African Journal of Biotechnology Vol. 11(50), pp. 11078-11085, 21 June, 2012
Available online at http://www.academicjournals.org/AJB
DOI:
ISSN 1684–5315 ©2012 Academic Journals

Full Length Research Paper

Microbial safety of raw mixed-vegetable salad sold as an accompaniment to street vended cooked rice in Accra, Ghana

E. Ameko*, S. Achio, S. Alhassan and A. Kassim

Department of Science Laboratory Technology, Accra Polytechnic, P. O. Box 561, Accra, Ghana.

Accepted 27 April, 2012

A survey of 90 randomly selected subjects indicated raw mixed-vegetable salad as a popular accompaniment to cooked rice sold by street-food vendors in the Kokomlemle municipality of Accra, Ghana, but the salad was generally considered unwholesome and a potential cause of diarrhoea. A survey of 15 vendors of cooked rice indicated that the sources of raw vegetables, method of transportation from the sources to the kitchens, and methods of storing the raw vegetables before processing, as well as the methods of processing and sale, made the raw mixed-vegetable salad accompaniment a potential source of food poisoning from microbial contamination. Microbial analysis of samples of the salads obtained from five randomly selected vendors in the mornings and afternoons, over 15 days, indicated that bacterial counts for all samples exceeded the recommended World Health Organization (WHO) standard of Log_{10} 3.0 cfu/g. Levels of *Pseudomonas*, *Salmonella typhi, Shigella* sp., and *Streptococcus faecalis* did not show any significant difference ($P<0.05$) among vendors and did not differ significantly ($P<0.05$) over the 15 days. Significantly, higher levels of microbial contamination ($P<0.05$) occurred in the afternoon, than in the morning samples. The results confirm that the raw mixed vegetable salads which are sold as accompaniment to street vended cooked rice in the Kokomlemle municipality contain *S. faecalis* from fecal contamination, *Pseudomonas*, *Shigella* sp., and *S. typhi* which could cause gastrointestinal infections and the highest risk was from the afternoon samples.

Key words: Ghana, street vended cooked rice, raw mixed-vegetable salad, microbial contamination.

INTRODUCTION

Street-foods are foods and beverages that are sold by street vendors or hawkers, and the foods and beverages could be raw or cooked. The various varieties of street-foods in Ghana evolve round the common starchy staples of maize, cassava, rice, plantain, and yam; legumes like cowpea and groundnuts; vegetables like tomatoes, onions, pepper, lettuce, spring onions, kontomire leaves from the cocoyam plant, cabbage, carrots and cucumber; animal protein like goat meat, beef, wele (smoked cow hide), and various types of fishes. The oils are from either palm oil or groundnut oil. Kenkey and banku are prepared from fermented corn and are eaten with vegetable stew, pepper sauce or soup, with fried, smoked or boiled fish or meat. Fufu is prepared from boiled cassava, yam, cocoyam or plantain, or a mixture of these, pounded with a wooden mortar and pestle, while simultaneously kneading with small additions of water to form soft dough. It is eaten with palm nut soup, groundnut soup, or light soup with various types of meats or fish, crabs, snails and mushrooms. Rice is cooked with cowpea to produce waakye, which is sold with vegetable salad and pepper sauce, with fried fish, meat, boiled egg and wele. Rice can also be cooked plain and also sold with the same accompaniments used for waakye.

A recent popular street vended food is fried rice, which is a good imitation of that sold in Chinese restaurants, especially in the cities. Semi boiled rice is fried in oil with chopped vegetables, soy sauce and egg, and served with tomato ketchup and fried chicken. Kose is fried fritters of dehulled cowpea paste and is eaten either plain, or

*Corresponding author. E-mail: edmundameko@yahoo.com.

stuffed into bread to form a burger with Hausa koko porridge, which is prepared from millet. “Yor ker Gari” is boiled cowpea, served with plain palm nut oil or Dzomi (spiced palm nut oil) and fried ripe plantain. Fruits like bananas, oranges, mangoes, watermelon, pineapple, etc, are sold fresh and whole. Oranges are also sold freshly peeled, while pineapple, watermelon and sugarcane may be sold peeled, sliced and packaged in small transparent polythene bags. Fresh corn on the cob, plantain, yam and cocoyam are roasted and sold with roasted groundnuts. Some common street vended beverages are sobolo, which is a red coloured drink prepared from the dried red sepals of Guinea sorrel (*Hibiscus sabdariffa*), akpeteshie (a locally distilled alcohol), coca cola, sprite, etc. The most popular pastry is ‘Boflot”, which is fried wheat flour doughnut.

