

Topic: Review of Microbial Food Contamination and Food Hygiene in Selected Capital Cities in Ghana

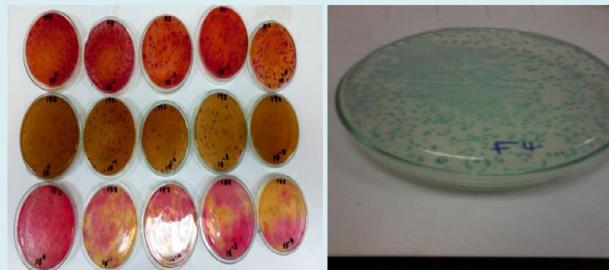


Served Banku



Served Waakye

Served Fufu



Bacterial colonies

## FOOD SCIENCE & TECHNOLOGY | RESEARCH ARTICLE

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## FOOD SCIENCE & TECHNOLOGY | RESEARCH ARTICLE

# Review of microbial food contamination and food hygiene in selected capital cities of Ghana

Enoch Yeleeire<sup>1\*</sup>, Samuel Jerry Cobbina<sup>1</sup> and Zarouk Imoro Abubakari<sup>1</sup>

**Abstract:** Food poisoning is a nationwide challenge that arises from both formal and informal sector in the food industry. This review presents a general overview of microbial food safety and hygiene in Ghana. Information available shows that most microbial food researches were highly concentrated on the regional capitals of Ghana with particular emphasis on the capital cities. Commercial food operations, specifically street foods have received the most concern. However, there was limited information from institutional catering and other forms of food hazards. Based on the review, the most predominant bacteria isolated in Ghanaian foods were *Enterobacter* spp., *Escherichia* spp., *Staphylococcus* spp. and *Pseudomonas* spp. which were found to be present in 20, 16, 12 and 11%, respectively. The most contaminated food samples were soup, stew, “fufu”, macaroni, salad, and “waakye”. Most of the research articles did not present clearly, whether the bacteria isolated were above set standards from the World Health Organisation and Ghana Standard Authority and also did not give directions for future research. Hence, a concerted effort in research on food safety is needed in Ghana to prevent the incidence of food-borne diseases particularly the preventable ones.

**Subjects:** Environment & Agriculture; Environmental Studies & Management; Food Science & Technology

**Keywords:** microbial quality; food contamination; food quality; hygiene; Ghana

### ABOUT THE AUTHORS

Enoch Yeleeire has BSc in Renewable natural resources option in Environmental management from the University for Development Studies. Samuel Jerry Cobbina (Phd) is a Senior Lecturer. He has been the principal researcher in UNICEF funded studies on hand washing in basic schools and the CIDA-funded FARMER project on the Quality of water in dugouts both in northern Ghana.

Together, Enoch Yeleeire and Dr Cobbina have written four articles; three on microbial quality of food and one on water resources management in Ghana. These articles are all submitted to recognized journal awaiting publication.

The incidence of microbial food contamination is a common case Ghana. However, not much has been seen with regards to sustainable strategies to curb it. This research seeks to make available information for the general public to be guided as well as prompting government of Ghana to take serious initiative in curbing this menace.

### PUBLIC INTEREST STATEMENT

The incidence of food poisoning is a common case in many hospitals in Ghana. However, not much has been seen with regards to sustainable strategies to curb it. It seems that, for the general public and for that matter government of Ghana to take an issue serious, there must be wide publicity about it. Consequently this work sought to make available comprehensive information about the extent of food poisoning cases and the microbes involved. After analyzing published literature we report that, foods that one has to be cautious of at public eateries include soup, stew, fufu, macroni, salad and waakye. Also, information reviewed showed that, these foods were mostly contaminated with *Enterobacter* spp. (20%), *Esherichia* spp. (16%), *Staphylococcus* spp. (12%) and *Pseudomonas* spp. (11%) amongst other bacteria. By this work we advise that, caterers should practice proper food handling techniques and that the national campaign on hand washing should be sustained.

## 1. Introduction

In a report given by the Ministry of Food and Agriculture and World Bank in 2007, one out of every 40 persons in Ghana suffers from food borne illness annually with over 420,000 year round reported cases.

Out of this number, 65,000 persons die resulting in economic loss of about US \$ 6,900,000.00. Some of the foodborne pathogens that account for these foodborne diseases include *Staphylococcus aureus*, *Listeria*, *Salmonella*, *Bacillus* and *Escherichia coli* (Ababio, 2014). Also, Saba and Gonzalez-Zorn (2012) reported that the most predominant bacteria in Ghanaian foods were *Enterobacter* spp., *Citrobacter* spp., *Klebsiella* spp., and *Escherichia* spp. Saba and Gonzalez-Zorn (2012) asserted that studies on microbiological food safety are were on the decline and highly centered in the capital city of the country. Food and Agricultural Organisation (FAO) and World Health Organisation (WHO) 2005 regional report on food safety for Africa recorded microbiological hazards as the most eminent risk from street foods. Also, WHO 2005 reported the danger of high levels of some heavy metals and pesticide residues from raw materials, utensils or transport methods used.

The problem of food safety is not a preserve of developing countries alone. There are recorded numbers of significant food poison cases and cholera in developed countries regardless of their advancement in food chain monitoring systems (Scallan, Griffin, Angulo, Tauxe, & Hoekstra, 2011). The problem is persistent despite significant efforts made to reduce the incidence of certain disease-causing pathogens in foods through better farm practices and food regulations. In Ghana, food laws and regulations include the Food and Drugs Law, 1992 (PNDCL 305B), Animals (Control and Importation) Ordinance (Cap 247), Diseases of Animals Act, 1961 (Act 83), Food and Drugs (Amendment) Act, 1996 (Act 523), Tourist Board Decree 1973 (NRCD 224), Ghana Tourist Board (Amendment) Decree, 1977 (SMCD 80) and the Local Government Act, 1961 (Act 54); 1993 (Act 462) (Sefa-Dedeh, 2009). The hygiene principles currently in existence are not legally binding (Ghana Standard Authority, 2013) but are protocols which the industry is supposed to use to ensure food safety.

