



Assessment of the Subjective Food Safety Knowledge, Attitudes and Practices of Informal Live Bird Traders in Accra, Ghana

ABSTRACT

This cross-sectional study was conducted to evaluate the food safety knowledge, attitudes and practices (KAP) of informal live bird traders operating in various markets in Accra, Ghana. A total of 132 live bird traders participated in the study. Semi-structured questionnaires were administered through face-to-face interviews, and responses were scored to determine the level of food safety KAP. Respondents who scored ≥ 70 of the maximum possible score were categorized as having good food safety knowledge and practices and positive attitudes. Respondents generally had insufficient food safety knowledge and poor food safety practices, with scores of 59.04 ± 28.66 (49.2%) and 9.24 ± 4.40 (33%), respectively. Respondents' attitudes toward food safety was generally positive, with a mean score of 17.15 ± 3.32 (78%). Significant gaps were observed in relation to ignorance of sources of contamination during primary poultry processing operations, infrequency of hand washing before and during poultry processing, infrequent washing of food contact surfaces and carcass showering

after evisceration, and complete disregard for carcass chilling. There is therefore a pressing need to educate the live bird traders on the food safety implications of their operational practices.

INTRODUCTION

Informal food processing and trade is significant in many developing countries. It contributes to food security, is a convenient source of daily nutrition for a significant proportion of the populace and aids in local food culture preservation (12). In Ghana, the informal food sector, particularly street food vending, is prominent and is likely to remain relevant in the future, as people in both the middle and upper class patronize this sector (11, 23). The live bird markets in Ghana are one of such street food operations located at traditional open markets throughout the country (12). Their services include trade of live poultry, mainly chicken but also guinea fowls, turkeys, doves, pigeons and ducks. The chicken traded in these markets come from both commercial (industrial/large scale, medium scale and small scale) and village/backyard systems of raising poultry (12).

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In addition to slaughtering and dressing birds for clients on demand, the live bird traders also serve as a niche market for local poultry products, which are preferred to imported frozen chicken because of their superior taste and texture (12, 13, 24). The live bird markets are similar to the farmers' markets in the U.S. where fresh, local products are traded, sometimes at premium prices (9, 30). These services have made the live bird markets a viable economic venture that customers and food preparation businesses patronize for fresh chicken meat.

The traditional open markets that host the live bird markets are characterized by temporary infrastructure, with poor access to potable water, power and appropriate slaughtering facilities (9, 13, 30). Globally, poultry meat has been identified as an important vehicle for the transmission of disease-causing organisms to humans (14). The European Food Safety Authority (11) estimated that, of the 9 million individuals with *Campylobacteriosis* each year in Europe, 20 to 30% of cases were associated with broiler meat. The strong association of *Campylobacteriosis* and *Salmonellosis* with poultry meat has been attributed to poor handling during processing operations, time-temperature abuse, cross-contamination and inadequate cooking (14). Improper handling of chicken meat during processing and after cooking, resulting in time-temperature abuses, accounts for most foodborne disease outbreaks associated with chicken meat (5). This is worth noting, as a nationwide assessment of the food safety knowledge, attitudes and practices of institutional food handlers in Ghana revealed that the majority of them were not familiar with time-temperature abuse and its related effect on food safety (4). This is further supported by the Ghana Food and Drugs Authority's report that 77% of all traceable foodborne diseases reported in Ghana result from improper handling of food in foodservice establishments (15). Also, fundamental food safety management systems such as Hazard Analysis Critical Control Points (HACCP) is not mandatory for food businesses in Ghana, so that very few food safety management systems have been implemented among locally owned businesses across the country (1, 2, 33).

Information is scanty about the quality and safety of fresh poultry meat from informal settings. The majority of chickens from both formal industrial farms and small scale/ village production systems end up in the informal markets through the live bird traders. These markets are patronized by the majority of food service establishments where traditional foods are prepared and by individuals who relish the taste of fresh chicken meat from layers, broilers and local breeds.