In Ghana, mixed vegetable salad, usually prepared with fresh lettuce, tomato and onion, and sometimes with the addition of carrots or green pepper, is a favourite supplement to waakye (rice and beans), koliko (fried yam) and fried fish, and plain rice and stew, sold by street vendors and in restaurants and canteens. Ghanaians depend heavily on street-foods (Johnson and Yawson, 2000) and about 60% of mothers in an urban slum in Accra, Ghana, supplement their children’s diet with street-food (Mensah et al., 2002). These street-foods pose a risk to consumers because of the danger of food poisoning from microbial contamination (Food and Agriculture Organization (FAO), 2005). Raw vegetables contamination occurs on the farm from the manure, irrigation water, contaminated hands of farmers (Centre for Food Safety, 2006), and from contaminated water used to wash the vegetables after harvest (Pavan da Silva et al., 2007). The farmers may sell the vegetables at the farm, directly to the food vendors, or to market women who then sell them to the food vendors at the market. If the raw vegetables are contaminated on the farm, it is highly possible that they would be consumed as such, because there is no step along the supply chain or during preparation, such as heating, for killing microorganisms (Centre for Food Safety, 2006).

A study on street vended foods in Atbara City in the Naher Elneen state of Sudan showed that the most prevalent bacteria contaminating cooked meals, bottled drinks and fresh fruit *were Escherichia coli, Staphylococcus aureus* and *Bacillus* sp. (Abdalla et al., 2009). According to the WHO (1996), raw vegetables should not be exposed to any further contamination during transport and storage.

Ohiokpehai (2003) in a study on street vended foods in Botswana observed that some vendors kept leftover food for sale the next day. It was recommended that instead of the vendors keeping leftover food for sale the next day, the leftovers should best be discarded but if not, then they should be stored at < 10°C, or reheated at > 70°C, before sale the next day. A study by Amoah et al. (2007) indicated that fresh vegetables have become a normal part of fast food, served on the street, canteens and restaurants in Ghana. However, farming practices like use of contaminated irrigation water, application of manure and contaminated soils is the main source of lettuce contamination (Consultative Group on International Agricultural Research: CGIAR, 2011). An earlier study by Amoah et al. (2005) in Kumasi, Ghana indicated that 95% of lettuce samples from urban vegetable farms, irrigated with piped water, had faecal coliform levels, which were more than 1000/100 g lettuce (wet weight) and according to the 1974 ICSMF (The International Commission on Microbiological Specifications for Food) guidelines, were classified as ‘‘undesirable’’.

According to Amoah (2007), poor sanitary handling practices after the farm gate and during marketing, did not increase the farm gate contamination levels. A potential point for reducing the risk associated with the consumption of contaminated vegetables is the stage where vegetables are prepared for consumption. Microbiological survey on street-food in Ghana showed that some street-foods are intrinsically safer than others. Kenkey and waakye (rice and beans) were identified to be safer products, while most fufu were contaminated (Department for International Development (DFID), 2002).

This study was conducted to evaluate the microbial safety of raw mixed-vegetable salad sold as an accompaniment to street vended cooked rice dishes within the Kokomlemle municipality of Accra in Ghana. The study was carried out between March and July, 2010.

MATERIALS AND METHODS

Study area

Kokomlemle is situated in Accra, the capital city of Ghana and its geographical coordinates are 5° 34' 0" North, 0° 13' 0" West (Maplandia.com, 2005) and due North of the city. There are basic services such as water and electricity. There are no markets in Kokomlemle and residents go to Malamata market in Accra New town or Makola market in the city centre to buy food (Wanted in Africa, 2005). There is improper disposal of rubbish in the area because of insufficient number of waste bins for collecting disposed rubbish in the area. Residents therefore dump and burn their refuse on the street (Mingle, 2010).

