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EXAMINING FOOD SAFETY KNOWLEDGE AND THE MICROBIOLOGICAL QUALITY OF SCHOOL MEALS IN GHANA

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Abstract

Food safety studies have received much empirical investigation; however, limited studies regarding food safety and the microbiological quality of meals in boarding senior high schools exist. This study examined the food safety knowledge, the microbiological quality of school meals, as well as the barriers to food safety practices among food handlers in boarding senior high schools (SHS) in the Volta Region of Ghana. A cross-sectional research design was adopted for the study, using questionnaires to collect data from 97 food handlers in five boarding senior high schools in Volta Region, Ghana. A total of sixty samples of four cooked foods were collected and subjected to laboratory analysis. Descriptive statistics and Chi-square test were used to analyze the data. Results of the study revealed that respondents had good food safety knowledge. The laboratory results revealed the presence of rod and cocci shaped bacteria, where some of these isolates were identified as *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas spp.*, and *Bacillus cereus* which are possible pathogens. The barriers to food safety practices revealed inadequate provision of equipment and irregular water supply. Findings of this study have implication for stakeholders involved in the management of SHS. Administrators of SHSs must design and implement food hygiene training and sanitation programmes for food handlers in schools. Also, more stringent supervision during food preparation processes is recommended.

Key words: Barriers, senior high school, food safety knowledge, food samples, pathogens

INTRODUCTION

Food is an important basic necessity in the human development process, as its procurement, preparation, and consumption are vital for the sustenance of life (Daniyan & Nwokwu, 2011). Undoubtedly, food has a direct impact on health (Daniyan & Nwokwu, 2011) and is, therefore, appropriate to avoid contamination from possible sources. Food handlers in hospitality operations play a major role in promoting and preventing food contamination (WHO, 1989 cited in Omemu & Aderoju, 2008). Consistently, they carry foodborne pathogens in their hands, cuts or sores, mouth, skin, and hair (Adams & Moss, 2008) and gradually transfer them onto foods

during preparation because they neglect and take for granted certain basic rules of safe hygiene practices, which eventually leads to outbreaks of foodborne illnesses. Food handlers are also asymptomatic carriers of food poisoning organisms (Walker, Pritchard, & Forsythe, 2003) and may present a real hazard during food preparation processes.

Foodborne illness constitutes a major public health and economic problem in almost all parts of the world (Martins, Hogg, & Otero, 2012). For example, reports from the United States of America (USA) indicate that an estimated figure of 48 million foodborne illnesses is recorded annually, out of which 128,000 result in hospitalizations and 3,000 result in the death of

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victims (CDC, 2011). Similarly, foodborne illnesses are common in Ghana, with 420,000 cases reported per year and an annual death rate of 65,000 costing US\$ 69 million to the Ghanaian economy (Mahami & Odonkor, 2012). As an ongoing phenomenon, incidents of foodborne illness are still reported, with the foodservice industry consistently implicated in several outbreaks (Lues & Van Tonder, 2007; Velusamy, Arshak, Korostynska, Oliwa, & Adley, 2010). For instance, data published by the European Food Safety Authority (EFSA, 2010) revealed that 48.7% of verified foodborne outbreaks were associated with catering services. Comparably, data from Ireland indicated that approximately 50% of all foodborne illnesses were traced to the food eaten in catering establishments (WHO, 2000).

Failure to observe satisfactory standards in the preparation, processing, cooking, storing, or retailing of food (Tomohide, 2010), obtaining food from unsafe sources, inadequate cooking, improper holding temperatures, and the use of contaminated equipment (Bean & Griffin, 1990) were the factors identified to be responsible for these frequent outbreaks. In addition, barriers to food safety practices were also reported as playing significant roles in obstructing safe food practices among food handlers in foodservice operations (Ackah, Gyamfi, Anim, Osei, Hansen, & Agyeman, 2011; Green & Selman, 2005; Hertzman & Barrash, 2007). Apart from these factors, specific mention has been made of the poor food safety knowledge and practices of food handlers (Howes, McEwen, Griffiths, & Harris, 1996; WHO, 2000) particularly in both the commercial and institutional sectors of the hospitality and tourism industry (Adams & Moss, 2008; EFSA, 2009; WHO, 2002).