A study carried out by Sheinberg et al. (30) on the food safety knowledge, behavior and attitudes of vendors of poultry products sold at Pennsylvania farmers' markets identified knowledge gaps with regard to pathogens and opportunities for cross-contamination during poultry processing by vendors. The study also revealed that, while most poultry vendors know the importance of strict

temperature control in poultry processing operations, a significant percentage did not comply with this practice (30). It has been established that our perceptions of food safety are shaped by our subjective knowledge, which could be erroneous or accurate (35). Those perceptions, once formed, will influence our attitudes and behaviors. As shown by Gomes-Neves et al. (17) in their study on meat handlers in Portugal, the impact of training intervention tailored to addressing subjective knowledge of respondents is effective. It is therefore important to understand the food safety knowledge of live bird traders and their corresponding self-reported food safety attitudes and practices. This information is necessary in identifying significant food safety gaps and the effective interventions for addressing them. It will also give policy makers the much-needed information for interventions that the informal poultry sector needs. This study therefore assessed the subjective knowledge and attitudes of live bird traders on food safety and how these influence their practices during processing operations.

MATERIALS AND METHODS

Study design

A cross-sectional survey was conducted to collect data through administration of semi-structured questionnaires. The questionnaire was designed to assess the food safety knowledge, practices and general attitudes related to food safety of live bird traders/processors in the Accra metropolis. Twelve live bird markets in Accra were selected on the basis of their size, estimated volume of shoppers per day and proximity to the research station.

Questionnaire design

A semi-structured questionnaire was prepared based on validated questionnaires used in similar studies (3, 20). The questionnaire was divided into four sections: (i) Socio-demographic characteristics (age, sex, religion, level of education, type of business), length of doing business, key customers, association and steps used in processing operations, (ii) Knowledge of food safety, (iii) Attitudes toward food safety, and (iv) Measures used to prevent contamination of poultry meat during processing. Responses to knowledge, attitude and practice questions were scored with 2 points awarded for a correctly answered question. Incorrect, "don't know" and 'not sure' responses received a score of 0. For questions with the options of "yes," "no," "often" and "occasionally" in the practice section, a score of 2 was awarded for "yes" and 0 for "no," "often" and "occasionally." Some of the knowledge questions had more than one correct response; each correct response was scored 2 points. In all, the food safety knowledge, attitudes and practices questions had a maximum score of 120, 22 and 28 points, respectively.

The food safety knowledge and practices scores were categorized as "poor" when they were less than 70% of the maximum possible score. Respondents who scored 70% or

above were classified as having “good” food safety knowledge and practices. Attitudes were classified as “negative” for total scores less than 70% of the maximum possible score, and “positive” when they were greater than or equal to 70%. The classifications and scoring systems were adapted from (20, 27, 29).

Pilot test

The questionnaire was pre-tested in the Madina market in Accra to obtain an estimate of interview duration and to confirm questionnaire clarity. The results from the pre-testing were used in revising the questionnaires. Ethical approval for the study was obtained from the Institutional Review Board of the Ethics Committee for Basic and Applied Science of the University of Ghana on November 25, 2016.

Data collection

The selected live bird markets were visited during the day when normal operations were in progress. The consent of the processors was obtained prior to administration of the questionnaires. Face-to-face interviews were used in obtaining data from all live bird traders/processors who agreed to participate. The questionnaire was developed in English but administered not only in English but also in two local dialects, Twi and Ga, depending on a respondent's language preference. The questions were read aloud, with respondents given enough time to respond to each question. The completed questionnaires were then checked for completeness. Incomplete questionnaires were rendered invalid. A total of 132 valid questionnaires out of the 152 administered was obtained at the end of the data collection. In addition to the interview, poultry processing operations from slaughter to packaging was observed and documented at each of the markets visited. The results were compared to the recommendations of a published standard operating procedure for poultry processing (7).

Statistical analysis

The data were analyzed using the IBM SPSS Statistics 22 statistical package and Microsoft Excel, 2013. A summary of the respondent's knowledge, attitudes and practices scores and biodata were obtained by use of descriptive statistics. Predictors (age, sex, marital status, and level of education, length of service in business and association membership) of knowledge, attitudes and practices were analyzed by use of Pearson's chi-square test of significance at an alpha level of 0.05. Spearman's correlation coefficient was used to test the association among knowledge, attitudes and practices of the respondents.

RESULTS AND DISCUSSION

Socio-demographic profile of live bird traders

Of the 132 live bird traders interviewed, 83.3% ($n = 110$) were males, while 16.7% ($n = 22$) were females (Table 1). Similarly high proportions of males, 70% and 97%, were

reported in similar studies (3, 20). This suggests that live bird trading and poultry processing activities are dominated by males. Over half (56.1%) of the participants were in the age range of 19–35 years. The respondents also had significant levels of experience in the poultry business, evident in the fact that only 29.5% of them had a length of service below 5 years. The majority (82.6%) of the respondents belonged to at least one poultry association.

