besides, for an easy interpretation of results, scores of responses are converted into percentages. The comparison of food safety KAP between the two participating groups and different working departments was also evaluated. An independent sample t-test was used to compare the parameters within the trained and newly appointed untrained groups. Shapiro-Wilk W test was done to check for normal data. The SPSS 20.0 statistical package was used for all analyses. A p-value of less than 0.05 considered statistically significant.

3. Results

3.1. Demographic characteristics of respondents

The demographic characteristics of the participating respondents are shown in Table 1. The total number of participants in the current study was two hundred and fifteen (n = 215). Among them about 74.4% (n = 160) were trained employees and 25.6% (n = 55) were untrained. From the study of different socio-demographic variables, it

was observed that among the participants, 63.7% (n = 137) were male, and 36.3% (n = 78) were female. Age of major percentage (44.2%, n = 95) of respondents was between 30 to 40 years, whereas the least percentage (6.9%, n = 15) of people was above 40 years old. A few numbers of respondents (6.5%, n = 14) were uneducated, while 93.5% (n = 201) had different levels of education. The minimum number (6.1%, n = 13) had a university-level education. Although not remarkable, some workers were found to possess technical education (14%, n = 30). Near about 53.9% (n = 116) workers were married and 42.8% (n = 92) were unmarried.

When we come to work experiences, it was evident that the maximum percentage (39.1%, n = 84) of respondents had working experiences less than two years in their current company. About 32.5% (n = 70) workers had experienced more than five years, and 28.4% (n = 61) fall in the group having experiences between two to five years. All the workers had previous job experience in different industries. For obtaining a clear view of food safety knowledge, attitudes, and practices (KAP) status for the study, respondents were chosen from different departments of the baking industry. Production department was at the top of the table having 70.2% (n = 151) of participants, followed by 9.3% (n = 20) of workers from quality assurance (QA) department, 7.4% (n = 16) from store and warehouse, and 6.1% (n = 13) from the maintenance department. Besides, a few numbers (6.9%, n = 15) of respondents from the human resource management (HRM) department also took part in this study as they are a part of the recruitment system and plays a vital role in the execution of food safety policies.

Table 1. Demographic characteristics of respondents.

Variables	Trained, n (%)	Untrained, n (%)
Sex		
Male	100 (62.5)	37 (67.3)
Female	60 (37.5)	18 (32.7)
Age group		
≤20	21 (13.1)	12 (21.8)
20–30	56 (35)	16 (29.1)
30–40	72 (45)	23 (41.8)
≥40	11 (6.9)	4 (7.3)
Education		
No schooling	10 (6.3)	4 (7.3)
Primary	51 (31.9)	18 (32.7)
Secondary	41 (25.6)	14 (25.5)
Higher secondary	27 (16.9)	7 (12.7)
University	10 (6.3)	3 (5.5)
Technical education/diploma	21 (13.1)	9 (16.4)
Marital status		
Married	87 (54.4)	29 (52.7)
Unmarried	69 (43.1)	23 (41.8)
Widowed	4 (2.5)	3 (5.5)
Length of employment in current company (years)		
≤2	29 (18.1)	55 (100)
2–5	61 (38.1)	0 (0)
≥5	70 (43.8)	0 (0)
Previous employment duration (years)		
≤5	99 (61.9)	55 (100)
5–10	50 (31.3)	0 (0)
≥10	11 (6.9)	0 (0)
Field of work in the current company		
Production	117 (73.1)	34 (61.8)
Quality assurance	13 (8.1)	7 (12.7)
Store & Warehouse	10 (6.3)	6 (10.9)
Maintenance	9 (5.6)	4 (7.3)
Human resource management	11 (6.9)	4 (7.3)

3.2. Food safety knowledge, attitude, and self-reported practices of trained and untrained respondents

The knowledge section of the questionnaire was divided into three parts, namely: product safety and sanitation, general food safety, and HACCP. The first part was on product safety and sanitation, and it showed a satisfactory outcome from the respondents. It was observed that among the 160 trained respondents, about 98.2% (on average) had clear understandings of product safety and sanitation. On the other hand, a minimal number of people (1.1% on average) were unable to find the correct answers. From Table 2 (question 1–15), it can be observed that the respondents had ample knowledge about finished goods quality and safety. They all (100%) provided correct answers regarding product moisture content, water activity, temperature status during baking,

storage of raw materials and finished goods, and product packaging conditions. All of them were conscious of the cleanliness of eggs used as ingredients. However, everyone chooses the correct option regarding cleaning and hygiene of the production area plus pest control. In the second part of the knowledge section of the questionnaire, a vivid fall can be seen in the average of the correct response given (89.4%). Question 16–25 in Table 2 have questions regarding general food safety knowledge. More than 90% of participants were found aware of reporting illness, coliform, destruction of pathogenic bacteria, and severity of foodborne illness. Questions on allergen, holding temperature of food, different diseases, oxygen content of modified atmospheric food, and bacterial growth rate received comparatively lower correct responses to them in this section. Cent Percent participants agreed that raw and cooked food should be kept separated for the prevention of cross-

Table 2. Questions and responses for the evaluation of food safety knowledge of trained and untrained respondents.