Institutional catering services provide meals to their customers either as part of a service to the community or as a complementary service to the main

product on offer (Marzano, 2010). These include police and military catering, schools and hospitals catering, nursing homes, prisons, daycare centres, and institutions for the aged. One major characteristic of this sector is the fact that it is non-profit oriented, usually operating within an allocated budget. Depending on the policy of the institutional operation, the budget allocated may usually span over a quarterly, termly, or an academic year period, as in the case of boarding senior high schools. Ghanaian senior high schools are either owned privately or publicly by individuals, corporate organizations, and the government. Unlike privately owned senior high schools, public senior high schools, apart from students' fees, mostly receive government subventions (feeding grant) as a subsidy to the cost of providing some basic needs, including school meals. Providing school meals to students is an important educational function and represents one of the most perceptible instruments for policy intervention in the development of healthy eating patterns for students (Moy, Gan, & Siti Zaleha, 2006; Yabancı & Sanlier, 2007).

Akin to other human institutions, food safety is fundamental to school catering due to the higher number of meals served to a larger number of students on daily basis and the fact that any outbreak can affect a higher number of students (Osaili, Abu Jamous, Obeidat, Bawadi, Tayyem, & Subih, 2013). According to Fisher et al. (2003), schools are the only institutions that can reach nearly all youth and are in a unique position to improve both their education and health status throughout the nation. As a result, schools, amongst other major institutions, occupy a sizable portion of governments' budget particularly in the developed world (Winson, 2008). But as one of many types of foodservice operations, school catering is mostly identified as a platform for facilitating the frequent



occurrence of foodborne illnesses (Sanlier & Konaklioglu, 2012; Seaman, 2010).

In Ghana, this assertion is confirmed, as 77% of all traceable foodborne illnesses in the country are directly linked to schools. (Alale, 2013). Evidently, there have been a number of media reports regarding outbreaks of foodborne illnesses in schools across the country. Accounting for this prevalence is the poor food preparation and storage practices, together with poor personal hygiene and the lack of knowledge in food safety practices inherent with food handlers' notably in boarding schools (Oranusi, Galadima, Umoh, & Nwanze, 2007). Apart from the immediate gastrointestinal symptoms such as nausea, vomiting, stomach pains, abdominal cramps, diarrhoea, affected students may experience long-term health effects such as kidney failure, and disorders of the brain and nervous system (Mossel & Struijk, 1995). This notwithstanding, it appears food researchers in Ghana have devoted less attention to the sporadic cases of foodborne disease outbreaks in schools and focused more on the commercial sector of the food industry, with specific highlights on street foods and vendors (Ababio & Lovatt, 2015). Thus, data on the food safety knowledge and practices of food handlers as well as the microbial quality of meals particularly those in the boarding senior high schools have not been adequately investigated creating a dearth of knowledge in literature. This study, therefore, seeks to investigate the food safety knowledge of food handlers, the barriers to food safety practices, and the microbial quality of school meals in boarding senior high schools in Ghana. The results will provide evaluative feedback to policymakers, administrators, and management of boarding senior high schools.

LITERATURE REVIEW

Food Safety in Schools

Worldwide, there is a growing interest in the quality of food supplied to consumers rather than how much food is produced. This interest has subsequently determined the level of food safety practised by concerned institutions, where food safety management systems (FSMS) such as HACCP and GHP are adopted. Generally, food safety is all about the safe handling of food throughout the food chain to avoid contamination which will eventually lead to foodborne illness. This mode of safe handling requires a conscious effort on the part of the food handler, bearing in mind the health of the consumer, as providing safe food is an important basic human right (WHO, 2000).