Questionnaires

A questionnaire was developed to collect data from potential customers on the popularity of street vended cooked rice dishes and raw vegetable salads among consumers, the perceptions of consumers concerning the wholesomeness of the salads, and perceived risk of food poisonings after consuming the salads. 50 households within the Kokomlemle municipality which were easy to identify and locate were selected, and questionnaires were administered to one male and one female in each of the households. The respondents were 43 (47.8%) and 47 (52.2%) males and females, respectively. A convenience sampling method was used in selecting 15 vendors selling cooked rice along the major streets and open spaces of Kokomlemle. The vendors were

Table 1. Respondent's patronage of street vended foods and their perceptions of the safety of raw mixed-vegetable salad sold with street vended cooked rice at Kokomlemle.

Activity description	Percentage of respondents (n = 90)		
	Yes	No	Not sure
Patronized street vended cooked food in the Kokomlemle area	83	17	-
Patronized street vended cooked rice in the Kokomlemle area	71	29	-
Regularly purchased salad together with cooked rice	81	19	-
Considered the raw vegetables salads wholesome	13	67	10
Had ever experienced diarrhoea after eating salad with cooked rice	81	19	-

approached in turns and those who expressed their willingness to participate in the study were selected. A questionnaire administered to the 15 selected vendors, determined food safety practices related to the sources, methods of transportation, handling and storage of raw vegetables; and the preparation and sale of raw mixed-vegetable salads that they sold as accompaniments to the cooked rice.

Sampling of raw mixed-vegetable salads

Five vendors were randomly selected from the 15 vendors interviewed in the earlier study. The vendors were assigned random alphanumeric codes, which were written on the top right corner of the questionnaire administered to them. The alphanumeric codes were later compiled into a list on the computer and then sorted in increasing order. The sorted list was printed out and the first five codes on the list were selected for the study.

Raw mixed-vegetables salad samples were purchased from the five randomly selected vendors at about 8:00 am in the mornings and 1:00 pm in the afternoons, from Monday to Friday. This was done for three separate weeks, for a total of 150 samples. Samples were placed in separate, sterilized pre-labeled containers, sealed, placed on crushed ice in an ice chest and sent to the laboratory for bacteriological examination (Canadian Food Inspection Agency, 2001).

Microbiological analysis

Stock preparation

A stock solution of 10^{-1} dilution was prepared by taking 20 g of each food sample and mixed with 180 ml of sterile phosphate-buffered saline and homogenised in a sterilized Warring blender for 5 min. The suspension was filtered through sterile filter paper (Whatman No. 2), and the filtrate received in a sterilized labeled conical flask, and used for subsequent tests.

Culture and enumeration

Aerobic plate count (APC) was done by preparing serial dilutions of the samples, ranging from dilutions of 10^{-2} to 10^{-7} from the stock. Duplicate pour plates were made for each dilution with Difco plate count agar and plates were incubated overnight (24 h), at 37°C. Plates with 30 to 300 colonies were selected and counted. Mean counts were calculated (Table 3) and analysed statistically for significant differences ($P<0.05$) between the morning and afternoon samples, and for significant differences between vendors. For each vendor, overall mean count was calculated for each week (Table 4) and the results analyzed statistically for significant differences ($P<0.05$) between weekly counts, and for significant differences between vendors.

Culture and isolation of microorganisms

About 1 ml from each of the prepared stocks was inoculated into separate test tubes of nutrient broth and incubated at 37°C overnight. Growth was determined by turbidity in the broth, and sub-cultured onto McConkey agar or Xylose lysine deoxycholate (XLD) agar (for Enterobacteriacae) and blood agar (for *Staphylococcus* spp. and other pathogenic organism such as *Salmonella typhi, Shigella* spp., etc.).

Isolates were sub-cultured on fresh agar plates for purity. Bacterial colonies that developed on the fresh agar plates were individually picked and streaked on fresh agar plates by dilution-streaking to obtain single colonies of pure isolates. The pure isolates were identified by their colonial and cell morphology, gram reaction and a combination of standard biochemical tests (Benson, 2001) using the Health Protection Agency Standards Unit (HPASU, 2008) Bacteriological Standard Operating Procedures for Identification (BSOPID) 17 for *Pseudomonas*, HPASU (2008) BSOPID 24 for *S. typhi*, HPASU (2008) BSOPID 20 for *Shigella* sp., and HPASU (2008) BSOPID 4 for *Streptococcus faecalis*.