The level of formal education among the live bird traders interviewed was rather low, with 28.8% percent having no formal education. This is in line with a study by Tomlins et al. (33) that showed that the level of education among food handlers in Ghana is low. This is noteworthy, because food safety studies (2, 10) have shown that workers with no formal education are unlikely to follow safe food handling procedures.

Food safety knowledge

The live bird traders generally had insufficient food safety knowledge. The total mean score for knowledge was 59.04 ± 28.66 , representing only 49.2% of the maximum possible score of 120 points. Salient responses to the food safety knowledge questions are summarized in Table 2.

The majority of the respondents (85.6%) had heard about foodborne illness. Radio (79.5%) and television (47%) were the main sources of information on foodborne illness. Diarrhea, vomiting and abdominal pain were the most commonly recognized symptoms of foodborne illness. Because of the annual cholera outbreaks in Ghana, it is conceivable to think that this influences the respondent's choice of these symptoms, especially diarrhea, as it is the most frequently advertised expression of foodborne illness in the media. Again, these are symptoms respondents will most probably attribute to consumption of unwholesome food. Unlike diarrhea, paralysis, jaundice and fatigue were less known among the participants as symptoms of foodborne diseases, a finding that has been reported in similar studies (6, 27). There is therefore the need to emphasize, during training and public education interventions, some of these lesser known symptoms of foodborne illness, in order to increase the likelihood that they are effectively reported and treated. Also, since radio and television are the primary sources of information on food safety for the live bird traders, it is important to communicate well-validated information on matters of food safety on such platforms to curb the potential for misinformation, which further adds to erroneous subjective food safety beliefs.

The majority (79.5%) of the live bird traders were also aware that germs could cause foodborne illnesses. One troubling observation was that less than half of the respondents recognized extraneous matter (46.2%) and toxic chemicals (40.9%) in food as possible causes of foodborne illness. The fact that they do not know makes it more probable that they will disregard the need to take necessary measures to limit the occurrence of these hazards during processing operations.

TABLE 1. Demographic characteristics of live bird traders and processors in Accra

Characteristics	N (%)
Sex	
Female	22 (16.7)
Male	110 (83.3)
Age (years)	
19–35	74 (56.1)
36–50	40 (30.3)
Above 50	18 (13.6)
Formal education	
Primary	27 (20.5)
JHS	29 (22)
SHS	33 (25)
Tertiary	5 (3.8)
No formal education	38 (28.8)
Marital status	
Single	41 (31.1)
Married	89 (67.4)
Divorced	2 (1.5)
Length of employment (years)	
Below 5	39 (29.5)
6–10	33 (25)
11–20	29 (22)
Above 20	31 (23.5)
Member of a poultry association	
Yes	109 (82.6)
No	23 (17.4)

Total number of respondents = 132, JHS: Junior Secondary School, SHS: Senior Secondary School

Another revelation was that less than a tenth of the respondents (8.3%) recognized that withdrawing feed 12 hours to slaughter of birds could reduce the risk of contamination. According to Mead (21), allowing an adequate feed withdrawal period prior to slaughter allows for clearance of the gastrointestinal tract. This reduces evisceration accidents, which may visibly contaminate the carcass with feces, which may contain *Campylobacter* spp. and *Salmonella* spp. (7). *Campylobacter* spp. and *Salmonella* spp.

are associated with the gut of healthy birds, including poultry (7). There is therefore a possibility of relatively high levels of carcass contamination with enteropathogens in the event of evisceration accidents during dressing of birds.

It was, however, encouraging to find that a high proportion of respondents recognized the importance of gloves (31.1%) and caps, masks and adequate clothing (28.8%) in reducing the risk of microbial contamination. They were also aware of the importance of washing hands thoroughly before work

TABLE 2. Subjective food safety knowledge of live bird traders and processors in Accra, Ghana