The present study focuses on school catering which ensures the preparation and provision of meals to students in schools either on a commercial or non-commercial basis. Food safety is fundamental to school catering due to the higher number of meals served to a larger number of students on a daily basis and the fact that any outbreak can affect a higher number of students (Osaili, Jamous, Obeidat, Bawadi, Tayyem, & Subih, 2013). School catering plays major functions within the schools' setting, namely constituting a part of the curriculum in comprehensive school education as well as an integral part of students' welfare (Tikkanen & Urho, 2009), forming one of the most perceptible instruments for policy intervention in the development of healthy eating patterns (Moy, Gan, & Siti Zaleha, 2006; Yabanci & Sanlier, 2007) for students, contributing to the physiological aspect of learning to eat properly and the cultural phenomenon of learning different varieties of foods (Pagliarini, Gabbiadini, & Ratti, 2005) and subsequently, a pivot of interest and a



cause of concern for parents, school officials, researchers as well as governments.

The boarding school setting represents a second home to students and stands out among all the institutional catering services due to communal feeding of a large number of students who equally require great care in terms of food safety (Ababio & Lovatt, 2015). School catering operations usually prepare large quantities of different types of food within the same food preparation area. Due to the large numbers catered for at a time, the food preparation process employs many hands, which possibly creates a risk environment for microbial contamination, thereby increasing the chances of food contamination due to improper handling (Annor & Baiden, 2011) among other factors. Hygienic food preparation and the education of those involved in storage, preparation, processing, and service of meals must be employed since they form crucial lines of defence in the prevention of most types of foodborne illness (Gibson, Rose, Haas, Gerba, & Rusin, 2002) during this period of nurturing in schools. Quite unfortunate, schools have been recognized as a platform for facilitating the occurrence of foodborne illnesses. Evidence from Malaysia (Ministry of Health, 2012), Portugal (WHO, 2003, 2004) and Ghana revealed that higher episodes of foodborne outbreaks were traced to schools (Alale, 2013). This makes the issue of food safety in schools a concern for all, most especially when outbreaks of foodborne illnesses have a significant impact in a school environment i.e., student absenteeism, insurance costs, attorney fees, and loss of revenues due to decreased participation of students in school meals.

The majority of school-related foodborne illness outbreaks are attributable to incorrect food safety knowledge and practices of food handlers at various stages of the food storage, preparation, or service process. Reports from a study conducted in Nigeria

indicated factors such as improperly washed utensils and equipment, poor hygiene, dirty environment, and the presence of animals in the cooking environment as contributing to the microbiological contamination of the foods served to students (Oranusi et al., 2007). Similar studies revealed poor hand washing (Hertzman & Barrash, 2007), lack of hair restraints (Giampaoli, Cluskey, & Sneed, 2002), lack of calibration of thermometers (Henroid & Sneed, 2004), improper reheating (Kim & Shanklin, 1999), inappropriate sanitizing of equipment, as well as consumption of food in food preparation areas (Giampaoli, Sneed, Cluskey, & Koenig, 2002) as factors contributing to food contamination in schools.

The Microbiological Quality of School Meals

Food safety and hygiene practices have a direct link with the microbiological quality of food, in that the type of food safety and hygiene practice violated determines the indicator organism to be present. The indicator organism contributes to the determination of the microbiological quality of food. According to Nik Rosmawati, Wan Manan, Noor Izani, and Nik Nurain (2014), common indicator organisms associated with food safety and hygiene practices include total plate counts (TPC), *total coliforms* (TC), *Escherichia coli* (*E. coli*), *Bacillus cereus* (*B. cereus*), *Staphylococcus aureus* (*S. aureus*), and *Salmonella spp.*

The Total Plate Count (TPC) analysis is a useful tool in monitoring food process and the results may reflect the hygienic level employed during food handling and storage (Collins, Lynes, & Grange, 1989) processes. The detection of coliforms in food is widely used as a means of measuring the effectiveness of sanitation programmes and their presence could indicate a substantially increased risk of the presence of pathogens (Lues & van Tonder, 2007). Improper handling and storage may increase the number of



coliforms in food or water. *E. coli*, on the other hand, is commonly used as a surrogate indicator, and its presence is thought to give a better indication of faecal contamination (De Wit & Rombouts, 1992) and poor personal hygiene practice of food handlers.