The number of samples contaminated with the selected pathogens under study was enumerated over the 15 day period, and the percentage of samples contaminated with each pathogen calculated (Table 3) and analysed statistically for significant differences ($P<0.05$) between pathogen counts and for significant differences between pathogen contaminations. Data were analyzed, using a two factor analysis of variance [ANOVA ($P<0.05$)] with Statistical Package for the Social Sciences (SPSS) 20.0 for Windows.

RESULTS AND DISCUSSION

90 out of 100 questionnaires, randomly distributed to potential customers, were retrieved; 47.8% of respondents were males and 52.2% females; 83% patronized street vended cooked food and 71% patronized street vended cooked rice in the Kokomlemle area; 81% said they had never suffered diarrhoea after eating salad with cooked rice, 81% indicated that they regularly purchased salad together with cooked rice; 13% considered the raw vegetables salads wholesome, 67% unwholesome and 10% were not sure (Table 1).

Responses from questionnaires administered to the 15 selected vendors (Table 2) showed that the vegetables used for preparing the accompaniment were mainly

Table 2. Food handling practices of 15 street food vendors during procurement of raw vegetables, processing into raw mixed-vegetable salads and sale of the salads.

Activity description	Response	Percentage of respondent (n = 15)
Source of raw vegetables	Farm gate	26.0
	Retailers at local market	47.0
	Hawkers	27.0
Method of transportation from source to processing site	Sacks	6.6
	Open trays	26.6
	Polythene bags	40.0
	Wooden sieve-net cages	13.3
Method of preservation prior to processing	In a refrigerator	53.3
	On a rooftop overnight	46.6
Method of decontamination before processing	Washed with plain tap water	100.0
Treatment of leftovers	Discarded	60.0
	Stored in a refrigerator for sale the next day	40.0
Took precautions to avoid contamination during preparation and sale	Took precautions	53.0
	Did not take precautions	47.0
Complaints from customers about perceived food poisoning after consuming the salads	Admitted ever receiving complaints	60.0
	Did not admit ever receiving complaints	40.0
Action taken by vendors who received complaints from customers about perceived food poisoning after consuming the salads	Made conscious efforts to prevent a recurrence	56.0
	Did not make any conscious efforts to prevent a recurrence	44.0
Precautions taken to avoid contamination during preparation and sale	Used a clean spoon to serve the salad	25.0
	Prepared salad in batches	12.5
	Protected the salads from flies and dirt	37.5
	Separated freshly prepared salad from the old stock	25.0

tomatoes, onions, cabbage, lettuce, and carrot; 47% of the vendors obtained the raw vegetables from the local market, 27% from hawkers and 26% directly from the farmers at the farms; 6.6% transported them home in sacks, 13.3% open trays, 26.6% baskets, 40% polythene bags and 13.3% in wooden-sieve net cages; 53.3% preserved the freshly purchased vegetables in the refrigerator and 46.6% on a rooftop overnight; 100% did not decontaminate the vegetables by washing them with plain tap water before slicing them on a wooden board; 60% discarded leftovers

Table 3. Mean aerobic plate counts on morning and afternoon samples of raw mixed-vegetable salads sold daily with cooked rice by five street vendors over a 15 day period.

Vendor	Log_{10} cfu/g of mean aerobic plate count	
	Morning	Afternoon
1	4.81 ± 0.45	4.94 ±0.49
2	4.16 ± 0.33	4.67 ±0.28
3	4.69 ± 0.43	4.93 ±0.26
4	4.68 ± 0.64	5.17 ±0.45
5	4.13 ± 0.19	5.08 ±0.51

Values are means ± standard deviation.

Table 4. Mean weekly aerobic plate counts on samples of raw mixed-vegetable salads sold daily with cooked rice by five street vendors over a three week period.