Questions	Sufficient Knowledge, N (%)	Mean score \pm SD
Have you heard of foodborne illness?	113 (85.6)	1.71 \pm 0.71
What are the symptoms of foodborne illness?		
1. Diarrhea	110 (83.3)	1.67 \pm 0.75
2. Vomiting	98 (74.2)	1.48 \pm 0.88
3. Abdominal pain	75 (56.8)	1.14 \pm 0.99
4. Fatigue	63 (47.7)	0.95 \pm 1.00
5. Jaundice	41 (31.1)	0.62 \pm 0.93
6. Dizziness	47 (35.6)	0.71 \pm 0.96
7. Paralysis	35 (26.5)	0.53 \pm 0.89
Have you heard about germs/microorganisms?	116 (87.9)	1.76 \pm 0.66
What are the causes of foodborne illnesses?		
1. Germs	105 (79.5)	1.59 \pm 0.81
2. Extraneous matter	61 (46.2)	0.92 \pm 1.00
3. Toxic chemicals	54 (40.9)	0.82 \pm 0.99
What are the sources of contamination in poultry meat?		
1. Meat handlers	101 (76.5)	1.53 \pm 0.85
2. Feed	65 (49.2)	0.98 \pm 1.00
3. Working surfaces	80 (60.6)	1.21 \pm 0.98
How can you minimize risk of poultry contamination?		
1. Withdrawing feed 12 hours to slaughter of birds	11 (8.3)	0.17 \pm 0.56
2. Use of gloves during poultry processing	41 (31.1)	0.62 \pm 0.93
3. Wash hands thoroughly before work	98 (74.2)	1.48 \pm 0.88
4. Using caps, masks and adequate clothing	38 (28.8)	0.58 \pm 0.91
5. Cleaning food contact surface between batch processing	82 (62.1)	1.25 \pm 0.97
6. Washing hands after using toilet	103 (78.0)	1.56 \pm 0.83
7. Using potable water	95 (72)	1.44 \pm 0.90
Which of the following temperature condition best facilitates the growth of germs?		
1. Cold food	N/A	N/A
2. Hot food	N/A	N/A
3. Luke-warm food	31 (23.5)	0.47 \pm .85
How can cross-contamination occur?		
1. Mixing of sick birds with healthy ones	11 (8.3)	0.25 \pm 0.83
2. Using dirty utensils to process poultry meat	8 (6.1)	0.12 \pm 0.48
3. Handling of raw meat with open wounds	1 (0.8)	0.02 \pm 0.18
Total	*31 (23.5)	59.04 \pm 28.66 (49.2%)

The maximum score for food safety knowledge is 120, where N is the total number of respondents (132).

*Total number of respondents who scored \geq 70% of the total food safety knowledge score.

(74.2%) and after visiting the toilet (78%). Bas et al (8) and Fuerst and Fuerstos (16) have demonstrated that the hands of food handlers can serve as conduits for transmission of foodborne pathogens into food via poor personal hygiene or cross-contamination.

The majority (72.5%) of the respondents, however, did not know which temperature condition best facilitated the growth of germs. In contrast, a convincing majority of poultry meat vendors in the U.S. and meat handlers in Iran knew the temperature at which raw poultry should be stored in order to slow down the growth of germs (6, 30). Recent reports (1, 4) suggest that food handlers in Ghana are ignorant of time-temperature control and the associated food safety risks. Time and temperature control during processing and storage is an area that needs to be addressed during training and future interventions.

When asked about cross-contamination, only 8.3% knew that mixing of sick birds with healthy ones can cause cross-contamination. About 6.1% and 0.8% of respondents indicated that using dirty utensils to process meat and handling of raw meat by workers with open wounds, respectively, can cause cross-contamination.

Food safety attitudes

The overall attitudes exhibited by the respondents toward food safety was positive, as has been reported in similar studies (6, 19). The attitudes toward food safety of the live bird traders interviewed in this study are presented

in Table 3. Positive attitudes of food handlers toward the implementation of food safety plans strongly influences the reduction in incidence of foodborne illness (4). Thus positive conduct and attitudes, as well as the level of formal education, of food handlers share a strong association in maintaining safe food handling practices (18). It was therefore encouraging to find that, despite the low levels of formal education of the respondents, there was a strong show of positive attitudes toward practices such as safe food handling, temperature control, learning about food safety, and keeping staff who are ill away from processing areas.

Approximately half (49.2%) of the live bird traders also agreed that chilling of chicken carcasses is important in raw chicken processing. A significantly higher percentage (86%) of poultry vendors assessed in farmers' markets in the state of Pennsylvania recognized that chilling was important to reducing the internal temperature of the carcass (30). Chilling has been identified as a critical control point in poultry processing. It is important to slow the growth of harmful mesophilic bacteria (25). However, none of the live bird traders in the various markets visited chilled their carcass after processing. Similar studies on food safety also reported poor temperature-time control practices among institutional food handlers in the country (2, 4, 27). This rather low belief in the importance of chilling should be of concern to all poultry stakeholders, given its importance in preservation and safety.