Much of the work done across the globe focused on the microbiological quality of foods, as a health risk is related to the potential of food to support microbiological growth. In Ghana, a study was conducted to investigate the microbial quality of street foods sold in Accra. Out of 511 menu items selected, 69.7% were contaminated with mesophilic bacteria. Salads, macaroni, fufu, *omo tuo* and red pepper had unacceptable levels of microbial contamination. Human pathogens, including *Salmonella arizonae*, *Shigella sonnei*, *Enterococcus faecalis*, and *Escherichia coli* were isolated from some food samples (Mensah, Yeboah-Manu, Owusu-Darko, & Ablordey, 2002). The authors concluded that street foods could be sources of enteropathogen and, therefore, vendors required education in hygiene training. Furthermore, a study was conducted to isolate pathogenic bacteria from some foods sold at selected private schools in Akoka area of Yaba, Lagos, Nigeria (Okolie, Omonigbehin, Badru, & Akande, 2012). The cooked foods selected for the microbial analysis included rice, beans, boiled beef, and spaghetti which were purchased from four randomly selected private primary schools within the study area. The results of the plate count indicated that the foods had high microbial counts, considering the recommended limit of bacterial count of less than 10^5 CFU/g (Rose & Osunnaiye, 2003). Monday, Francis, and Mohammad (2014) carried out a study to assess the microbiological quality of ready-to-eat foods (Rice and Moimoi) sold by food vendors in Federal Polytechnic Bali, Taraba State, Nigeria. The result obtained revealed a total bacterial count ranging from 1.0×10^2 to $8.7 \times$

10^4 cfu/g. Microorganisms isolated include *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella spp.*, *Salmonella spp.*, *Mucor spp.*, and *Aspergillus spp.* Undeniably, the major health hazard associated with school meals is microbial contamination, even though few might be caused by physical or chemical contamination (Esen & Owusu, 2013). The risk of microbial contamination is dependent on the type of food and the mode of its preparation. Foods that are cooked immediately before consumption are safer than those which have been cooked and stored at ambient temperature.

Model for the Study

The model for food safety knowledge, attitude, and HACCP practices by Ko (2013) was adapted for the study. Originally, the model posits that food safety knowledge acquired through a form of training translates into food safety attitude and practices. As well documented, training helps to improve overall employee food safety knowledge (Pirshaebe, Almasi & Rezaee, 2010; Afolaranmi, Hassas, Bello, Tagurum, Miner, Zoakah & Ogbonna, 2014) within the foodservice establishment. Although training may increase food safety knowledge, knowledge does not ultimately result in positive changes in food handling practices. More often, food handlers seem to think that they know how to handle food safely but their self-reported food handling behaviours do not support this confidence (Fawzi & Shama, 2009). Hence the existing gap between food safety knowledge and practice is partly attributed to the presence of food safety barriers emanating from either personal or institutional perspectives. The evidence of this gap is traced to the microbiological quality of meals subsequently prepared and served by these food handlers. For this study, the model was modified to include the barriers to food



safety practices which are expected to obstruct the practices of food safety knowledge, thereby influencing

the microbiological quality of meals provided to students.