The Food and Drugs Authority (FDA) is the national regulatory body under the Ministry of Health with the responsibility of implementing food policies and ensuring the safety and wholesomeness of food for consumers. Ghana Standard Authority develops and promotes international and locally acceptable standards for the industry with the help of agencies including Ministry of Food and Agriculture, Ministry of Health, Ghana Tourist Authority and Environmental Protection Agency. The Ghanaian government has empowered Metropolitan and Districts Assemblies to actively control and monitor food vendors, who sell ready to eat foods.

The object of this work is to provide a review on microbial food safety and hygiene researches in Ghana. It is the hope of the researchers that this work will guide future researches and provide a comprehensive data base for policy makers.

## 2. Common Ghanaian street foods

A study by Hiamey, Amuquandoh, and Boison (2015) reported on the common foods patronized in a market in Takoradi and in Accra. The study revealed that the most popular street food among the people were rice with stew/bean sauce (23.5%), “banku” with stew/okro/pepper sauce (17.5%), “fufu”/“kokonte” with soup (14.4%), fried rice (1%), tuozaafi (0.7%), “akyeke” with tilapia (0.3%) and “Omo tuo” (0.3%). The level of fruit consumption was low as only 2.4% consumed fruits Nicolò’s (2012) study on pupils’ favourite street food for breakfast showed that, 13% liked porridge (“rice water” porridge, “tom brown” porridge made of toasted maize flour and “millet porridge”) served with sugar (or condensed milk). This was followed by tea (12.5%) frequently accompanied with bread (10%).

For lunch, the most popularly consumed dish was banku with tomato stew and dishes made with rice such as “waakye” and jollof rice (12%).

For dinner, the main dishes were “banku”, “fufu” and yam served with tomato stew. In the case of snacks: pastries are the favourite ones, followed by ice cream. Only very few consumed fruits (mostly cocoa, then orange, banana, and papaya). Soft drinks (16%) were the most consumed fluids, followed by juice (9%) and sachet water (7.5%).

### 3. Reported cases of food poisoning (Table 1)

#### 3.1. Food safety alert

Food safety is a main concern for many people as almost everyone for the past years has ever experienced food borne illness at least once (WHO, 2015). Most foods are prepared in open-air public spaces either itinerant or stationary, on foot or from mobile outlets, fixed outlets or removable outlets without enclosed space (Food & Agriculture Organization of the United Nations, 2016).

Over 625,000 food poisoning incidences are recorded annually in Ghana (Ministry of Food & Agriculture/World Bank [MoFA/World Bank], 2007) with over 297,104 people hospitalised annually (Food & Drugs Authority, 2008) representing 47.5% of total food poisoning cases reported. Death rate in Ghana due to food related illnesses stood up to about 90,692 deaths annually (Food & Drugs

**Table 1. Media report on food poisoning cases in Ghana from 2007 to date**

Media/Year	Case/Report	Institutions
Ghana Web (2017)	Jack and Jill biscuits suspected to be poisonous	Accra, Ghana
Myjoyonline (2016)	Ninety eight percentage off salad by street food vendors contain <i>E. coli</i>	Accra, Ghana
Citi FM (2014)	Fifteen students rushed to hospital over suspected case of food poisoning	North Ridge SHS
Adomonline (2014)	Two dead from food poisoning in Akropong in Eastern region	Akropong community
Modernghana.com (2014)	University of cape coast closed down food market as student dies from suspected food poisoning	University of Cape Coast
GNA (2014)	Twenty students hospitalized from suspected food poisoning	Awudome SHS in Ho-Volta Region
GNA (2013)	Forty SHS students rushed to hospital over suspected food poisoning after evening meal	Twifo Praso SHS – Central Region
Citifm (2013)	Over 40 students hospitalized over food Poisoning.	Adonten SHS in Eastern Region
Ghana Web (2012)	Fifteen farmers died in late 2010 from suspected pesticides food poisoning	Upper East Region-Ghana
Daily Guide, Ghana Web (2011)	Seventeen die of suspected food poisoning	Ghana
Annon (2010)	Outbreak of food poisoning at child naming ceremony Anyaa, Ghana. Fifty three guest felt ill	Ghana
Joy News (2010)	Over 100 girls hospitalized from food poisoning after eating in dining hall	Archbishop Porter Girls—Western Region
Joy News (2009)	Pupils reject insect infested meals supplied in school feeding program me	Atwima Nwabiagya- Ashanti Region
Ministry of Health (2007)	1,348 children suffered food poisoning among school food served by contracted caterers	Ghana
Daily guide (2007)	Dozens of students from two public schools hospitalized from food poisoning from school meals	Public schools—Greater Accra Region

Authority, 2008) representing (14%) of the total number of people being hospitalised. The total cost incurred by the government of Ghana on curbing food borne diseases annually is estimated to be 69 million US \$ (MoFA/World Bank, 2007).

### 3.2. Food hygiene issues

Studies shows that the food industry in Ghana has been characterized in the last fifteen years by food hygiene and safety (FHS) issues. Along with these, despite visible improvements, still require a lot more work to control.

Food is considered hygienic when there is no dangerous substance that can be injurious to the health of human or animal (Ababio & Adi, 2012). The practice or observation of food and personal hygiene are keen to the prevention of many food-borne diseases. Generally, the deliberate or accidental food contamination due to inappropriate handling of food causes potential danger to consumers' health (Annor & Baiden, 2011). Several unhygienic practices such as inappropriate storage of food and drinks, improper preparation and cooking, and poor personal and environmental hygiene are noted to compromise food safety (Odonkor, Adom, & Boatin, 2011).