Knowledge		Correct (%)		Incorrect (%)		No knowledge (%)	
		Trained	Untrained	Trained	Untrained	Trained	Untrained
Product safety and sanitation	1. Storing conditions of food can have possible effects on human health	98.7	20	1.3	9.1	0	70.9
	2. Maintaining standard moisture content and water activity is mandatory for baked product	100	54.6	0	1.8	0	43.6
	3. It is required to clean the food thermometers at a regular interval	98.1	14.6	1.3	1.8	0.6	83.6
	4. Environmental hygiene condition can affect the product	96.3	30.9	3.1	21.8	0.6	47.3
	5. Eggshell in the dough can increase the risk of foodborne illness	93.7	12.7	5	49.1	1.3	38.2
	6. Fluctuation of oven temperature has adverse effects on product quality during baking	100	61.8	0	12.7	0	25.5
	7. Raw materials should not be stored with finished goods	100	52.7	0	7.3	0	40
	8. It does a matter to food safety if the egg is broken	98.1	18.2	1.3	0	0.6	81.8
	9. Leak package causes harm to the food product shelf life	100	43.6	0	16.4	0	40
	10. When a shipment of raw materials arrives, it is required to inspect all right away before storing	98.1	12.8	1.3	20	0.6	49.2
	11. Before and after production, cleaning of processing area and equipment is a must to ensure food safety	100	50.9	0	0	0	49.1
	12. Pest control inside and outside the factory is an important consideration for food safety	100	52.7	0	9.1	0	38.2
	13. Cleanliness of eggs is important before use	100	23.6	0	30.9	0	45.5
	14. Necessary temperature and relative humidity must be maintained at different production areas	96.9	3.6	1.3	1.8	1.8	94.4
	15. Due to poor temperature control bacteria can grow on stored cream	93.1	20	1.9	12.7	5	67.3
General	16. Coliform can be transmitted through drinking water	98.1	27.3	0.6	21.8	1.3	50.9
	17. Disease like typhoid and jaundice can be transmitted by food	85.6	5.5	8.8	40	5.6	54.5
	18. Allergens information should be mentioned on the package	72.5	7.3	6.9	0	20.6	92.7
	19. It is very important to report illness immediately to management	99.4	85.5	0.6	1.8	0	12.7
	20. Most pathogenic bacteria will be destroyed by heat	94.4	23.6	4.3	14.6	1.3	61.8
	21. A hot potentially hazardous food should be held at 60 degree C	76.3	3.6	16.9	5.5	6.8	90.9
	22. Modified atmosphere foods (MAP) are foods that contains less oxygen than other kinds of foods	83.7	7.3	6.9	7.3	9.4	85.4
	23. Keeping raw and cooked food separate prevents cross-contamination	100	38.2	0	23.6	0	38.2
	24. Bacteria multiplies and grows faster in warm environments	88.1	5.5	4.4	3.6	7.5	90.9
	25. Food borne diseases can cause death	96.3	63.6	3.7	9.1	0	27.3
HACCP	26. Dirt, broken glass, and staples from packing are classified as physical hazards	100	36.4	0	20	0	43.6
	27. Metal detection just before the packing is a CCP	100	1.8	0	3.6	0	94.6
	28. Calibration of equipment such as balances, measuring instruments, temperature meters, etc. is compulsory in due time	100	3.6	0	14.6	0	81.8
	29. All checklists at every point of production floor must be updated at 30 min interval	100	67.3	0	7.3	0	25.4
	30. It is necessary to construct a flowchart for individual processes and display it in a relevant area	96.3	20	3.1	23.6	0.6	56.4
	31. Document the deviation is a step in the corrective action process	85.6	0	5	0	9.4	100
	32. During record keeping, you should sign and date as necessary	100	52.7	0	0	0	47.3
	33. Falsifying records is a criminal offense	58.1	25.5	17.5	50.9	24.4	23.6
	34. The first line of food defense is the employee	93.8	34.6	2.5	18.2	3.7	47.2
	35. Cleaning and disinfection is a type of prerequisite program	100	0	0	0	0	100

contamination. From Table 2 (question 26–35), it is apparent that employees had an excellent understanding of HACCP principles. 100% of workers knew about physical hazards, metal detection before packing as a CCP, the mandatory need for calibration, maintaining checklist, recordkeeping, cleanliness, and disinfection as a prerequisite program during the food manufacturing process. Falsifying records is a criminal offense; it was unknown to approximately 25% of respondents.

On the other hand, product safety and sanitation part did not show satisfactory outcomes in case of the untrained respondents. The study revealed that about 31.5% had clear understandings of product safety and sanitation. A major (54.3%) percentage of respondents did not have any knowledge while the least proportion (12.9%) gave incorrect answers on food safety and sanitation issues. It can be observed that most of the untrained respondents had poor knowledge on product safety and sanitation. More than 50% of respondents had good knowledge of product moisture content, water activity, temperature status during baking, storage of raw materials, and finished goods as well as pest control. The general food safety knowledge section also showed poor response percentage. Question 26–35 reflects that employees have poor knowledge of the HACCP system. No one seemed to have knowledge of cleaning disinfection as a prerequisite program and corrective action in this section.

About 99% of trained respondents agreed on questions asked for evaluating food safety attitudes followed by no oppose and nearly 1% not having any idea that is displayed in Table 3 (question 1–15). More than 90% of respondents recognized that changing gloves at regular intervals is important, the use of apron is essential for reducing cross-contamination, and no one should eat anything in the production area. Nonetheless, everyone (100%) defended the rest of the questions successfully on hygiene, safety, sanitation, and online production procedures.

Approximately 69.5% of untrained respondents agreed on questions asked for evaluating food safety attitudes. On the matters of washing hands before work, taking a bath and health checkup at regular intervals, respondents were found totally correct. More than half of them had positive attitude towards issues like wearing protective cloth, health checkups, sanitizing hands, changing the hand gloves etc.

Self-reported food safety practices of trained food handlers were evaluated by 15 questions. These are demonstrated in Table 4. All reported that they washed their hands on every possible occasion but not everyone used to apply sanitizer after that. Comparatively fewer amounts (68.8%) of workers maintained the practice of not eating anything in the production and processing floor. The practice of changing hand gloves (86.9%) and masks (60.6%) showed a divergent outcome. Again working in diseased condition was much common (28.7% regular, 15.6% seldom) among them.

Self-reported practice of untrained workers was also poor. No one did learn food safety at home or advised anyone inside the factory about hygienic practices. A good proportion of them reported that they were habituated with washing hands with soap after restroom break and restricts them in touching foods in empty hands in the processing line. Working with jewelry was much common (52.7%). Nearly 95% were found to have no knowledge about HACCP.