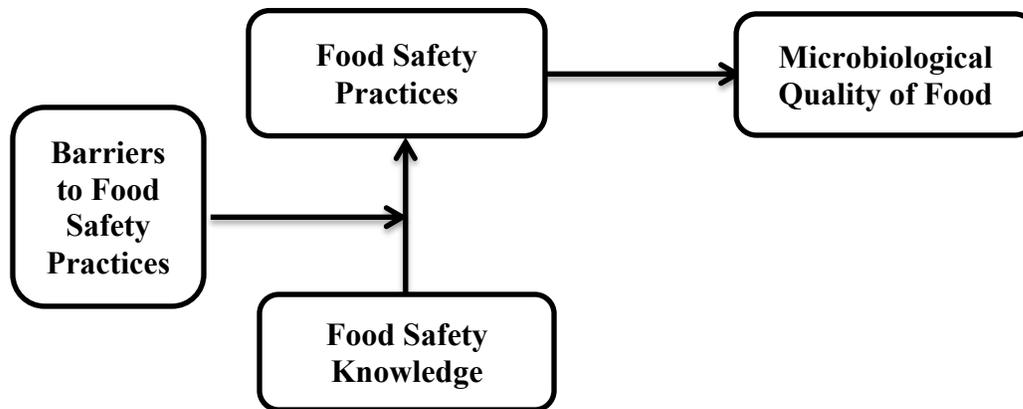


Figure 1: The Proposed Model for Food Safety Knowledge, Practices and the Microbiological Quality of Food

METHODOLOGY

A cross-sectional survey was conducted to examine the food safety knowledge, barriers to food safety practices, and the microbial quality of meals served in boarding senior high schools between March and April 2016. Based on data from the GES, only five (5) schools with a population of about three thousand, one hundred and forty two (3,142) were registered with them as having boarding facilities and were included in the study. Also due to the unavailability of data on the number of kitchen staff in the selected schools, a reconnaissance survey was undertaken and a total of 97 kitchen staff were identified and included in the study. A census which involved a complete enumeration of the elements of a population was employed for the study. Questionnaires were used in data collection, and these were pretested for clarity and validity on twenty (20) food handlers from five (5) randomly selected boarding senior high schools within the Cape Coast Metropolis.

The revised questionnaire, which contained forty-seven (47) open- and close-ended questions, was divided into four major modules. Module 1 assessed food handlers' knowledge on food safety and hygiene in

the areas of health and personal hygiene (10 questions), food hygiene (10 questions), and environmental hygiene (5 questions) using a 'True' or 'False' scale. Module II included ten (10) major barriers deduced from reviewed literature (Ackah, Gyamfi, Anim, Osei, Hansen & Agyeman, 2011; Green & Selman, 2005; Hertzman & Barrash, 2007), to which respondents were to tick as many as were applicable, resulting in their inability to practice food safety. Module III constituted the demographic characteristics of food handlers. Descriptive analysis and Chi-square test (χ^2) set at a <0.05 significance level was used to analyze the data.

A total of sixty (60) food samples which included Banku, Boiled Rice, Waakye, and Beans were collected from the selected schools, using serving utensil from the schools' kitchen. The use of the serving utensils from the schools' kitchen was to avert any possible source of external contamination. The food samples were then carefully placed into sterile specimen containers and immediately transferred into cooled packs under aseptic condition. These were subsequently transported to a laboratory at the University of Health



and Allied Sciences within an hour for microbiological analysis.

The samples were subjected to microbial analysis for the determination of their microbial loads. Food samples were further inoculated in the McConkey agar and Nutrient agar media as base media before isolation. The isolation of the organisms was done after 24 hours of incubation at 37°C. Isolates were randomly picked using a sterile wire loop and re-inoculated on fresh sterile McConkey agar and Nutrient agar plate which were incubated for 24 hours at 37°C. This was to help achieve purity. Suspected isolates were picked and identified on the bases of colonial morphological and biochemical characteristics (Sneath et al., 1986).

RESULTS

Profile of Respondents

Females comprised 79.4% of the sample surveyed and males constituted only 20.6%. Their ages ranged from 23 to 58 years, with a mean age of 42.2 years. Respondents aged between 35 to 44 years were 39.1% whilst 12.4% were younger than 25 years. More than half (74.2%) of the respondents had their level of education up to the basic level and, therefore, their source of knowledge on food preparation showed only 13% of them acquiring this knowledge through formal training. Respondents who were married constituted 69.1%, those employed as cooks (76.2%), and those who had been working for more than five years constituted 66% of the sample. Interestingly, 96.9% of

the respondents had undertaken their annual medical examination at the time of study and had certificates to that effect.