Hygiene practices among food vendors and catering services have been reported to be below acceptable standards (Feglo & Sakyi, 2012). Feglo and Sakyi (2012) in their study on food vendors found that, the vendors had little education on food handling, processing and food hygienic practices.

Dun-Dery and Addo (2016) explored the practices and vendor perceptions on food and personal hygiene and the challenges faced by environmental health officers in implementing hygiene standards and policies in Ghana. They observed that majority (44%) of food vendors washed their hands every 20–30 min, while 42% washed at each serving and 14% washed each and every hour. They concluded that a good number of food vendors are yet to adopt basic hygiene practices in Ghana.

Also, a study by Boateng (2014) reported that 84.0% of food vendors used the same hands for serving and receiving money from buyers, 89% used their bare hands to serve or dish out food and 30.3% of vendors had not been given certificate to operate. This study also revealed that, out of 216 total food samples collected, faecal coliforms were isolated in 128 (59.3%), *E. coli* in 90 (41.7%), *Salmonella typhi* in 26 (12.0%) and *S. aureus* in 134 (62.0%) samples. These were slightly above acceptable limits (Boateng, 2014).

Ensuring FHS practice among vendors is very challenging however there is the need for vendors to adhere to high standards of food safety and hygienic practices (Monney, Agyei, Ewoenam, Priscilla, & Nyaw, 2014). Thus it is encouraged for continuous awareness creation and enforcement of regulation in the Ghanaian food industry.

### 3.3. Microbial quality of street foods

A research carried out by Mensah, Yeboah-Manu, Owusu-Darko, and Ablordey (2002) in Accra found that the microbial quality of sampled salads, macaroni, “fufu”, “omo tuo” and red pepper had unacceptable levels of contamination. Mesophilic bacteria were detected in 69.7% of foods. *Bacillus cereus* detected in 5.5% of the foods, 31.9% contained *S. aureus* and 33.7% contained *Enterobacteriaceae*. Also, *Shigella sonnei* and enteroaggregative *E. coli* were isolated from macaroni, rice, and tomato stew, and *Salmonella arizonae* from light soup.

Several scientific studies on street food in Ghana have detected high levels of microbial food contamination. A recent study by Atter, Ofori, Anyebuno, Amoo-Gyasi, and Amoah-Awua (2015) revealed the presence of coliform bacteria, *E. coli*, *S. aureus*, aerobic mesophiles, yeast and moulds in ice-kenkey sold in Accra and Tema.

Barker, Amoah, and Drechsel (2014) work on salad sold in the street of Kumasi showed high levels of rotavirus, a rather disturbing revelation for street food consumers. Pesewu et al. (2014) indicated

that all the raw-mixed vegetable salads they sampled in Accra Metropolis had high microbial contamination of *E. coli* (35%), *S. aureus* (33%), *Klebsiella* spp. (17%), and *Bacillus* spp. (15%). Also, Feglo and Sakyi (2012) found that most ready-to-eat foods in Kumasi such as ice-kenkey, cocoa drink, “fufu”, ready-to-eat red pepper (normally eaten with “kenkey”), salad, and macaroni were contaminated with enteric bacteria and other potential food poisoning organisms with bacterial counts higher than acceptable levels. Similarly, Amissah and Owusu (2012) reported microbial count for *E. coli*, *S. typhi* and *S. aureus* from selected food samples. The total viable count (TVC) test on “fufu” showed that *E. coli* ( $>1.0 \times 10^3 \pm 1.1 \times 10^1$ ) and *S. aureus* ( $>7.0 \times 10^3 \pm 1.0 \times 10^1$ ) were beyond the acceptable limits, whilst the counts of *S. aureus* ( $<1.0 \times 10^2 \pm 2.0 \times 10^0$ ) in “waakye” samples was unsatisfactory (Amissah & Owusu, 2012).

Annan-Prah et al. (2011) analysed street foods sold in Cape Coast and recorded the following bacterial contamination levels in colony forming units per gram (cfu/g). Meat pie ( $1.3 \times 10^5$ ), khebab ( $5 \times 10^4$ ), rice with stew ( $4.1 \times 10^5$ ), fried fish ( $8 \times 10^4$ ), pepper sauce ( $1.4 \times 10^5$ ), stew with “banku” ( $3 \times 10^5$ ), beans with gari ( $2 \times 10^4$ ), “fufu” ( $1.6 \times 10^5$ ), “waakye” ( $6.6 \times 10^5$ ), and “dakua” ( $2.3 \times 10^5$ ). *E. coli* of faecal origin were detected in all investigated food samples. Khebab, fried fish and beans with gari had acceptable bacterial contamination levels of  $<5 \log_{10}$  cfu/g. The following major fungi were identified in the street foods: *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus candidus*, *Cladosporium herbarum*, *Necrospora crassa*, *Penicillium citrinum*, *Fusarium*, *Mucor* and *Rhizopus* species. Yeboah-Manu, Kpeli, Akyeh, and Bimi (2010) studied street food in Accra and found that 52% of the foods sold had aerobic colony count (ACC) values – presence of *E. coli* and other *Enterobacteriaceae*. *Salmonella* spp. and *Shigella* spp. Levels were above acceptable limits while 40.7% of the food samples had *Enterobacteriaceae* contaminations above the WHO limit.

Contamination does not only affect the food industry, but also sachet water sold in Ghana. A study by Kwakye-Nuako, Borketey, Mensah-Attipoe, Asmah, and Ayeh-Kumi (2007) reported the presence of contaminants of faecal and zoonotic origin in some sachet water examined. 77% of the samples analysed contained pathogenic parasitic organisms, 29.6% contained at least one, 14.8% contained at least two, 25.9% contained at least three, and 29.6% contained four types of parasites and 93% contained unidentified impurities/artifacts. As of chemical contamination, analysis of street food in Accra by Tomlins and Johnson (2004) and Tomlins (2000) found heavy metals such as lead and also the presence of mycotoxins.