3.3. Comparison of food safety KAP scores according to different departments

Table 5 shows the scores of knowledge, attitude, and self-reported practices of trained and untrained respondents from different departments of two baking industry. Trained workers from quality assurance (QA) department scored higher (34.5 ± 0.05) than production, maintenance, store and warehouse, and human resource management (HRM) department. In the attitude section, the score of QA department remained higher among the five departments. When it comes to self-reported practice, scores of QA (13.5 ± 0.13) remained close to the HRM (12.2 ± 0.26) followed by rest of the departments. On the other hand, in case of untrained respondents, knowledge, attitude, and self-reported practices score of the QA department was also higher than the other four departments.

3.4. Comparison of food safety KAP between two participating groups

Trained participants of this current study provided more correct answers than the untrained participants in the knowledge, attitude, and self-reported practices related questions. From Figure 1, it can be observed that 94.3% of trained respondents were correct in questions of food safety knowledge, while only 27.5% of untrained respondents found to be accurate in the same. Percentages of correct responses of trained and untrained participants in the attitude section were 99.1% and 69.5% respectively. Lastly, in case of self-reported food safety practices, 71.7% of trained workers were correct in place of 39.4% untrained workers. Moreover, the knowledge, attitude, and self-reported practices scores of the trained and the untrained group remained statistically significant (p -value < 0.001) (Table 6).

4. Discussion

This current study is the first KAP study on food industry workers in Bangladesh. Improper management and handling of food are the crucial reasons of food safety issues and workers in most of the industries have

Table 3. Questions and responses for the evaluation of food safety attitude of trained and untrained respondents.

Attitude	Agree (%)		Disagree (%)		Not sure (%)	
	Trained	Untrained	Trained	Untrained	Trained	Untrained
1. For reducing the risk of food contamination it is required to wash hand before work	100	100	0	0	0	0
2. Sanitizing the hands after washing is also necessary for food safety	100	56.4	0	0	0	43.6
3. Wearing masks, head cover, beard cover, and gloves is one of the most important responsibilities to ensure food safety	100	92.7	0	0	0	7.3
4. While working in the production line it is necessary to change hand gloves at a regular interval	90.6	60	0	18.2	9.4	21.8
5. Using an apron is very important for reducing the contamination	98.1	49.1	0	10.9	1.9	40
6. One should not eat or chew anything in the food processing area	96.9	32.7	0	16.4	3.1	50.9
7. It is necessary to check the health status of workers before employment	100	85.5	0	0	0	14.5
8. Health check-up should be done at a regular interval	100	100	0	0	0	0
9. Before coming to work it is good to take a bath every day	100	100	0	0	0	0
10. Learning more about food safety and food quality is a personal responsibility	100	54.5	0	0	0	45.5
11. Oven temperature should be monitored at a regular interval	100	69.1	0	0	0	30.9
12. Date code, shelf life printing information should be checked with high importance before dispatch	100	69.1	0	0	0	30.9
13. Faulty raw materials and processed products should not be allowed inside of the factory	100	81.8	0	0	0	18.2
14. Specified product quality standard must be ensured before dispatch	100	80	0	0	0	20
15. HACCP must be implemented in plant to ensure food safety	100	12.7	0	0	0	87.3

Table 4. Questions and responses for the evaluation of self-reported food safety practices of trained and untrained respondents.

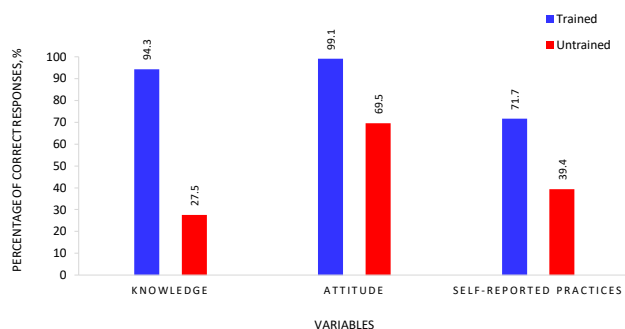
Self-reported practices	Yes (%)		No (%)		Sometimes (%)	
	Trained	Untrained	Trained	Untrained	Trained	Untrained
1. Do you eat anything in the processing area?	8.7	76.4	68.8	21.8	22.5	1.8
2. Do you change your gloves at regular intervals?	86.9	20	0	74.5	13.1	5.5
3. Do you change your mask after coughing or sneezing?	60.6	3.6	24.4	85.5	15	10.9
4. Do you wash your hand every time after restroom break?	100	81.8	0	0	0	18.2
5. Do you work in a condition when you're suffering from diarrhea?	28.8	0	55.6	100	15.6	0
6. Do you bath regularly?	70.6	49.1	29.4	50.9	0	0
7. Do you try to learn about food safety while at home?	17.5	0	68.1	100	14.4	0
8. Do you advise or encourage someone inside the factory about hygienic practices?	43.7	0	51.3	100	5	0
9. Do you touch foods in empty hands in the processing line?	8.8	80	60.6	20	30.6	0
10. Do you use sanitizer every time after washing hands?	61.9	30.9	19.4	50.9	18.7	18.2
11. Do you use soap every time while washing hands inside the factory?	100	63.6	0	20	0	16.4
12. Do you try to maintain a specified product quality standard while working at the processing line?	100	74.5	0	0	0	25.5
13. Do you maintain the respective checklist properly?	100	72.7	0	27.3	0	0
14. Do you know the seven principles of HACCP?	93.1	5.5	6.9	94.5	0	0
15. Did you ever work wearing jewelry in food handling areas?	25	52.7	56.9	47.3	18.1	0

Table 5. Food safety knowledge, attitude, and self-reported practices scores of workers from different departments^b.