Food Safety Knowledge

Results on the areas of food safety knowledge tested are presented in Table 1. Respondents displayed the highest level of knowledge in the areas of environmental hygiene (96%), followed by health and personal hygiene (75.5%). They however had the least knowledge on food hygiene (48.8%). More specifically, respondents were knowledgeable in keeping domestic animals and dust bins away from food preparation areas respectively. They were also well aware of the fact that food preparation should be carried out in designated areas under hygienic conditions. Higher levels of knowledge were also recorded in health and personal hygiene, where respondents knew the importance of washing hands in between food preparation processes (92.8%), abstaining from food preparation when suffering from cold or cough (91.8%), and also avoiding food preparation without using hair restraints (84.5%). However, regarding food hygiene, respondents were not knowledgeable in the right source of procuring wholesome meat (46.4%), the correct storage of raw meat in a refrigerator (23.7%), and the importance of sanitizing work surfaces after cleaning (23.7%). In addition, knowledge on the correct method of thawing frozen foods (15.5%) as well as the correct temperature of a refrigerator (6.2%) was not encouraging.

**Table 1: Food Safety Knowledge of Respondents**

Food Safety Aspects	Frequency (N = 97)	Percentage %
<i>Health and Personal Hygiene</i>		
Wearing short fingernails during food preparation is necessary	92	94.8
It is necessary to wash hands in between food preparation processes	90	92.8
A chief cook suffering from cold or cough cannot be allowed to prepare food	89	91.8
Safe hands are those washed with water and soap	83	85.6
A chief cook should only be permitted to prepare food using hair restraints	82	84.5
A matron should not be permitted to wear jewelleries while preparing food	72	74.2
A chief cook should not be allowed to taste food using the fingers	70	72.2
It is safer to use a kitchen napkin to dry hands than to use a clean serviette	55	56.7
It is necessary to wear hand gloves when serving cooked food	54	55.7
It is unhygienic to handle cooked food with an injured finger	44	45.4
Overall Percentage for food safety aspects	75	75.5
<i>Environmental Hygiene</i>		
It is not safe to keep domestic in food preparation areas	94	96.9
It is not hygienic to keep a dust bin in the food preparation area to keep waste	97	100
It is safer to begin food preparation only after cleaning the environment	95	97.9
The presence of flies and dust in food preparation areas is harmful	97	100
It is important to carry out food preparation in an enclosed environment	97	100
Overall Percentage for environmental hygiene	96	96.0
<i>Food Hygiene</i>		
Cleaning work surfaces in between uses is necessary	85	87.6
Using a clean knife to clean fish and cut vegetables is not hygienic	84	86.6
Using separate utensils to handle raw and cooked food is important	84	86.6
Washing green leafy vegetables under cool running water is hygienic	56	57.7
It is unsafe to refrigerate leftover soup without reheating	53	54.6
It is unsafe to purchase meat from the open market	45	46.4
Sanitizing work surface after cleaning is necessary	23	23.7
Storage of raw meat at the top part of a fridge is unsafe	23	23.7
Thawing frozen poultry on the kitchen counter is unhygienic	15	15.5
The correct temperature for a refrigerator is < 1°C	6	6.2
Overall Percentage for food hygiene	47	48.8

Source: Survey Data (2016)

Food Safety Knowledge and Respondents' Profile

Generally, this study found that the extent of food safety and hygiene knowledge of respondents ranged between "high", "moderate," and "low," where more than half (58.8%) of the respondents possessed high knowledge. Further, it was observed that there were relationships

regarding respondents' demographics, including age, marital status, educational level, and gender (Table 2), using the Chi-square test of significance. The latter, however, appeared to show a significant relationship, where females displayed higher knowledge on food safety ($P < 0.05$).