Food is considered hygienic and when it does not pose any threat or risk or better still substance that cannot be injurious to the health of human or animal (Ababio & Adi, 2012). The practice or observation of food and personal hygiene are keys for the prevention of many food-borne diseases. Generally, the deliberate or accidental food contamination due to inappropriate handling of food causes potential danger to consumers’ health (Annor & Baiden, 2011). Numerous hygiene practices such as inadequate storage of food and drinks, improper preparation and cooking, and poor personal and environmental hygiene are noted to compromise food safety (Odonkor et al., 2011).

Though, microbiological menaces in ready to eat food and chemical risks, particularly pesticides from agricultural foods such as fresh vegetables and fruits have been highlighted (Foriwaa & Lovatt, 2015)—some previous studies have assessed consumer behaviour for possible answers to the following questions: why, what, when, where and how vendors purchase raw materials for processing (Medeiros & Salay, 2013).

Hygiene practices among food vendors and catering services have been reported to be below acceptable standards. At the same time food vendors had little education on food handling, processing and food hygiene practices (Feglo & Sakyi, 2012).

### 3.4. Food safety concerns

Feglo and Sakyi (2012) and Ababio, Adi, and Commey (2012) reported significant low levels of education among food vendors in the Kumasi and Accra Metropolis. They reported limited number of food

safety management systems nationwide particularly among locally owned food establishments. Their report revealed that the local food industry largely lacked the capacity to implement, and maintain acceptable national and international standards as compared to their international competitors. Rheinlander, Bakang, Takyi, Konradsen, and Samuelson (2008) for instance reported that food handling practices in Kumasi did not reflect knowledge of vendors given the fact that, vendors had some level of food safety and hygiene awareness. They emphasized that both consumers and food handlers used aesthetic qualities such as appearance of environment and vendor, price and proximity to the neglect of good hygienic practices like food hygiene, vendors' personal hygiene as well as proper hand washing procedures and kitchen cleanliness to judge food safety and quality.

There has been a rising concern that food vendors and handlers in the country downplay documentation and quality assurance as an integral part of food production. This can be substantiated by the absence of a strict regulation on who can handle food on commercial bases. However, it is mandatory under the public health policy for food vendors to be medically screened before preparing food for sale or venturing into food business (Feglo & Sakyi, 2012). A research conducted by Ackah et al. (2011) showed that a little over 40% of sampled food vendors had health certificates with marked absence of periodic screening in the capital city of Ghana.

#### **4. Reported cases of microbial related diseases in Ghana**

According to the Ghana Health Service Annual Report (2011), the total number of diarrhoea cases recorded among persons above five years was 125,074. Out of these, 1,832 cases suffered severe dehydration and 71 died (CFR = 3.88%). The Ashanti Region recorded the highest incidence of acute watery diarrhoea disease (1,010.4 per 100,000 populations). Central Region recorded the second highest incidence (766.2 per 100,000 populations). Both regions had comparatively higher indices to national average of 609.4 per 100,000 populations.

During the year under review a total of 24,242 cases with 22 deaths were reported (CFR-0.024%) giving an incidence rate of 94.49/100,000 population. The highest incidence of bloody diarrhea was recorded in Upper East region 637.44/100,000 of the population, about seven times above the national average (Ghana Health Service Annual Report, 2011).

Several major cholera outbreaks over the past three decades have been reported in Ghana. In 1982, as many as 15,032 cases the highest number of cases recorded in a single year were reported.

In 2011, 9,174 cases, in 2012, total of 9,566 cases, in 2013, 22 cases were recorded. In 2014, the index case of cholera was reported on 10 June 2014 but over a period of less than 3 months, as at 14 September 2014, 16, 527 cases including 128 deaths (CFR: 0.8%) had been reported from 8 out of 10 regions.

The cholera outbreak that started in June, 2014 has protracted and spilled over to 2015. At the end of 2014 (week 52), a total of 28,975 cases with 243 deaths (CFR of 0.8%) were reported from 130 out of the 216 districts in all the 10 regions of the Ghana. In the year 2015, a total of 591 cases with 5 deaths, a case fatality rate (CFR) of 0.8% have been reported from 29 districts in 8 regions as of 24 May 2015. However, the cases have been on the decline. During the week under review (18–24 May – Week 21), 3 cases with no death were reported (from one district) as compared to 7, 6 and 6 cases reported during the week of 20, 19 and 18, respectively (Dzotsi, Odoom, Opere, & Davies-Teye, 2014; WHO, 2015).

#### **4.1. Food and microbial research works conducted in Ghana**

A total of 71 food samples with 103 bacterial isolates were obtained from 11 articles (Table 2). Twenty percent of the total bacterial isolated from the publications gathered were *Enterobacter* spp. closely followed by *E. coli* (16%), *Staphylococcus* spp. (12%) and *Pseudomonas* spp. (11%) (Figure 1). However, Saba and Gonzalez-Zorn (2012) reported in a review that there is a downward trend in