Different departments	Knowledge ^a		Attitude ^a		Self-reported practices ^a	
	Trained	Untrained	Trained	Untrained	Trained	Untrained
Production	33.5 ± 0.08	8.0 ± 0.23	14.9 ± 0.01	10.1 ± 0.29	10.3 ± 0.27	5.7 ± 1.36
Quality assurance	34.5 ± 0.05	20.7 ± 0.33	15 ± 0	14.1 ± 0.07	13.5 ± 0.13	8.6 ± 2.03
Store & warehouse	30.3 ± 0.18	6.8 ± 0.25	14.2 ± 0.19	9.3 ± 0.37	9.8 ± 0.32	5.2 ± 1.26
Maintenance	31.1 ± 0.16	9.7 ± 0.30	14.5 ± 0.09	9.7 ± 0.30	10.2 ± 0.33	5.7 ± 1.38
Human resource management	30.1 ± 0.18	10.7 ± 0.35	14.5 ± 0.08	9 ± 0.35	12.2 ± 0.26	5 ± 1.23

^a Data presented as mean ± SD.

^b Scores range for knowledge, attitude, and self-reported practices are 0–35, 0–15, and 0–15, respectively.

**Figure 1.** Correct response percentage comparison between the two groups.

been accountable for some occurrences of food safety issues like food-borne diseases and foodborne illness (Greig et al., 2007; Ansari-Lari et al., 2010). Special consideration is needed to address this problem and some concerns are also required to improve the situation. The manufacturing industries are required to adopt numerous Food Safety Management

Systems (FSMS) for the enhancement of the safety of their food products (Rafeeqe and Sekharan, 2018). Along with this, food handlers must have the knowledge and skills relevant to their duties (Work Cover Tasmania, 2013). Establishing food safety standards should start with the individuals working inside the factory. They should possess ample knowledge on food safety; should have a very positive attitude towards a safe and secure production and quality assurance; furthermore, on the whole, bring the acquired knowledge and outlook to a regular practice. However, for understanding and practicing food safety, food safety culture can be perceived as a new concept for Bangladeshi food industries. Food safety culture is required to create proper food handling and establishing regulations concerning food hygiene and safety (de Andrade et al., 2020; Nyarugwe et al., 2018). As there are no studies on the evaluation of safety knowledge, attitude, and practices of food industry people in Bangladesh, especially not a single one of a baking industry, this work may have some influences on future studies.

There was a clear dominance of male participants over female participants in this current study. As found in the quarterly labor force survey (QLFS) 2015-16 in Bangladesh, about 15% of total industry employments were male when nearly 5% of them were female (null),

Table 6. Comparison of knowledge, attitude, and self-reported practices of trained and untrained respondents^b.

Variables	Trained group ^a	Untrained group ^a	p-value
Knowledge	33 ± 0.09	9.8 ± 0.23	<0.001
Attitude	14.8 ± 0.03	10.4 ± 0.26	<0.001
Self-reported practices	10.6 ± 0.25	5.9 ± 0.33	<0.001

^a Data presented as mean ± SD.

^b Scores range for knowledge, attitude, and self-reported practices are 0–35, 0–15, and 0–15, respectively.

Bangladesh Bureau of Statistics, 2017 the proportion of respondents in this current study have similarity with that data as well as with a study by Ansari-Lari et al. (2010). Most of the respondents fall in the age group between 30 to 40 years. The same sort of findings in age patterns also was shown by Jianu and Chiş (2012) and Ansari-Lari et al. (2010). In the two baking industries, most of the people have educational qualifications. We came to know from the management that they usually recruit workers with minimal educational background. Because of educated unemployment in countries like Bangladesh (Ahmed and Khan, 2015), the number of the educated labor force in the agricultural and manufacturing sectors seemed to be higher than before (BBS, 2010). In this current study, we did not evaluate the KAP according to some demographic characteristics, such as age, education, marital status, and experience. According to a study by Martins et al. (2012), age and experience did not seem to have significant effects on the findings. There are also some studies that have found no significant association of gender and marital status with food safety knowledge of food handlers (Taha et al., 2020; Alqurashi et al., 2019; Carbas et al., 2013; Gruenfeldova et al., 2019; Kunadu et al., 2016).

The total food safety knowledge, as well as attitude towards food safety of trained participants from the baking industries in this current study, was very much satisfactory. This result is similar to some studies (Taha et al., 2020; Smigic et al., 2016; Al-Kandari et al., 2019; Pichler et al., 2014) but certainly better in percentage of results. There is no better way to improve food handler's knowledge than an effective food safety training (Choudhury et al., 2011; Gormley et al., 2012; Hislop and Shaw, 2009; Taha et al., 2020). Appropriate handling of training materials, approach, and suitable types of delivery can be proved useful at the time of providing training (Taha et al., 2020). According to the present study, trained food handlers in surveyed baking industries have significantly higher total food safety knowledge than the untrained ones. Some recent studies (Taha et al., 2020; Osaili et al., 2018) also showed similar findings.

Knowledge of product safety and sanitation was quite desirable, and almost all of the trained respondents found to be correct in almost every aspect. We came to know from the section managers that, these companies had proper online checklists of finished products, which were strictly maintained at every 30 min interval in various areas of the production floor. They also used to a compulsory practice on the cleaning of every corner of food processing areas before and after the production. This may be one reason why the workers are very conscious of online quality standards like maintaining standard moisture content and water activity of the finished products, control of baking temperature, pest control, etc. However, in the area of the temperature profile of microbial growth, the findings of the current research confronted a contrary with the study of Jianu and Chiş (2012), as they indicated a poor level of response of the subjects. More than 90% of trained workers found aware of this issue. In a study conducted by Jianu and Chiş (2012) in Romania, it was observed that only 44% of food handlers believed that raw and processed foods should not be kept together. Workers faced problems in matters concerning raw and finished materials storage, as found in some studies (Jianu and Chiş, 2012; Gomes-Neves et al., 2007; Jevšnik et al., 2008). But an exceptionally outstanding result has been seen in this current study where every trained respondent answered this correctly. Along with this, a maximum amount of them responds positively about storing conditions of foods that may cause adverse effects on human health.