TABLE 3. Food safety attitudes of live bird traders and processors in Accra, Ghana

Statements	Positive attitudes N (%)	Mean score \pm SD
Safe food handling is an important part of my job responsibility	121 (91.7)	1.83 \pm 0.56
Learning more about food safety is important to me	115 (87.1)	1.74 \pm 0.67
Toxic chemicals and cleaning solutions should be stored away from the food processing area	108 (81.8)	1.64 \pm 0.77
Chilling of chicken carcasses is important in raw chicken processing	65 (49.2)	0.98 \pm 1.00
Food-processors with abrasion or cuts on hands should not touch raw chicken	113 (85.6)	1.71 \pm 0.71
Employees suffering from foodborne illness and other illness should not be permitted to work in the food processing area	112 (84.8)	1.70 \pm 0.72
It is necessary to use antibacterial soap when washing hands	112 (84.8)	1.70 \pm 0.72
I believe good personal hygiene can prevent foodborne illness	131 (99.2)	1.98 \pm 0.17
I am willing to change my food handling practices when I know they are incorrect	129 (97.7)	1.95 \pm 0.30
Total	*106 (80.3)	17.15 \pm 3.32 (78%)

The total maximum score for food safety attitudes questions is 22; N is the total number of respondents (132).

*Total number of respondents who scored \geq 70% of the total food safety attitude score.

Food safety practices

Generally, the reported food safety practices of the live bird traders during processing operations were poor. Of the 132 respondents interviewed, 124 (94%) admitted to processing birds for consumers. The mean practice score of live poultry traders and processors at live bird markets was 9.24 ± 4.40 out of a maximum score of 28, which represents 33% of the maximum food safety practice score. Only 3 (2.4%) of the 124 poultry processors were found to have implemented good levels of food safety practices. [Table 4](#) summarizes the responses from the live bird traders concerning their food safety practices.

A little over half (57.3%) of the respondents reported washing their hands before slaughter and dressing of chicken. Better hand washing behaviors have been reported in similar studies among meat processors (6, 20). The importance of hands as a potential route for transmission of zoonotic bacteria is well established (23, 32). Therefore, the low percentage of live bird traders who reported washing hands before and during processing (57.3%) is a significant risk factor in poultry slaughter and dressing at live bird markets in Accra.

The percentage of respondents who did not wash their hands after touching clothes, money and offal were

also high. Only 38.2% of the respondents used anti-bacterial soap to wash their hands. Items such as money and clothes can serve as vectors for transmission of pathogens to the hands and eventually be transferred to meat during processing.

Regarding the use of antibacterial soap for hand washing, Toshima et al. (34) stipulated that antimicrobial soaps were more efficient than other soaps in reducing total coliforms on the hands. A convincing majority (94.4%) of the respondents reported washing hands after using the toilet, a practice that was also common in reports of similar studies in different countries such as Romania, Iran and Malaysia (19, 31). Half of the respondents reported always washing contact surfaces with soap and water before processing. Such a high percentage (50%) of non-compliance to a basic hygiene practice highlights the need for training on food safety for poultry processors. Observations made at the markets were even more discouraging, as most of the processing sites visited had no pest control mechanisms as evidenced by numerous flies, which are important vectors for transmission of disease-causing organisms. In addition, only 46.8% reported using disposable tissues when sneezing or coughing, followed by immediate washing of hands. This practice has been implicated as a significant mode of pathogen transmission to food (27).

TABLE 4. Food safety practices of live bird processors in selected market in Accra-Ghana

Questions	Good practices N (%)	Mean score \pm SD
Do you always wash your hands before slaughter and dressing of chicken?	66 (57.3)	1.07 ± 1.00
During chicken processing, which of the following do you wash your hands after touching?		
1. Clothes	5 (4)	0.08 ± 0.40
2. Money	57 (46)	0.47 ± 0.85
3. Offal	29 (23.3)	0.92 ± 1.00
4. After visiting toilet	117 (94.4)	1.89 ± 0.46
Do you always wash your hands with anti-bacterial soap?	47 (38.2)	0.76 ± 0.98
Do you always wash contact surfaces with soap and water before processing?	62 (50)	1.00 ± 1.00
Do you process chicken when sick?	12 (9.1)	0.19 ± 0.59
Do you use disposable tissues when coughing or sneezing and immediately dispose them and wash hands?	58 (46.8)	0.94 ± 1.00
Total	*3 (2.4)	9.24 ± 4.40 (33%)

The total maximum score for food safety practices is 28, where N is the number of respondents who process chicken (124).