**Table 2. Research articles on food safety**

Author/Year of Publication	Food type	Microorganisms isolated
Boye, Hope, and Dwomoh (2015)	Food and cooking utensils	<i>Bacillus cereus</i> , <i>E. coli</i> , <i>Listeria monocytogenes</i> , <i>Staphylococcus aureus</i> , <i>Klebsiella pneumoniae</i> , <i>Enterobacter</i> spp, <i>Coagulase negative Staphylococci</i> , <i>Proteus mirabilis</i> and <i>micrococcus</i> spp.
Ernest Bonah (2014)	Ready to eat tomato	<i>Bacillus</i> spp., <i>Staphylococcus aureus</i> , <i>E. coli</i>
Boateng (2014)	“Fufu”, kenkey, “banku”, pepper/tomato sauce, jollof, fried, “waakye” and plain	<i>Faecal coliforms</i> , <i>E. coli</i> , <i>Salmonella typhi</i> , <i>Staphylococcus aureus</i>
Ofosu, Dzigbede, Agidi, Adjei, and Koranteng (2014)	Macaroni	<i>Shigella sonnei</i> , <i>Pseudomonas fluorescens/putida</i> , <i>Klebsiella pneumoniae</i> , <i>Enterobacter sakazakii</i> , <i>Citrobacter freundii</i> , <i>Serratia liquefaciens</i> , <i>Enterobacter cloacae</i> , <i>Enterobacter agglomerans</i> , <i>Citrobacter diversus/amalonicus</i> , <i>Citrobacter</i> spp.
	Salad	<i>Pseudomonas aeruginosa</i> , <i>S. liquefaciens</i> , <i>E. sakazakii</i> , <i>E. cloacae</i> , <i>P. fluorescens/putida</i> , <i>C. freundii</i> , <i>E. coli</i> , <i>C. diversus/amalonicus</i>
	Kenkey	<i>Pseudomonas</i> spp. <i>E. cloacae</i> , <i>K. pneumoniae</i> , <i>Sterile mycelium</i> , <i>Aspergillus flavus</i>
	Kenkey stew	<i>C. freundii</i> , <i>E. sakazakii</i> , <i>E. coli</i> (enteroaggregative localised)
	Raw “waakye”	<i>E. coli</i> (enteroaggregative diffuse), <i>P. fluorescens/putida</i> , <i>Enterobacter</i> , <i>Acinetobacter</i> spp, <i>Erwinia</i> spp, <i>E. cloacae</i>
	“Waakye” stew	<i>Klebsiella cloacae</i> , <i>K. pneumoniae</i> , <i>E. cloacae</i> , <i>E. coli</i>
	“Fufu”	<i>C. diversus</i> , <i>E. cloacae</i> , <i>E. sakazakii</i> ,
	Light soup (meat)	<i>Aspergillus niger</i> , <i>Penicillium citrium</i> , yeast, <i>Cladosporium herbadum</i> , <i>herbarum</i> , <i>Aspergillus</i> spp. and <i>Fusarium</i> spp.
	Fried fish	<i>Salmonella arizonae</i>
		<i>C. diversus</i> , <i>E. coli</i> , <i>C. luteola</i> , <i>P. Fluorescens</i>
		<i>Putida</i> , <i>E. sakazakii</i> , <i>C. diversus/amalonicus</i>
Amissah and Owusu (2012)	“Fufu”, “waakye”, soup, sauce and goat meat	<i>Esherishia coli</i> , <i>Salmonella</i> , <i>S. aureus</i>
Feglo and Sakyi (2012)	“Fufu”, salad, macaroni, red pepper, ice kenkey and cocoa drink,	<i>Coagulase negative Staphylococci</i> , <i>Bacillus</i> sp., <i>Klebsiella pneumoniae</i> , <i>Aeromonas pneumophila</i> , <i>Enterobacter cloacae</i> , <i>Staphylococcus aureus</i> , <i>E. coli</i> , <i>Pseudomonas aeruginosa</i>
Saba and Gonzalez-Zorn (2012)	Chicken, Kebab (beef and pork), Milk, “Koko”, Macaroni, Salad, Shito (over cooked stew), Tomato stew, “Nkontomre” stew, Fish, Palm nut soup, Groundnut soup, Light soup (meat), Okro soup, white oil, Red oil, Red pepper, Beans, “Kenkey”, “Gar”, Rice, Yam, Plantain, “Fufu”, “Waakye” and “Akple” / “Banku”	<i>Enterobacter</i> spp., <i>Citrobacter</i> spp., <i>Klebsiella</i> spp. and <i>E. coli</i>
Ameko, Achio, Alhassan, and Kassim (2012)	Raw mixed vegetable salad	<i>Pseudomonas</i> , <i>Salmonella typhi</i> , <i>Shigella</i> spp., <i>Streptococcus faecalis</i>

(Continued)

Table 2. (Continued)	Author/Year of Publication	Food type	Microorganisms isolated
Nyarko, Tagoe, and Aniwah (2011)	Tiger nuts ( <i>Cyperus esculentus</i> L.)	Bacillus spp., E. coli, Enterococcus spp., Staphylococcus spp., Pseudomonas aeruginosa, Streptococcus spp. and Enterobacter cloacae	
Yeboah-Manu et al. (2010)	Fried rice, salad, "waakye", tomato stew, black pepper, red pepper, macaroni, plain rice and beans stew	E. coli, Klebsiella pneumoniae, Streptococcus spp., Enterobacter cloacae, Bacillus spp., Pseudomonas aeruginosa, Staphylococcus aureus, Proteus spp., Streptococcus agalactiae and Enterococcus faecalis	
Mensah et al. (2002)	Chicken, Kebab (beef and pork), Milk, "Koko", Macaroni, Salad, Shito (over cooked stew), Tomato stew, "Nkontomre" stew, Fish, Palm nut soup, Groundnut soup, Light soup (meat), Okro soup, white oil, Red oil, Red pepper, Beans, "Kenkey", "Gari", Rice, Yam, Plantain, "Fufu", "Waakye" and "Akple"/"Banku"	Mesophilic bacteria, Bacillus cereus, Staphylococcus aureus and Enterobacteriaceae	

Notes: "Koko" = porridge made of fermented/dried corn.

"Nkontomre" = leafy vegetable.

"Gari" = dried-grated cassava.