In the general food safety knowledge section, questions related to allergen and temperature required to make a hot hazardous food free from hazard seemed a bit unfamiliar to the workers. This may be due to giving less importance to these issues during the training programs or due to lack of contents. 2021 Ajala et al., 2010 conducted a similar study, where an inadequacy was remarked in company strategies to address training concerning food allergens. Training in food industries mostly focuses on topics related to online production and product quality control. Besides, industrial food safety training gives importance to hygiene (Worsfold and Griffith, 2003) rather than general food safety knowledge.

This may be a reason for having a comparatively low amount of correct answers in questions on transmissible diseases, modified atmospheric foods, or bacterial growth rate. The current baking industry has already implemented HACCP in their plant. As training for employees is a prerequisite for HACCP certification (Mortimore and Wallace, 2013), they conducted several training programs before and after the HACCP certification. The positive outcomes of the training program can be seen in the section of HACCP knowledge of trained workers. Expectingly, the maximum amounts of workers were able to provide correct replies to different questions related to HACCP. But, we found a large number of people unaware of an ethical issue. 'Falsifying record is a criminal offense' - is entirely unknown to almost half of the respondents. We cannot say anything precise about this, but a strong suggestion was given to the management for including ethical training for their employees. In the current study, almost all the respondents agreed with various statements in the attitude section of the provided questionnaire.

Maintaining and practicing personal hygiene is extremely important, and a must to confirm the production of safe food (Jianu and Chiş, 2012). In this study, self-reported data was obtained from the respondents for evaluating their food safety practices. It is one of the widely used ways of data collection (Short et al., 2009). Self-reporting is a cheap and easy way of collecting data, can be applicable to a large number of samples, and helps elaboration of responses (Dodd-McCue and Tartaglia, 2010). However, the accuracy of data obtained through self-administered questionnaires is comparatively lower than those obtained via records (Kim et al., 2013). The self-reported practice of trained workers in the industry didn't pass up to expectations. Almost 60% (often and seldom) of them used to work with wearing the jewelry. But, some studies showed a different outcome where maximum workers removed such kinds of accessories before entering the processing area (Walker et al., 2003; Giritlioglu et al., 2011). But, every one of them was found well-practiced in washing hands properly on every occasion, following online checklists, and maintaining specific product standards. Online checklists and product standards are regularly inspected by QA persons. That is why there is less chance of any deviation. When come to practices, the current result resembles almost all earlier studies that showed very positive outcomes in knowledge and attitude regarding food safety issues while having comparatively poor practices (Baş et al., 2006; Angelillo et al., 2001; Gomes-Neves et al., 2007; Jevšnik et al., 2008; Walker et al., 2003; Ansari-Lari et al., 2010). In this study, some vital issues related to product safety, like changing mask after sneezing or working with diseases, were found as unpracticed by many workers. Despite of having knowledge, they possibly do not perceive the associated risks. This kind of optimistic bias, as mentioned by Gouveia and Clarke (2001), can lead to improper hygienic practices. Training perhaps may bring enhancement in knowledge level, on occasion in attitude also, but it always may not bring noteworthy changes in behavior and practices (Ansari-Lari et al., 2010).

On the contrary to trained workers, untrained workers had lower knowledge, less positive attitude, and poor self-reported practices scores. Although as a beginner, they showed comparatively good attitudes (69.57%). And possibly many of them had no previous experience working in a food manufacturing industry. So, it was not a big deal that they did not know the HACCP, and they tried to learn food safety at home or advise someone to practice food safety. As a result, it was expected to have such kinds of outcomes. Despite having reduced knowledge and practices score, the attitude of the untrained participants was comparatively higher. We can say that, after a work time of seven to ten days with trained people, these people may become a little bit familiar with regular food safety and hygiene practices. This can bring about comparatively improved changes in attitude among the untrained workers. A simple explanation can stand within this short time of employment; no one got ill. The dominance of trained participants over untrained participants in food safety knowledge, attitude, and practices was also reported by McIntyre et al. (2013).

Among the five different departments, quality assurance (QA) showed comparatively improved performance in their knowledge, attitude, and

practices in both trained and untrained groups. QA professionals are supposed to be proficient and knowledgeable in a variety of aspects of the food processing industry. These may include regulatory, processing, sanitation, safety, audit, and human relations (Vasconcellos, 2003). Moreover, in the untrained group, QA people found to perform exceptionally well than the others. The newly recruited QA people are from a technical background. This may be one of the reasons for their excellent performance.

In the food industries of Bangladesh, unhygienic practices have become a common phenomenon (Ali, 2013). Training is a prerequisite to many food safety certifications like HACCP, ISO, etc. In many countries participating in a food protection certification program (like ServSafeO, the food handler program of the National Restaurant Association, USA) is compulsory for the food handlers (Soares et al., 2013). In the current study, the trained participants were superior in knowledge, attitude, and self-reported practices to the untrained participants. Training has been proved effective in improving food safety and hygiene knowledge in many studies (McIntyre et al., 2013; Gruenfeldova et al., 2019; da Cunha et al., 2014; Soon et al., 2012; Taha et al., 2020). However, compared to knowledge and attitude, self-reported practices of trained food handlers seemed a bit weak in this study. In addition to training, guidance and supervision are essential for improved practices (Gruenfeldova et al., 2019) as training itself always not associated with practices (da Cunha et al., 2014). So, for the improvement in the behavior of workers, some behavior-based training would be helpful. Because it is quite understandable that, at the moment of a busy and rush operation on the production floor, employees may give up some hygiene steps intentionally. nulls Yu et al., 2018 studied the effect of behavior-based training on workers' hand washing performance and frequency and it was found fruitful. In addition to the general and object-oriented food safety training, emphasis should be given on behavior-based motivation. Besides, the managers and floor supervisors should play a significant role to motivate the workers by providing recognition and rewards.