*Total number of respondents who scored $\geq 70\%$ of the total food safety practices score.

Predictors of knowledge, attitudes and practices of live poultry traders

A test of association between the demographic characteristics of the respondents and their level of food safety knowledge revealed that one could not predict a respondent's level of knowledge by his or her characteristics, as has been shown to be the case in similar studies (1, 3, 27, 28). Table 5 summarizes the results of a chi-square test to determine the association between sex, age, education, length of service and affiliation to a cooperative, and a respondent's level of food safety knowledge, attitudes and practices. It was interesting that not even the level of formal education had a significant association with the outcome of a respondent's food safety knowledge, as was the case in similar studies (3, 5, 6). It was even more curious to find that the majority of the traders who belonged to an association or cooperative had poor food safety knowledge. There are several poultry associations in Ghana categorized as localized live bird traders associations, regional poultry associations and national poultry associations. These associations, which are made up of poultry farmers, poultry feed producers, processors, retailers and other input suppliers, work closely with the relevant government ministries and benefit from training programs organized internally by the associations themselves or by Non-Governmental Organizations (NGOs) and government agencies. During these training programs, members are introduced to new and efficient methods in the poultry business with regard to feed formulation, disease prevention and other control measures. Members are also educated on food safety practices during poultry processing. Further probing in this study revealed that some of these associations were inactive, and therefore there are few avenues for training on safe handling practices.

The respondents' food safety attitudes had a significant association with their level of education (P -value = 0.031), as presented in Table 5. This is an encouraging observation, as positive attitudes toward food safety and level of formal education share a strong link in maintaining safe food handling practices (19). A significant association was also noted between the outcome of respondents' food safety attitude and age (P -value = 0.048). The older the respondents, the higher the chance of having positive attitudes toward food safety. The strength of this association was, however, very weak (Φ = 0.215).

A respondent's sex as well as affiliation with an association was found to be significantly associated with implementation of good practices (P -value = 0.019) and (P -value = 0.023), respectively (Table 5). It is, however, important to note that, since the poultry traders and processors were predominantly male, this association cannot be relied on with certainty. Belonging to an association may, however, make an individual more readily compliant with rules, which may explain the relatively high level of implementation of poultry-related safety practices evident in this group. Level of formal education had

no significant association with good food safety practices, which is likely due to the fact that information on processing operations carried out by these processors are predominantly obtained from training during apprenticeship, work experience and media information. Over time, these conventions likely shape their subjective knowledge of what good food safety practices entail.

A summary of the association among the respondent's food safety knowledge, attitude and practices is presented in Table 6. No significant associations were found between food safety knowledge and practice, practice and attitude, or knowledge and attitude. This was evident in the fact that positive attitudes did not translate into implementation of food safety practices. For example, only 9.1% of the processors reported not processing chicken when sick, although over 84% showed a positive attitude toward preventing this practice (Table 5). No significant association was found between a respondent's marital status and sufficient food safety knowledge, practices and positive attitudes towards food safety, as was the case in similar studies (4, 27).

Poultry processing operations of live bird traders

The food safety practices of the live bird traders were self-reported; for this reason, the likelihood of good food safety practices being exaggerated was substantial, as has been the case in similar studies (17, 26). It was for this reason that a simple field observation of poultry processing procedures was carried out at the various markets visited. The summary of the various processing operations observed in the live bird markets assessed, as compared with standard operating procedures, is represented in Fig. 1. The left end of the figure (A) is the condensed standard process flow diagram, with the critical control points highlighted in grey (7). The first two critical control points in poultry processing are the scalding and defeathering steps. The water used for scalding of slaughtered birds has high microbial counts because of the high organic matter content (22). The standard for scalding is 750 ml of water per bird (18). The temperature of the water used for scalding must also be documented. Most of the processors interviewed reported changing the scalding water no more than twice a day. The same water was used for all the carcasses throughout the processing period in the day. With such high microbial loads, the possibility of carcass contamination during processing is high.