Vendor	Log_{10} cfu/g of mean aerobic plate count		
	Week 1	Week 2	Week 3
1	4.84 ± 0.41	4.85 ± 0.19	4.94 ± 0.46
2	4.24 ± 0.39	4.81 ± 0.26	4.02 ± 0.31
3	5.06 ± 0.17	4.80 ± 0.22	4.36 ± 0.48
4	5.01 ± 0.34	4.86 ± 0.11	5.08 ± 0.22
5	5.04 ± 0.11	4.89 ± 0.32	4.10 ± 0.42

Values are means ± standard deviation.

while 40% stored them in the refrigerator for sale the next day; 47% of vendors said they did not take any precautions to avoid contamination of the raw salad during preparation and sale and of the 53% who said they did, 25% did so by using a clean spoon to serve the salad, 12.5% by preparing the salad in batches, 37.5% by keeping the salad from flies and dirt and 25% by separating freshly prepared salad from the old; 60% admitted ever receiving complaints from customers about perceived food poisoning after consuming the vegetables, but 56% of these vendors failed to take precautions to prevent a recurrence. The survey results show that the sources of raw vegetables, modes of transport from the source and storage before processing, as well as the modes of processing and sale, makes raw mixed vegetable salads accompaniment to street vended cooked rice a potential source of food poisoning from microbial contamination.

Results of the microbiological analysis of raw mixed vegetable salads indicate that 20% of the vendors had the salads that they sold in the mornings with microbial loads in excess of 5×10^4 cfu/g (Log_{10} 4.70 cfu/g), and this increased to 80% of the vendors in the afternoons (Table 3).

The mean weekly aerobic plate counts on samples of raw mixed-vegetable salads did not differ significantly ($P<0.05$) among the vendors (Table 4). In this study, *S. typhi, Shigella* sp., *S. faecalis*, and *Pseudomonas* sp., were found on the samples in the mornings and afternoons but generally, contamination was significantly higher ($P<0.05$) in the afternoons than in the mornings.

Pseudomonas, *S. typhi* and *S. faecalis* were found more frequent in the salads in the morning than in the afternoon, while the frequency of contamination by *Shigella* sp. was the same, both mornings and afternoons (Table 5). *Pseudomonas* was found in 6.7% of the samples in the mornings and on 20% of samples in the afternoons. *S. typhi* was detected in 33.3 and 66.6% of morning and afternoon samples, respectively. *S. faecalis* contamination occurred in 80 and 93.3% of morning and afternoons samples, respectively. *Shigella* sp. and *S. faecalis* were present in more of the samples than the other isolates.

The results of this study agree with those of Adu-Gyamfi and Nketsia-Tabiri (2007), where late morning samples of vegetable salads, served with waakye, had higher levels of contamination than early morning samples. Aerobic mesophyllic counts of 6.9 and 7.6, coliforms counts of 5.7 and 6.4, moulds and yeasts counts of 4.9 and 5.4 log_{10} cfu/g, were obtained by Adu-Gyamfi and Nketsia-Tabiri (2007) for early and late morning samples, respectively.

Processing of raw vegetables into salads for sale creates conducive environments and opportunities for the multiplication of pathogenic microorganisms on the salads. In this study, microbial contamination and counts of specific pathogens increased during sale, and the percentage of contaminated samples also increased during sale. This is because the salads still retain enough moisture to promote microbial growth, and also the

Table 5. Percentage of samples of raw mixed-vegetable salads purchased daily with street vended cooked rice over a three week period which were contaminated with four pathogenic microorganisms.

Pathogen	Number of contaminated sample		percentage of contaminated sample (%)	
	Morning (n = 75)	Afternoon (n = 75)	Morning (n = 75)	Afternoon (n = 75)
S. typhi	25	50	33.3	66.7
Shigella sp.	70	70	93.3	93.3
S. faecalis	60	70	80.0	93.3
Pseudomonas sp.	5	15	6.7	20.0

natural protective covering on the leaves against the entry of microorganisms may have been lost during harvesting, storage, transport and processing (Samarajeewa, 2005). The salad may also have undergone some fermentation during sale and the increased acidity may promote the growth of certain microbes such as *Bacillus*, *Cereus*, *Clostridium botullinum*, *Salmonella* sp. and *S. aureus,* which grow well in optimal pH of 4.2 to 8.2 (Samarajeewa, 2005). According to Amoah et al. (2005), lettuce from vegetable farms in Accra, irrigated with drain, stream and piped water, had faecal coliform levels exceeding common guidelines for food quality, irrespective of the irrigation water source. Lettuce irrigated with piped water had significantly lower coliform concentrations than those irrigated with shallow well or stream water.