**Table 2: Food Safety Knowledge based on Respondents' Profile**

Profile	Levels of food safety knowledge			χ^2 (p-value)
	Low	Medium	High	
Gender				
Male	0.0	36.4	14.0	8.326 (0.016*)
Female	100.0	63.6	86.0	
Educational Status				
Formal education	85.7	90.9	80.7	1.674 (0.433)
No Formal Education	14.3	9.1	19.3	
Marital Status				
Unmarried	28.6	24.2	35.1	1.170 (0.557)
Married	71.4	75.8	64.9	
Age				
< 25	0.0	15.2	12.3	4.579 (0.599)
25-34	28.6	15.2	15.8	
35-44	14.3	42.4	40.4	
45 and above	57.1	27.3	31.6	
Source of Knowledge on Food Preparation				
Observation	85.7	87.9	86.0	0.071 (0.965)
Formal Training	14.3	12.1	14.0	
Work Experience				
< 5 years	42.9	27.3	36.1	0.910 (0.635)
5 years and above	57.1	72.7	64.9	
School				
Vavie SHS	14.2	9.1	3.5	3.924 (0.864)
Tang SHS	0.0	3.0	7.0	
Lasa SHS	28.6	21.2	17.5	
Akowu SHS	28.6	24.2	24.6	
Lima SHS	28.6	42.5	47.4	

Source: Survey Data (2016)



Microbial Quality of School Meals

Figure 2 depicts the overall levels of microbial contamination in relation to the Aerobic Colony Count (ACC) microbial parameter. As shown in Figure 2, the majority (41.7%) of the food samples were of unacceptable quality whilst 35% of them were of acceptable quality, and less than one-third (23.3%) were of tolerable quality.

Individual levels of microbial load for the food samples were analyzed and the aerobic Colony Count result showed that beans (6.9×10^4 CFU/ml) contains the highest level of microbial load, followed by waakye (4.9×10^4 CFU/ml), rice (3.5×10^4 CFU/ml) and banku (2.4×10^4 CFU/ml). Comparing these results to the recommended limit of bacterial count by the international standards for microorganisms in foods (Rose & Osunnaiye, 2003)—acceptable ($0-10^3$), tolerable (10^4-10^5), and unacceptable ($\geq 10^6$) levels—laboratory analysis revealed higher levels of microbial contamination in the food samples analyzed. Further biochemical tests performed on the Gram-positive isolates revealed that, out of the seven Gram-positive isolates, four were *S. aureus* and three were *B. cereus*. In addition, the result revealed that,

among the Gram-negative isolates, seven of the nine were *E. coli* while the rest are *Pseudomonas spp.* Clearly, this result exposes the possibility of cooked foods being contaminated with pathogenic bacteria.

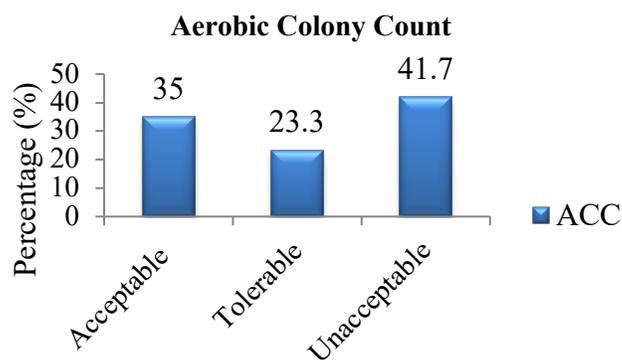


Figure 2: Overall Levels of Microbial Contamination in Food Samples

Barriers to Food Safety Practices

Results of the barriers to food safety practices are presented in Table 3. The inadequate provision of equipment and resources (96.9%), irregular water supply (94.8%), inadequate space and the unenclosed nature of the kitchen (92.8%), as well as busy work schedule (91.8%), were flagged as major barriers obstructing food safety practices among respondents in

Table 3: Barriers to Food Safety Practices

Barriers to Food Safety Practices	Frequency (N = 610)	Percentage in acceptance %
Inadequate provision of equipment and resources	94	96.9
Irregular water supply	92	94.8
Inadequate space and the unenclosed nature of the kitchen	90	92.8
Busy work schedules	89	91.8
Lack of funds	84	86.4
Lack of training and education on food safety practices	72	74.2

Source: Survey Data (2016)



the schools surveyed. Also mentioned were the lack of funds (86%) and lack of training and education on food safety practices (74.2%).