The next critical control point is the washing or carcass shower stage. This step, if properly done, has been found to reduce the microbial loads on the carcass (7). The water used by some of these processors was inadequate because of rationing of the limited water quantities for the day's operations (field observation). The carcass shower stage is followed by the evisceration stage, which is a critical control point because of the high risk of carcass contamination with pathogenic bacteria in the event of gut rupture (26). As part of the codes of conduct proposed by the New Zealand Food

TABLE 5. Association between respondent demographics and their level of food safety knowledge, attitudes and practices

Characteristics	Number of respondents N (%)						
		Knowledge		Attitudes		Practices	
		Poor Score	Good score	Poor Score	Good score	Poor Score	Good score
Sex	Male	86 (78.2)	24 (21.8)	22 (20)	88 (80)	109 (99.1)	1 (0.9)
	Female	15 (68.2)	7 (31.8)	4 (18.2)	18 (81.8)	20 (90.9)	2 (9.1)
	P-value	0.312		0.845		0.019*	
	Phi & Cramer's V	0.088		0.017		0.205	
Age	19–35	56 (75.7)	18 (24.3)	9 (12.2)	65 (87.8)	71 (95.9)	3 (4.1)
	36–50	28 (70)	12 (30)	12 (30)	28 (70)	40 (100)	0 (0)
	> 50	17 (94.4)	1 (5.6)	5 (27.8)	13 (72.2)	18 (100)	0 (0)
	P-value	0.123		0.048*		0.300	
	Phi & Cramer's V	0.178		0.215		0.135	
Education	None	32 (84.2)	6 (15.8)	14 (36.8)	24 (63.2)	38 (100)	0 (0)
	Primary	23 (85.2)	4 (14.8)	3 (11.1)	24 (88.9)	26 (96)	1 (3.7)
	JHS	19 (65.5)	10 (34.5)	4 (13.8)	25 (86.2)	27 (93.1)	2 (6.9)
	SHS	25 (75.8)	8 (24.2)	5 (15.2)	28 (84.8)	33 (100)	0 (0)
	Tertiary	2 (40)	3 (60.0)	0 (0)	5 (100)	5 (100)	0 (0)
	P-value	0.09		0.031*		0.308	
	Phi & Cramer's V	0.247		0.280		0.191	
Length of service (years)	< 5	31 (79.5)	8 (20.5)	6 (15.4)	33 (84.6)	36 (92.3)	3 (7.7)
	6–10	26 (78.8)	7 (21.2)	5 (15.2)	28 (84.8)	33 (100)	0 (0)
	11–20	20 (69)	31 (9)	6 (20.7)	23 (79.3)	29 (100)	0 (0)
	> 20	24 (77.4)	7 (22.6)	9 (29)	22 (71)	31 (100)	0 (0)
	P-value	0.748		0.455		0.062	
	Phi & Cramer's V	0.096		0.141		0.235	
Association	Yes	82 (75.2)	27 (24.8)	20 (18.3)	89 (81.7)	108 (99.1)	1 (0.9)
	No	19 (82.6)	4 (17.4)	6 (26.1)	17 (73.9)	21 (91.3)	2 (8.7)
	P-value	0.448		0.396		0.023*	
	Phi & Cramer's V	0.066		0.074		0.198	
Total		101 (76.5)	31 (23.5)	26 (19.7)	106 (80.3)	121 (97.6)	3 (2.4)

*Significant at $\alpha < 0.05$. Poor score is < 70% of maximum score. Good score is $\geq 70\%$ of maximum score.

Safety Authority, poultry must be eviscerated within an hour of being slaughtered (25). The practice of slaughtering and defeathering birds and keeping the carcasses in open wooden baskets for about 2–3 hours awaiting evisceration was observed among some of the poultry processors surveyed. A majority of them did not follow the evisceration step with the washing step. This is a risk factor, as an incidence of fecal

contamination of the carcass during evisceration accidents is likely to cause bacteria to spread and proliferate during waiting periods and during transportation by clients under ambient conditions. Most of the carcass cutting procedures practiced in the markets visited was with knives that were reportedly washed only at the close of the day. Also, the tables on which the carcasses are dressed were mostly

TABLE 6. Associations among food safety knowledge, attitudes and practices

Level	Pearson Chi square	Sig ¹
Knowledge vs. Practice	0.166 ^a	0.684
Knowledge vs. Attitudes	2.571 ^a	0.109
Attitude vs. Practice	0.753 ^a	0.386

¹Values in the same column with different superscript letters represent statistical significance at $\alpha < 0.05$.