5. Limitations of the study

This study is prone to bias by the respondents and may not reflect the actual practice because it measured their self-reported practices and behaviors.

6. Conclusion

We observed a good level of knowledge, attitudes, and self-reported practices of the trained workers of the two baking industries in Dhaka, Bangladesh. They had quite a clear knowledge of food safety and a very positive attitude towards it. But compared to the knowledge and attitude, their self-reported practices seemed some sort weaker. In this study, the trained respondents don't effectively translate their knowledge and attitude into self-reported practices. On the other hand, the Knowledge, attitude, and self-reported practices of the newly recruited untrained workers were not up to the mark. Based on the overall performance, the trained people were superior in their KAP to the untrained ones. According to the findings of the study, it was suggested that the trained workers might have further need of some behavior-based food safety training. In addition, for the newly appointed people, there should be a provision of training before starting the online work inside the production plant. This study also reveals the need for more KAP studies on food safety in different food processing and manufacturing industries in Bangladesh.

Declarations

Author contribution statement

Fahad Jubayer: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Shahidullah Kayshar: Performed the experiments; Analyzed and interpreted the data.

Sajjad Hossain: Performed the experiments; Wrote the paper.

Nasir Uddin, Al-Emran: Performed the experiments; Contributed reagents, materials, analysis tools or data.

Syeda Sabrina Akter: Analyzed and interpreted the data.

Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

Acknowledgements

We sincerely acknowledge the participation of the employees and cooperation of the management team, especially the production manager and QA manager of the baking industries during the study.

References

- Ahmed, S.S., Khan, M.K., 2015. Employment and unemployment situation in Bangladesh: a dismal picture of development. In: Biennial Conference of the Bangladesh Economic Association, Dhaka, pp. 1–29.
- Aguado, V., Vitas, A.I., Garcia-Jalon, I., 2001. Random amplified polymorphic DNA typing applied to the study of cross-contamination by *Listeria monocytogenes* in processed food products. *J. Food Protect.* 64 (5), 716–720.
- Ajala, A.R., Cruz, A.G., Faria, J.A., Walter, E.H., Granato, D., Sant, A.S., 2010. Food allergens: Knowledge and practices of food handlers in restaurants. *Food Control* 21 (10), 1318–1321.
- Ali, A.N.M.A., 2013. Food safety and public health issues in Bangladesh: a regulatory concern. *Eur. Food Feed Law Rev.* 31–40.
- Al-Kandari, D., Al-abdeen, J., Sidhu, J., 2019. Food safety knowledge, attitudes and practices of food handlers in restaurants in Kuwait. *Food Contr.* 103, 103–110.
- Alqurashi, N.A., Priyadarshini, A., Jaiswal, A.K., 2019. Evaluating food safety knowledge and practices among foodservice staff in Al Madinah hospitals, Saudi Arabia. *Saf. Now.* 5 (1), 9.
- Angelillo, I.F., Viggiani, N.M., Rizzo, L., Bianco, A., 2000. Food handlers and foodborne diseases: knowledge, attitudes, and reported behavior in Italy. *J. Food Protect.* 63 (3), 381–385.
- Angelillo, I.F., Viggiani, N.M., Greco, R.M., Rito, D., 2001. HACCP and food hygiene in hospitals knowledge, attitudes, and practices of food-services staff in Calabria, Italy. *Infect. Contr. Hosp. Epidemiol.* 22 (6), 363–369.
- Ansari-Lari, M., Soodbakhsh, S., Lakzadeh, L., 2010. Knowledge, attitudes and practices of workers on food hygienic practices in meat processing plants in Fars, Iran. *Food Contr.* 21 (3), 260–263.
- Autio, T., Hielm, S., Miettinen, M., Sjöberg, A.M., Aarnisalo, K., Björkroth, J., Korkeala, H., 1999. Sources of *Listeria monocytogenes* contamination in a cold-smoked rainbow trout processing plant detected by pulsed-field gel electrophoresis typing. *Appl. Environ. Microbiol.* 65 (1), 150–155.
- Bangladesh Bureau of Statistics, 2017. Quarterly Labor Force Survey (QLFS): Improving of Labor Statistics and Labor Market Information System through Panel Survey (LMIS) Project. Bangladesh bureau of statistics.
- Baş, M., Ersun, A.Ş., Kivanç, G., 2006. The evaluation of food hygiene knowledge, attitudes, and practices of food handlers' in food businesses in Turkey. *Food Contr.* 17 (4), 317–322.
- BBS, Y., 2010. Report on Labour Force Survey 2010. Bangladesh bureau of Statistics.
- Carbas, B., Cardoso, L., Coelho, A.C., 2013. Investigation on the knowledge associated with foodborne diseases in consumers of northeastern Portugal. *Food Contr.* 30 (1), 54–57.
- Choudhury, M., Mahanta, L.B., Goswami, J.S., Mazumder, M.D., 2011. Will capacity building training interventions given to street food vendors give us safer food?: a cross-sectional study from India. *Food Contr.* 22 (8), 1233–1239.
- Cotterchio, M., Gunn, J., Coffill, T., Tormey, P., Barry, M.A., 1998. Effect of a manager training program on sanitary conditions in restaurants. *Publ. Health Rep.* 113 (4), 353.
- Cohen, E., Reichel, A., Schwartz, Z., 2001. On the efficacy of an in-house food sanitation training program: statistical measurements and practical conclusions. *J. Hospit. Tourism Res.* 25 (1), 5–16.