According to a study by Amponsah-Doku et al. (2010) on the bacterial contamination of lettuce and at production sites, markets and street-food restaurants in the city of Kumasi, Ghana in general, the levels of thermo-tolerant coliforms on lettuce was increased by 18%, while *Enterococci* numbers reduced by 64% from the farms to the street-foods. In this study, microbial contamination increased during the course of sale of the salads. There are several possible sources of contamination. *S. faecalis* and *E. coli* are fecal contaminants (Samarajeewa, 2005) which could be from the manure in the soil on the farm. *Micrococcus* sp., *Salmonella* sp., and *Shigella* sp. from contaminated hands of food handlers may easily contaminate the vegetables (Samarajeewa, 2005). The spores of bacteria such as *Bacillus*, *Micrococci,* etc, are carried in air and dust and if the food is not properly covered, these spores could settle on the food, and once nutrients are present, the spores can actively grow and thrive on the food.

Apart from the polythene bags, all the other containers (for example, sacks, open trays, baskets, and wooden-sieve net cages) do not protect the raw vegetables from dust and other forms of contamination from the environment during transporting from the source to the site of preparation. The vendors who did not have assess to refrigerators placed the raw vegetables on rooftops overnight. This keeps the temperature of the vegetables low overnight, resulting in lower rates of respiration and deterioration (Dauthy, 1995). Refrigerator storage does not necessarily inhibit the growth of microorganisms since psychrophiles, such as *Alcaligenes* and *Pseudomonas* could survive refrigeration temperatures and in some cases even multiply (Samarajeewa, 2005). The condensation of dew on the vegetables overnight also makes the vendors perceive the vegetables to be still fresh. However, the exposure of the vegetables to the environment could lead to increased contamination.

Halablab et al. (2011) reported that lettuce samples from the Bekaa Valley in Lebanon had *E. coli, S. aureus* and coliforms. According to Amponsah-Doku et al. (2010), thermotolerant coliforms on lettuce varied from 2.3×10^3 to 9.3×10^8 cfu/g on farm, 6.0×10^1 to 2.3×10^8 cfu/g on market and 2.3×10^6 to 2.4×10^9 cfu/g at street-food vendor sites in Kumasi.

In a study by Amoah et al. (2007), all the fast-food sellers questioned claimed to wash the lettuce at home with tap water containing salt and/or vinegar before they prepared it for sale, but the amounts of salt and vinegar used were not enough to significantly decontaminate the lettuce. In this study, the vendors said they used only tap water to remove physically visible foreign matter on the raw vegetables before processing them into salads for sale. None of the vendors said they added salt or vinegar to the washing water.

Bacterial counts on farm lettuce and irrigation water, market lettuce and refreshing water and street-foods all exceeded the recommended World Health Organization (WHO) and International Commission on Microbiological Specifications for Food (ICMSF) standards of 10^3 cfu/g (for example, Log_{10} 3.0 cfu/g) (Amponsah-Doku et al., 2010). This agrees with the results obtained in this study, where bacterial counts on all salad samples exceeded Log_{10} 3.0 cfu/g.

Forty percent of the vendors surveyed in this study said they stored leftover salads in the refrigerator for sale the next day. The leftovers could also serve as good source for contaminating freshly prepared salads. It is advisable to separate the leftovers from freshly prepared salads, to prevent cross contamination. The leftovers could be kept for sale the next day, only if they are kept under cold storage and then reheated above 70°C before being sold (WHO, 1996). However, since salads are generally not heated, it is advisable that the leftovers are discarded. Vendors should therefore prepare just enough salad for

the day's sales. They could also prepare separate batches of fresh salads in the mornings and afternoons.

In this study, 44% of the vendors did not take conscious precautions to avoid contamination of the raw salads during preparation and sale, and this is due to the ignorance of majority of them on the causes of food contamination. In a previous work by Mensah et al. (2002) on the microbial quality of foods sold on the streets in Accra, only 17.9% of vendors associated diarrhoea with germs. In Rajvanshi (2010), all the samples of street vended salads in Jaipur City, India, carried gram positive as well as gram negative bacteria; and samples contaminated with certain pathogens were as follows: *Bacillus* (24.5%), *E. coli* (11.8%), *Pseudomonas* (11.8%), *Staphylococcus* (10.9%), *Enterobacter* (9.0%), *Streptococcus* (6.4%), *Klebsiella* (5.4%) and *Citrobacter* (3.6%).