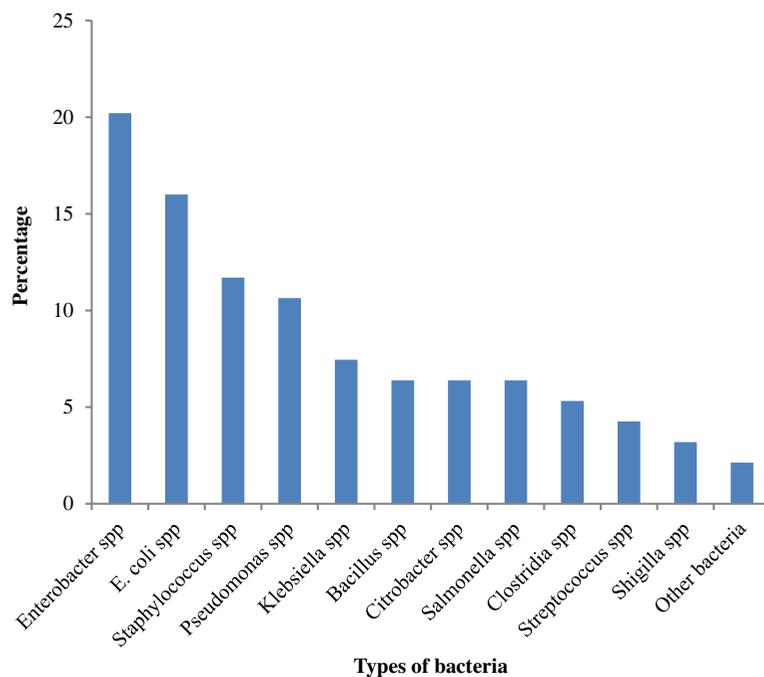
"fufu" = boiled cassava/plantain/yam pounded individually or mixed.

"Kenkey" = made of boiled fermented corn dough.

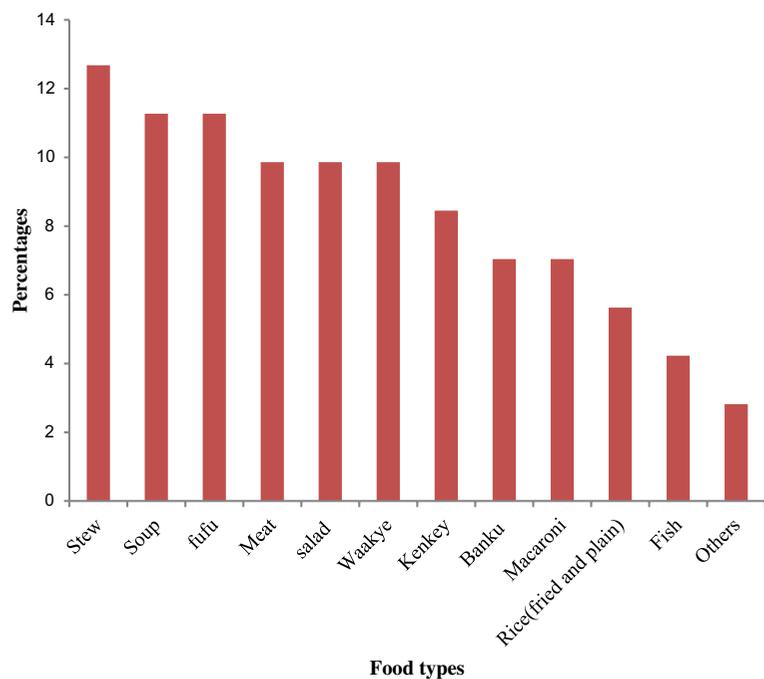
"Banku" = mixture of corn and cassava dough.

"Akple" = solidified porridge made of only corn.

**Figure 1. Microorganisms isolated and their percentages.**



**Figure 2. Percentage distribution of most contaminated foods.**



publications of microbial food safety articles. This review has shown that the most predominant bacteria isolated in Ghanaian foods are *Enterobacter* spp. which is in line with the findings of Saba and Gonzalez-Zorn (2012).

From Table 2, stew was the most “microbially” contaminated food (13%), followed by both soup and “fufu” (12% each). Then by meat, salad and “waakye” representing 10% each of total food sampled (Figure 2).

## 5. Conclusion

Literature reviewed in this work showed that, the most predominant bacteria isolated in Ghanaian foods are *Enterobacter* spp., *Escherichia* spp., *Staphylococcus* spp. and *Pseudomonas* spp. While the most contaminated foods were stew, soup, “fufu”, macaroni, salad, and “waakye”. Most of the articles did not present clearly as to whether the bacteria isolated were above set standards of WHO and or that of Ghana standard authority. These works did not give directions for future research. The trend of publications on the subject of microbial food safety is centered on Accra and Kumasi with few across other regional capitals and almost none at the district level.