- da Cunha, D.T., Stedefeldt, E., de Rosso, V.V., 2014. The role of theoretical food safety training on Brazilian food handlers' knowledge, attitude and practice. *Food Contr.* 43, 167–174.
- Dodd-McCue, D., Tartaglia, A., 2010. Self-report response bias: learning how to live with its diagnosis in chaplaincy research. *Chaplain. Today* 26 (1), 2–8.
- de Andrade, M.L., Stedefeldt, E., Zanin, L.M., da Cunha, D.T., 2020. Food safety culture in food services with different degrees of risk for foodborne diseases in Brazil. *Food Contr.* 112, 107152.
- Egan, M.B., Raats, M.M., Grubb, S.M., Eves, A., Lumbers, M.L., Dean, M.S., Adams, M.R., 2007. A review of food safety and food hygiene training studies in the commercial sector. *Food Contr.* 18 (10), 1180–1190.
- Farjana, F., Rayhan, M.A., 2014. Productivity assessment of bakery firm in Khulna region of Bangladesh. *IOSR J. Humanit. Soc. Sci.* 19 (12), 1–8.
- Foley, S.L., Johnson, T.J., Ricke, S.C., Nayak, R., Danzeisen, J., 2013. *Salmonella* pathogenicity and host adaptation in chicken-associated serovars. *Microbiol. Mol. Biol. Rev.* 77 (4), 582–607.
- Girtlioglu, I., Batman, O., Tetik, N., 2011. The knowledge and practice of food safety and hygiene of cookery students in Turkey. *Food Contr.* 22 (6), 838–842.
- Gomes-Neves, E., Araújo, A.C., Ramos, E., Cardoso, C.S., 2007. Food handling: comparative analysis of general knowledge and practice in three relevant groups in Portugal. *Food Contr.* 18 (6), 707–712.
- Gouveia, S.O., Clarke, V., 2001. Optimistic bias for negative and positive events. *Health Educ.* 101 (5), 228–234.
- Greig, J.D., Todd, E.C., Bartleson, C.A., Michaels, B.S., 2007. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 1. Description of the problem, methods, and agents involved. *J. Food Protect.* 70 (7), 1752–1761.
- Gormley, F.J., Rawal, N., Little, C.L., 2012. Choose your menu wisely: cuisine-associated food-poisoning risks in restaurants in England and Wales. *Epidemiol. Infect.* 140 (6), 997–1007.
- Gruenfeldova, J., Domijan, K., Walsh, C., 2019. A study of food safety knowledge, practice, and training among food handlers in Ireland. *Food Contr.* 105, 131–140.
- Hislop, N., Shaw, K., 2009. Food safety knowledge retention study. *J. Food Protect.* 72 (2), 431–435.
- Huq, A.O., Uddin, M.J., Haque, K.F., Roy, P., Hossain, M.B., 2013. Health, hygiene practices and safety measures of selected baking factories in Tangail region, Bangladesh. *Int. J. Curr. Microbiol. Appl. Sci.* 2 (10), 68–75.
- International Standard Organization (ISO), 2005. ISO/IEC22000-Food Safety Management Systems. Requirements for Any Organization in the Food Chain. International Organization for Standardization, Geneva, Switzerland.
- Islam, S., 2016. Bakers & bakeries stories of blooming urban bakeries and confectioneries. *IDLC Mon. Bus. Rev.* 2.
- Jevšnik, M., Hlebec, V., Raspor, P., 2008. Food safety knowledge and practices among food handlers in Slovenia. *Food Contr.* 19 (12), 1107–1118.
- Jianu, C., Chiş, C., 2012. Study on the hygiene knowledge of food handlers working in small and medium-sized companies in western Romania. *Food Contr.* 26 (1), 151–156.
- Kim, H., Lee, K., Chang, S., Kang, G., Tak, Y., Lee, M., Jeong, H., 2013. Factors affecting the validity of self-reported data on health services from the community health survey in Korea. *Yonsei Med. J.* 54 (4), 1040–1048.
- Kotsianis, I.S., Giannou, V., Tzia, C., 2002. Production and packaging of bakery products using MAP technology. *Trends Food Sci. Technol.* 13 (9–10), 319–324.
- Kunadu, A.P.H., Ofosu, D.B., Aboagye, E., Tano-Debrah, K., 2016. Food safety knowledge, attitudes and self-reported practices of food handlers in institutional foodservice in Accra, Ghana. *Food Contr.* 69, 324–330.
- Liu, Y., Lu, Y., Wang, L., Chang, F., Yang, L., 2015. Survey of 11 mycotoxins in wheat flour in Hebei province, China. *Food Addit. Contam. B* 8 (4), 250–254.
- Martins, R.B., Hogg, T., Otero, J.G., 2012. Food handlers' knowledge on food hygiene: the case of a catering company in Portugal. *Food Contr.* 23 (1), 184–190.
- McElroy, D.M., Cutter, C.N., 2004. Self-reported changes in food safety practices as a result of participation in a statewide food safety certification program. *Food Protect. Trends* 24 (3), 150–161.
- McIntyre, L., Vallaster, L., Wilcott, L., Henderson, S.B., Kosatsky, T., 2013. Evaluation of food safety knowledge, attitudes and self-reported hand washing practices in FOODSAFE trained and untrained food handlers in British Columbia, Canada. *Food Contr.* 30 (1), 150–156.
- Mortimore, S., Wallace, C., 2013. HACCP: A Practical Approach. Springer science and business media.
- Motarjemi, Y., Käferstein, F., Moy, G., Quevedo, F., 1993. Contaminated weaning food: a major risk factor for diarrhea and associated malnutrition. *Bull. World Health Organ.* 71 (1), 79.
- Noor, R., Feroz, F., 2016. Food safety in Bangladesh: a microbiological perspective. *Stamford J. Microbiol.* 6 (1), 1–6.
- Nyarugwe, S.P., Linnemann, A., Nyanga, L.K., Fogliano, V., Luning, P.A., 2018. Food safety culture assessment using a comprehensive mixed-methods approach: a comparative study in dairy processing organizations in an emerging economy. *Food Contr.* 84, 186–196.