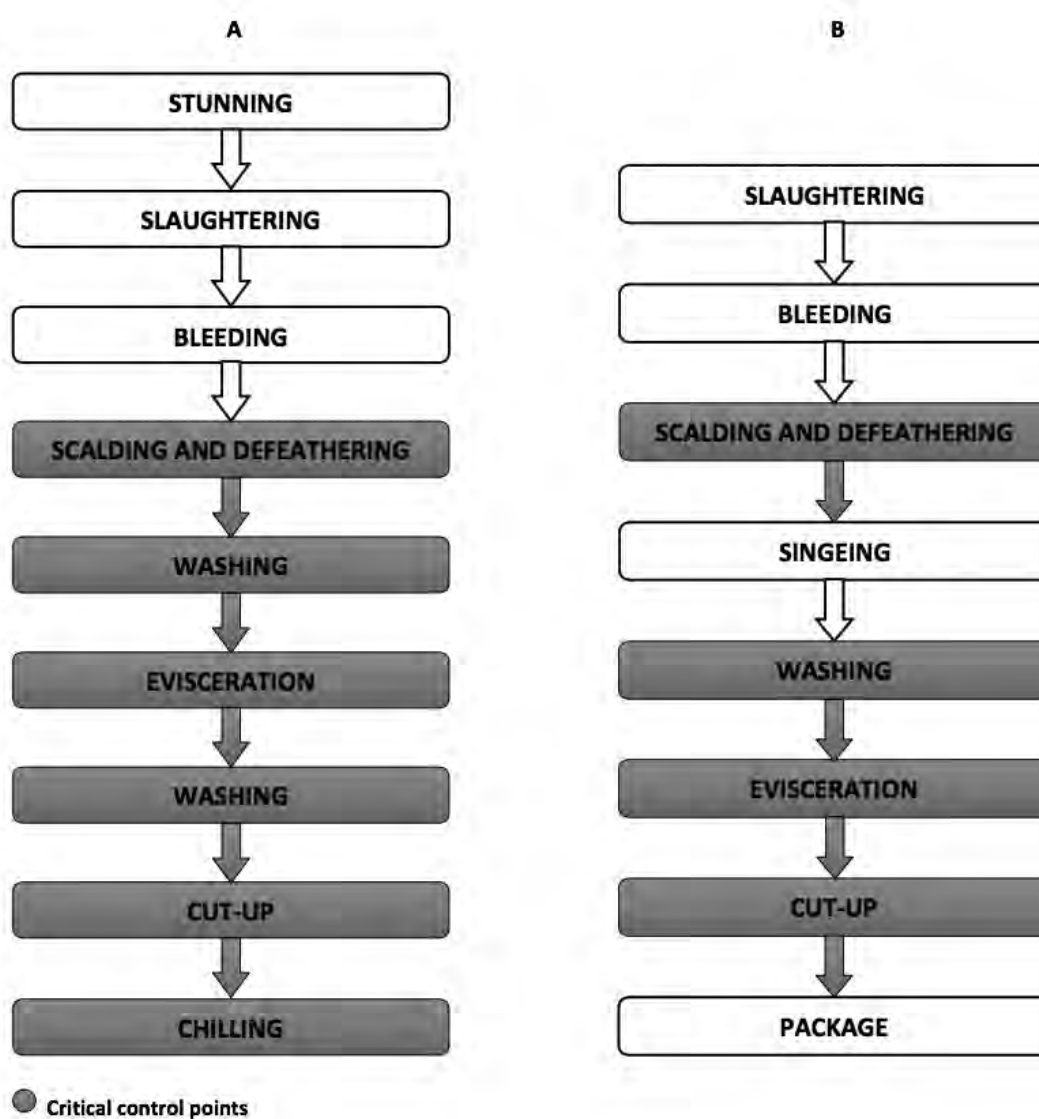


Figure 1. Flow diagram of standard poultry processing operations (A, adopted from (10)) compared to a summary of field observations of raw chicken processing operations in Accra, Ghana (B).

covered with pieces of chicken meat and were not washed by a majority of the processors surveyed after every batch process, a practice that further increases the risk of carcass contamination. The chilling step, which is primarily carried out to reduce the temperature of the carcass and slow the growth of harmful bacteria, was completely omitted by the processors surveyed (7). This critical omission was troubling, as it allows for rapid proliferation of mesophilic bacteria, some of which are zoonotic.

In summary, this study revealed the significant gaps in respondents' food safety knowledge, attitudes and practices. The areas of most concern were the handling practices during primary processing operations that could lead to cross-contamination, such as poor hand washing, failure to wash contact surfaces after every batch process, and failure to withdraw feed prior to slaughter. The total disregard for chilling of poultry carcass after dressing was also a cause of great concern.

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