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### References

- Ababio, P. F., & Adi, D. D. (2012). Evaluating food safety practices among food handlers in the Kumasi Metropolis. *Internet Journal of Food Safety*, 14, 35–43.
- Ababio, P. F., Adi, D. D., & Commey, V. (2012). Food safety management systems, availability and maintenance among food industries in Ghana. *Food Science and Technology*. Retrieved from [www.fstjournal.org/node/add/article](http://www.fstjournal.org/node/add/article)
- Ackah, M., Gyamfi, E. T., Anim, A. K., Osei, J., Hansen, J. K., & Agyeman, O. (2011). Economic profile, knowledge of hygiene and food safety practices among street food vendors in some parts of Accra-Ghana. *Internet Journal of Food Safety*, 13, 191e197.
- Ameko, E., Achio, S., Alhassan, S., & Kassim, A. (2012). Microbial safety of raw mixed-vegetables salad sold as an accompaniment to street vended cooked rice in Accra, Ghana. *African Journal of Biotechnology*, 11(50), 11078–11085. Retrieved from <http://www.academicjournals.org/AJB>
- Amisshah, A., & Owusu, J. (2012). Assessing the microbiological quality of food sold on and around. *Annals of Food Science and Technology* (pp. 60–67). Targoviste: Valahia University Press.
- Annan-Prah, A., Amewowor, D. H. A. K., Osei-Kofi, J., Amoano, S. E., Akorli, S. Y., Saka, E., & Ndadi, H. A. (2011). Street foods: Handling, hygiene and client expectations in a World Heritage Site Town, Cape Coast, Ghana. *African Journal of Microbiology Research*, 5(13), 1629–1634.
- Annon. (2010, June). *Outbreak of food poisoning at child naming ceremony Anyaa, Ghana*. Training Programmes in Epidemiology and Public Health Interventions Network (TEPHINET) Library.
- Annor, G. A., & Baiden, E. A. (2011). Evaluation of Food Hygiene Knowledge Attitudes and Practices of Food Handlers in Food Businesses in Accra, Ghana. *Food and Nutrition Sciences*, 02(08), 830–836. doi:10.4236/fns.2011.28114
- Atter, A., Ofori, H., Anyebuna, G. A., Amoo-Gyasi, M., & Amoa-Awua, W. K. (2015). Safety of a street vended traditional maize beverage, ice-kenkey, in Ghana. *Food Control*, 55, 200–205. <https://doi.org/10.1016/j.foodcont.2015.02.043>
- Barker, S. F., Amoah, P., & Drechsel, P. (2014). A probabilistic model of gastroenteritis risks associated with consumption of street food salads in Kumasi, Ghana: Evaluation of methods to estimate pathogen dose from water, produce or food quality. *Science of the Total Environment*, 487, 130–142. <https://doi.org/10.1016/j.scitotenv.2014.03.108>
- Boateng, A. E. (2014). *Assessment of food hygiene practices by street food vendors and microbial quality of selected foods sold* (B. A Nursing and Psychology. Thesis KNUST). A study at Dunkwa-On-Offin, Upper Denkyira East municipality of the Central Region.
- Bonah, E. (2014). *Heavy metal health risk assessment and microbial quality of locally milled ready-to-eat tomato in tamale, Ghana. A thesis submitted to the institute of distance learning, Kwame Nkrumah University of science and technology in partial fulfillment of the requirements for the award of Master of Science degree (M.Sc. food quality management)*. KNUST.
- Boye, A., Hope, A., & Dwomoh, F. P. (2015). Transmission of foodborne illnesses. The role of serving utensils-dependent transmission of enteric pathogens from streets-food vending outlets at the University of Cape Coast community Ghana. *EC Nutrition*, 2(4), 386–395.
- Citifm. (2013). *Over 40 student hospitalised in Adonten Secondary in Eastern region of Ghana over food poisoning. Case under investigation*. CITIFMONLINE. Retrieved December 18, 2016, from <http://exposeghana.com/2013/03/er-40-students-of-adonten-shs-hospitalised-for-food-poisoning/>.