DISCUSSION

From this study, it is evident that most of the respondents had good knowledge of the need to practice personal hygiene during food preparation processes, such as washing of hands before commencing food preparation and in between food preparation processes. This corroborates the findings of Walker et al. (2003), where the respondents surveyed were able to correctly identify aspects of good personal hygiene practice. However, it is noted that respondents in this study were not knowledgeable in the use of hand gloves when handling cooked foods. It is important to indicate that the absence of hand gloves during food preparation can result in inoculating food items with infected excreta, respiratory drippings, pus, or other infectious discharges (Kaferstein, 2003). Thus, it is desirable that the use of hand gloves which serve as a barrier between bare hand contact and cooked foods during food preparation and service (Green & Selman, 2005) be encouraged among food handlers.

Food hygiene, like other forms of hygiene, plays a significant role in ensuring the safety of food during its preparation and service processes where cross-contamination and time-temperature abuse have greatly been implicated in several food poisoning incidents. Respondents in this study were unable to determine the correct method of thawing frozen foods. Similarly, Osaili et al. (2013) reported very low knowledge among their respondents in this regard. As a best practice, frozen foods should never be defrosted on the counter or in hot water, as bacteria multiply rapidly between 40 and 140°F (4-60°C), but rather in the refrigerator, in cold water, and the microwave.

The existing gap between food safety knowledge and practice remains critical to the success of any foodservice industry. Understanding which barriers are currently obstructing food safety practices among food handlers particularly in schools will influence the implementation of focused training programmes. In this study, the major barriers responsible for compromising food safety were inadequate provision of equipment and resources, irregular water supply, as well as inadequate space and the unenclosed nature of the kitchen. Consequently, the microbial analysis of school meals showed the presence of some pathogenic organisms. It is important to indicate that pathogenic organisms release toxins which are the agents responsible for illnesses such as diarrhoea, dysentery, nausea, and vomiting which are caused by these organisms upon consumption of the contaminated foods. Consuming them in small quantities is enough to cause illness since they can grow quickly into dangerous hordes under favourable conditions. However, the acidic nature of the stomach and the body's natural defensive mechanisms are often able to deal with food which is not too heavily contaminated and so it is sometimes possible to eat food contaminated with pathogenic bacteria without becoming ill.

CONCLUSION AND RECOMMENDATIONS

This study which examined the food safety knowledge, microbial quality of school meals, and the barriers to safe food practices among food handlers in boarding senior high schools in Ghana concludes that a gap still remains between the knowledge and practices of food safety. It further concludes that pathogenic bacteria can exist in cooked foods, even though they may physically appear to be quite wholesome. Based on the findings from this study, it is recommended that food safety training of food handlers in boarding senior high



schools in Ghana be given serious attention to improving the food safety practices in schools, thereby reducing microbial levels of contamination in school meals. Also, closer and more stringent supervision during food preparation processes in boarding senior high schools should be carried out by the relevant authorities, together with the school authorities to prevent a possible outbreak of foodborne illnesses in the future. Additionally, routine microbial analysis of cooked foods served to students should be carried out at regular intervals, so as to be informed of their microbial quality, thereby adopting measures that will help reduce health risks along feeding in boarding senior high schools. Finally, policymakers, including government, are advised to give utmost attention to the institutional foodservice industry, particularly boarding schools, by providing adequate funds, equipment, and resources necessary to improve upon their food safety practices, thereby overcoming the barriers identified in the study.

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