In Yeboah-Manu et al. (2010) mean microbial loads of 8.54 to 8.69 Log_{10} cfu/g was reported for salad sold with waakye on and around the University of Ghana campus, and 6.41 Log_{10} cfu/g from restaurants outside campus. Pathogens identified were *E. coli, P. aeruginosa, K. pneumoniae*, and *Streptococcus* sp., but *S. aureus* was absent. The salads had salad cream added to them and the salad was not heated. Salad cream contains egg yolk, which is a good medium for supporting microbial growth.

The salad samples used in this study did not contain salad cream. This could account for the lower values of 4.16 Log_{10} cfu/g obtained in this study, compared to that of Yeboah-Manu et al. (2010).

Conclusion

The results of the microbial analysis confirmed that the raw mixed vegetable salads which are sold as accompaniment to street vended cooked rice in the Kokomlemle municipality of Accra, Ghana contain *S. faecalis* from fecal contamination and *S. typhi,* which could cause food poisoning and the highest risk is in the afternoons than in the morning samples.

It is recommended that food inspection officers intensify their supervisory duties and educate cooked food vendors on the basic tenets of food hygiene, with particular attention to the decontamination and proper handling of raw vegetables. Patrons of salads, especially street vended ones, should be made aware of the risk associated with consumption of the accompaniment. It is also recommended that the project be replicated in other parts of the city, so as to ascertain whether the findings of this project are a citywide problem or an isolated case.

REFERENCES

Abdalla MA, Suliman SE, Bakhiet AO (2009). Food safety knowledge and practices of street-food vendors in Atbara City (Naher Elneel State Sudan). Afr. J. Biotechnol. http://www.sustech.edu/staff_publications/2010052405134728.pdf 8(24): 6967-6971.

Adu-Gyamfi A, Nketsia-Tabiri J (2007). Microbiological studies of macaroni and vegetable. salads in Waakye, a local street-food. Ghana J. Sci., 47: 3-9.

Amoah P, Drechsel P, Abaidoo RC (2005). Irrigated urban vegetable production in Ghana: Sources of pathogen contamination and health risk elimination. Irrig. and Drain., 54: S49–S61. Published online in Wiley InterScience. http://onlinelibrary.wiley.com/doi/10.1002/ird.185/pdf

Amoah P, Drechsel P, Abaidoo RC (2007). Irrigated urban vegetable production in Ghana: microbiological contamination in farms and markets and associated consumer risk groups. Q IWA Publishing 2007 J. Water and Health | 05.3 | 2007. http://www.iwaponline.com/jwh/005/0455/0050455.pdf

Amponsah-Doku F, Obiri-Danso K, Abaidoo RC, Andoh L A, Drechsel P, Kondrasen F (2010). Bacterial contamination of lettuce and associated risk factors at production sites, markets and street-food restaurants in urban and peri-urban Kumasi, Ghana. Scientific Research and Essay. http://www.academicjournals.org/SRE. 5 (2): 217-223,

Benson HJ (2001). Microbiological applications: A laboratory manual in general microbiology, 8th Edition, McGraw Hill, Pp. 151- 181.

Canadian Food Inspection Agency (2001). Food safety, fresh fruit and vegetables-sampling for laboratory testing, http.//www. canadian foodag.htin

Centre for Food Safety (2006). Microbiological food safety of raw vegetables intended for human consumption, Hong Kong, http//www.cfs.gov.hk/English/programme/programme-rafs-fun02-01.htil

Consultative Group on International Agricultural Research (CGIAR) Challenge Program on Water and Food (2011). Safeguarding public health concerns, livelihoods and productivity in wastewater irrigated urban and peri-urban vegetable farming in Ghana. http://www.waterandfood.org/page/PN38.

Dauthy ME (1995). Fruit and vegetable processing. FAO Agricultural Services Bulletin No.119. Food and Agriculture Organization of the United Nations Rome.

DFID (2002). Street-food in Ghana. funded by British Government Department for International Development. www.nri.org/projects/streetfoods/project2-moreinfo.pdf

FAO (2005). Informal food distribution sector in Africa. (Street-foods): Importance and challenges. Regional Conference on Food Safety in Africa. FAO of the UN, ftp://ftp.fao.org/docrep/fao/meeting/010/a0215e/a0215e00.pdf . Pp. 99-100.