- Daily guide. (2007). *Dozens of pupils from two basic schools in Madina admitted in various hospitals for food poisoning after eating rice balls*. Retrieved December 21, 2016, from [www.modernghana.com](http://www.modernghana.com)
- Dun-Dery, E. J., & Addo, H. O. (2016). Food hygiene awareness, processing and practice among street food vendors in Ghana. *Food and Public Health*, 6(3), 65–74.
- Dzotsi, E., Odoom, J. K., Opore J. K. L., & Davies-Teye, B. B. K. (2014). Outbreak of cholera, greater Accra region-Ghana, 2014. *Journal of Scientific Research & Reports*, 9(3): 1–12. Article No. JSRR.2146. ISSN: 2320-0227. SCIEENCEDOMAIN international. Retrieved from [www.sciencedomain.org](http://www.sciencedomain.org)
- FAO & WHO Final Report. (2005). *Regional conference on food safety for Africa*. Harare Zimbabwe: Practical Actions to Promote Food Safety.
- Feglo, P., & Sakyi, K. (2012). Bacterial contamination of street vending food in Kumasi, Ghana. *Journal of Medical and Biomedical Sciences*, 1(2026–6294), 1–8.
- Food and Agriculture Organization of the United Nations. (2016). *Street food in urban Ghana; A Desktop review and analysis of findings and recommendations from existing literature*. (Stefano Marras Mohamed Agbendech, ed.). Accra: Food and Agriculture Organization of the United Nations.
- Food & Drugs Authority. (2008, March 12). *FDA school caterers on good hygiene practice*. Accra: Ghana News Agency.
- Foriwa-Ababio, P. (2014). *Challenges in food hygiene and safety-comparing Lincolnshire and Ashanti Region school canteens*. University of Lincoln College of Sciences – NCFM.
- Foriwa, P., & Lovatt, P. (2015). A review on food safety and food hygiene studies in Ghana. *Food Control*, 47, 92–97. doi:10.1016/j.foodcont.2014.06.041
- Ghana Health Service Annual Report. (2011). Retrieved December, 2016, from [http://www.ghanhealthservice.org/includes/upload/publications/FINAL\\_DRAFT\\_2011\\_GHS\\_Annual\\_Report%20final%20final.pdf](http://www.ghanhealthservice.org/includes/upload/publications/FINAL_DRAFT_2011_GHS_Annual_Report%20final%20final.pdf)
- Ghana Standard Authority. (2013). Personal communication with standard documentation department.
- Ghana Web. (2011). *Dozens suffer food poisoning in Obuasi*. Retrieved December 29, 2016, from [www.ghanweb.com](http://www.ghanweb.com)
- Ghana Web. (2017). *Jack and Jill biscuits suspected to be poisonous*. Retrieved January 31, 2017, from [www.ghanweb.com](http://www.ghanweb.com)
- Hiamey, S. E., Amuquandoh, F. E., & Boison, G. A. (2015). *Are we indeed what we eat? Street food consumption in the market circle area of Takoradi, Ghana*. Nutrition and Health.
- Kwakye-Nuako, G., Borketey, P. B., Mensah-Attipoe, I., Asmah, R. H., & Ayeh-Kumi, P. F. (2007). Sachet drinking water in Accra: The potential threats of transmission of enteric pathogenic protozoan organisms. *Ghana Medical Journal*, 41(2), 1–2.
- Medeiros, C. O., & Salay, E. (2013). A review of food service selection factors important to the consumer. *Food and Public Health*, 3(4), 176–190. doi:10.5923/j.fph.20130304.02
- Mensah, P., Yeboah-Manu, D., Owusu-Darko, K., & Ablordey, A. (2002). Street foods in Accra, Ghana: How safe are they? *Bulletin of World Health Organisation*, 80(7), 546–554.
- Ministry of Food and Agriculture/World Bank. (2007). *Review of food safety in Ghana*. Retrieved October 14, 2016, from [www.worldbank.org](http://www.worldbank.org)
- Modernghana.com. (2014). *University of cape coast closed down food market as student dies from suspected food poisoning in University of Cape Coast*. Retrieved November 11, 2016, from <https://www.graphic.com.gh/news/general-news/ucc-closes-down-food-market-as-student-dies-from-suspected-food-poisoning.html>
- Monney, I., Agyei, D., Ewoenam, B. S., Priscilla, C., & Nyaw, S. (2014). Food hygiene and safety practices among street food vendors: An assessment of compliance, institutional and legislative framework in Ghana. *Food and Public Health*, 4(6), 306–315. doi:10.5923/j.fph.20140406.08
- Myjoyonline. (2016). *98% off salad by street food vendors contain E. coli in Accra, Ghana*. Retrieved December 31, 2016, from [www.myjoyonline.com](http://www.myjoyonline.com)
- Nicolò, G. (2012). *Report on the Study of street food vending in Ghana*. Accra (Ghana): FAO RAF. Unpublished.
- Nyarko, H. D., Tagoe, D. N. A., & Aniweh, Y. (2011). *Assessment of Microbiological safety of tiger nuts (Cyperus esculentus L.) in the Cape Coast Metropolis of Ghana*. Scholar research Library. ISSN 0975-508X. Retrieved from [www.scholarsresearchlibrary.com](http://www.scholarsresearchlibrary.com)
- Odonkor, S., Adom, T., & Boatın, R. D. (2011). Evaluation of hygiene practices among street food vendors in Accra metropolis, Ghana. *Elixir Online Journal*, 41, 5807–5811.
- Ofori, A. H., Dzignbede, B. A., Agidi, J. E. L., Adjei, J., & Koranteng, A. (2014). A study into microbial quality of ready to eat foods sold in the Sunyani Municipality of Ghana. *Global Journal Biology Agriculture Health & Sciences*, 3(3), 84–91. ISSN: 2319-5584.
- Pesewu, G. A., Agyei, J. N., Gyimah, K. I., Olu-Taiwo, M. A., Osei-Djarbeng, S., Codjoe, F. S., & Ayeh-Kumi, P. F. (2014). Bacteriological assessment of the quality of raw-mixed vegetable salads prepared and sold by street food vendors in Korle-Gonno, Accra Metropolis, Ghana. *Journal of HealthScience*, 2, 560–566.
- Rheinlander, T., Bakang, M. O., Takyi, H., Konradsen, F., & Samuelson, H. (2008). Keeping up appearances: Perceptions of street food safety in Urban Kumasi, Ghana. *Journal of Urban Health*, 85(6), 952–964. <https://doi.org/10.1007/s11524-008-9318-3>
- Saba, S. K. C., & Gonzalez-Zorn, B. (2012). Microbial food safety in Ghana- Meta-analysis. *Journal of Infection in Developing Countries*, 6(12), 828e835.
- Scallan, E., Griffin, P. M., Angulo, F. J., Tauxe, R. V., & Hoekstra, R. M. (2011). Foodborne illness acquired in the United States – Unspecified agents. *Emerging Infectious Diseases*, 17, 16–22. <https://doi.org/10.3201/eid1701.P21101>
- Sefa-Dedeh, S. (2009). *Ghana: Overview of food safety situation in Africa-Country position*. Presented at the Go-Global Conference, Accra.
- Tomlins, K. I. (2000). Heavy metals, pesticides and mycotoxins in streetvended foods. In P. N. T. Johnson & R. M. Yawson (Eds). *Report on workshop for stakeholders, policy makers and regulators on street food vending in Accra* (pp. 20–23). Accra: Food Research Institute.
- Tomlins, K. I., & Johnson, P.-N. T. (2004). *Developing food safety strategies and procedures through reduction of food hazards in street-vended foods to improve food security for consumers, street food vendors and input suppliers*. Crop Post harvest Programme (CPHP) Project R8270. Funded by DFID. Natural Resources Institute, UK & Food Research Institute, Ghana.
- World Health Organisation. (2002). *Global strategy of food safety: safer food for better health*. Retrieved December, 2016, from [www.who.int/foodsafety/publications/general/en/strategy\\_en.pdf](http://www.who.int/foodsafety/publications/general/en/strategy_en.pdf)
- World Health Organisation. (2015). *Food Safety: What you should know*. World Health Day: 7 April 2015 SEA-NUT-196 Distribution: General World Health Organization.
- Yeboah-Manu, D., Kpeli, G., Akyeh, M., & Bimi, L. (2010). Bacteriological quality of ready to eat foods sold on and around University of Ghana campus. *Research Journal of Microbiology*, 5(2), 130–136.



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