- Osaili, T.M., Al-Nabulsi, A.A., Krasneh, H.D.A., 2018. Food safety knowledge among foodservice staff at the universities in Jordan. *Food Contr.* 89, 167–176.
- Pichler, J., Ziegler, J., Aldrian, U., Allerberger, F., 2014. Evaluating levels of knowledge on food safety among food handlers from restaurants and various catering businesses in Vienna, Austria 2011/2012. *Food Contr.* 35 (1), 33–40.
- Rafeeqe, K.T., Sekharan, N., 2018. Multiple food safety management systems in food industry: a case study. *Int. J. Food Sci. Nutr.* 3 (1), 37–44.
- Riba, A., Bouras, N., Mokrane, S., Mathieu, F., Lebrihi, A., Sabaou, N., 2010. *Aspergillus* section *Flavi* and aflatoxins in Algerian wheat and derived products. *Food Chem. Toxicol.* 48 (10), 2772–2777.
- Rivoal, K., Quéguiner, S., Boscher, E., Bougeard, S., Ermel, G., Salvat, G., Protais, J., 2010. Detection of *Listeria monocytogenes* in raw and pasteurized liquid whole eggs and characterization by PFGE. *Int. J. Food Microbiol.* 138 (1–2), 56–62.
- Sakib, S.M.N., 2018. Baking Business Booms. *The Financial Express*. https://today.thefinancialexpress.com.bd/print/baking-business-booms-1523554764?fbclid=IwAR3A0f8HXrql8m1lXJZxJSeEK12h4nblWLjw_b-sD9ExFvSWUMkX6UL9s.
- Short, M.E., Goetzel, R.Z., Pei, X., Tabrizi, M.J., Ozminowski, R.J., Gibson, T.B., Wilson, M.G., 2009. How accurate are self-reports? An analysis of self-reported healthcare utilization and absence when compared to administrative data. *J. Occup. Environ. Med.* 51 (7), 786.
- Soares, L.S., Almeida, R.C., Cerqueira, E.S., Carvalho, J.S., Nunes, I.L., 2012. Knowledge, attitudes and practices in food safety and the presence of coagulase-positive staphylococci on hands of food handlers in the schools of Camaçari, Brazil. *Food Contr.* 27 (1), 206–213.
- Soares, K., Garcia-Diez, J., Esteves, A., Oliveira, I., Saraiva, C., 2013. Evaluation of food safety training on hygienic conditions in food establishments. *Food Contr.* 34 (2), 613–618.
- Smigic, N., Djekic, I., Martins, M.L., Rocha, A., Sidiropoulou, N., Kalogianni, E.P., 2016. The level of food safety knowledge in food establishments in three European countries. *Food Contr.* 63, 187–194.
- Soon, J.M., Baines, R., Seaman, P., 2012. Meta-analysis of food safety training on hand hygiene knowledge and attitudes among food handlers. *J. Food Protect.* 75 (4), 793–804.
- Taha, S., Osaili, T.M., Saddal, N.K., Al-Nabulsi, A.A., Ayyash, M.M., Obaid, R.S., 2020. Food safety knowledge among food handlers in food service establishments in United Arab Emirates. *Food Contr.* 110, 106968.
- Todd, E.C., Greig, J.D., Bartleson, C.A., Michaels, B.S., 2007. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 3. Factors contributing to outbreaks and description of outbreak categories. *J. Food Protect.* 70 (9), 2199–2217.
- Tompkin, R.B., 2002. Control of *Listeria monocytogenes* in the food-processing environment. *J. Food Protect.* 65 (4), 709–725.
- Vasconcellos, J.A., 2003. Quality Assurance for the Food Industry: a Practical Approach. CRC press.
- Vogel, B.F., Jørgensen, L.V., Ojienyi, B., Huss, H.H., Gram, L., 2001. Diversity of *Listeria monocytogenes* isolates from cold-smoked salmon produced in different smokehouses as assessed by random amplified polymorphic DNA analyses. *Int. J. Food Microbiol.* 65 (1–2), 83–92.
- Walker, E., Pritchard, C., Forsythe, S., 2003. Food handlers' hygiene knowledge in small food businesses. *Food Contr.* 14 (5), 339–343.
- World Health Organization, 2002. WHO Global Strategy for Food Safety: Safer Food for Better Health. WHO.
- World Health Organization (WHO), 2009. 10 facts on food safety. Available at: http://www.who.int/features/facilities/food_safety/en/index.html (assessed on March 2nd, 2011).
- World Health Organization (WHO), 2017. Food safety key facts. Available online at: http://www.who.int/news-room/fact-sheets/food_safety/ (assessed on October 31, 2017).
- WHO World Health Organization, WHO Consultation on Health Surveillance, and Management Procedures for Food-Handling Personnel, 1989. Health Surveillance and Management Procedures for Food-Handling Personnel: Report of a WHO Consultation, Vol. 785. World Health Organization.
- Work Cover Tasmania, 2013. Food Safety in the Workplace. [worksafe.tas.gov.au. https://worksafe.tas.gov.au/_data/assets/pdf_file/0011/288182/Food_safety_in_the_workplace_fact_sheet.pdf](https://worksafe.tas.gov.au/_data/assets/pdf_file/0011/288182/Food_safety_in_the_workplace_fact_sheet.pdf).
- Worsfold, D., Griffith, C.J., 2003. A survey of food hygiene and safety training in the retail and catering industry. *Nutr. Food Sci.* 33 (2), 68–79.
- Wu, S., Ricke, S.C., Schneider, K.R., Ahn, S., 2017. Food safety hazards associated with ready-to-bake cookie dough and its ingredients. *Food Contr.* 73, 986–993.
- Yu, H., Neal, J., Dawson, M., Madera, J.M., 2018. Implementation of behavior-based training can improve food service employees' hand washing frequencies, duration, and effectiveness. *Cornell Hospit. Q.* 59 (1), 70–77.
- Zanin, L.M., da Cunha, D.T., de Rosso, V.V., Capriles, V.D., Stedefeldt, E., 2017. Knowledge, attitudes and practices of food handlers in food safety: an integrative review. *Food Res. Int.* 100, 53–62.