Halablab MA, Sheet IH, Holail HM (2011). Microbial quality of raw vegetables grown in Bekaa valley, Lebanon. Am. J. Food Technol. Acad. J. Inc., 6(2): 129-139.

Health Protection Agency, Standards Unit (2008). Identification of *Salmonella* Species, Issue No: 2.1, Issue date: 29.09.08. Issued by Standards Unit, Department for Evaluations, Standards and Training. Reference No: BSOP ID 24i2.1. p. 13. www.evaluations-standards.org.uk. http://www.hpastandardmethods.org.uk/documents/bsopid/pdf/bsopid24.pdf.

Health Protection Agency, Standards Unit (2008). Identification of Shigella Species, Issue No: 2.1, Issue date: 29.09.08. Issued by Standards Unit, Department for Evaluations, Standards and Training. Reference no: BSOP ID 20i2.1. p. 13. www.evaluations-standards.org.uk. http://www.hpa-standardmethods.org.uk/documents/bsopid/pdf/bsopid20.pdf.

Health Protection Agency, Standards Unit (2008). Identification of Streptococcus Species, Enterococcus Species and Morphologically Similar Organisms, Issue No: 2.1, Issue date: 29.09.08. Issued by Standards Unit, Department for Evaluations, Standards and Training. Reference No: BSOP ID 4i2.1. p. 13. www.evaluations-standards.org.uk. http://www.hpa-standardmethods.org.uk/documents/bsopid/pdf/bsopid4.pdf.

Health Protection Agency, Standards Unit (2008). Identification of Glucose Non-Fermenting Gram-Negative Rods, Issue No: 2.1 Issue date: 29.09.08. Issued by Standards Unit, Department for

Evaluations, Standards and Training. Reference No: BSOP ID 17i2.1. p. 13. www.evaluations-standards.org.uk. http://www.hpa-standardmethods.org.uk/documents/bsopid/pdf/bsopid17.pdf.

Johnson PNT, Yawson RM (2000). Enhancing the food security of the peri-urban and urban poor through improvements to the quality, safety and economics of street-vended foods. Report on workshop for stakeholders, policy makers and regulators of street-food vending in Accra, Miklin Hotel, 25-26, Sept. 2000. www.nri.org/projects/streetfoods/streetfdwkshopproceedings.doc. p. 35.

Maplandia.com. (2005). http://www.maplandia.com/ghana/greater-accra/accra-tema/kokomlemle/

Mensah P, Yeboah-Manu D, Owusu-Darko K, Ablordey A (2002). Street-foods in Accra, Ghana: how safe are they? Bull. World Health Org., 80:546-554.

Mingle NB (2010). Residents turn Kokomlemle street into rubbish dump, .Ghanaian Chronicle - http://ghanaian-chronicle.com/?s=Residents+turn+Kokomlemle+street+into+rubbish+dump.

Ohiokpehai O (2003). Nutritional aspects of street-foods in Botswana.. http://www.pjbs.org/pjnonline/fin89.pdf. Pak. J. Nutri., 2 (2): 76-81.

Pavan da Silva SK, Verdiu SEF, Pereira DC, Schatkoski AM, Rott MB, Cao G (2007), Microbiological quality of minimally processed vegetables sold in Porto Alegre Brazil, Braz. J. Microb., http://www.scielo.br/pdf/bjm/v38n4/a03v38n4.pdf. 38: 594-598

Rajvanshi A (2010). Bacterial load on street vended salads in Jaipur City, India. http://www.internetjfs.org/articles/ijfsv12-22.pdf. Internet J. Food Safety, 12: 136-139.

Samarajeewa U (2005). Manual on microbiological analysis, Srilanka, pp. 54-64.

Wanted in Africa (2005). Accra Medium area: Asylum Down/Kokomlemle. Wanted Worldwide Ltd. http://accra.wantedinasfrica.com/area_description.php?id_area=358

WHO (1996). Essential Safety Requirements for Street-vended Foods. Revised edition. Food Safety Unit Division of Food and Nutrition World Health Organization. http://www.who.int/foodsafety/publications/fs_management/en/streetvend.pdf.

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. Res. J. Microbiol., 5: 130-136. http://scialert.net/fulltext/?doi=jm.2010.130.136&org=10.