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Bacteriological Quality of Ready-to-Eat Foods Sold within Korle-Bu Teaching Hospital and Its Immediate Environs

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Abstract:
Objective: To compare the bacteriological quality of ready-to-eat foods being sold within the hospital premises with those being sold outside the hospital premises.
Design: Prospective cross sectional study
Setting: Urban township in a developing country
Method: 64 food samples (comprising of 12 different food types) were taken from vendors within the hospital premises and those outside the hospital premises. All food samples were collected in sterile disposable containers (Sterilin bags). Each sample was properly labeled with a number code, subject name, type of food and date of collection. Demographic data of the vendors and the sanitary nature of the vending environment were adequately noted. Culture of samples collected was performed and organisms isolated were thus identified using standard biochemical methods.
Results: The standard plate counts of 37.5% of the samples analyzed was within the satisfactory limit while 62.5% of the samples were above the acceptable limit. 42.2% of the samples analyzed had enterobacteriaceae counts within the satisfactory limit while 57.8% were above the acceptable limit. There was no significant difference between the Standard Plate Count and Enterobacteriaceae Count of foods sold within and outside the hospital thus, the quality of foods sold within the hospital and those sold outside the hospital is the same.
Conclusion: The bacterial load of ready to-eat foods sold within Korle-Bu teaching hospital and its immediate environs could pose a substantial risk to its consumers.

Keywords: *Ready-to-eat foods, quality, hospital, risk, Korle-Bu teaching hospital*

1. Introduction

Ready-to-eat foods are those that are ordinarily consumed in the same state as they are sold; and these do not include nuts, raw fruits and vegetables that are intended for hulling, shedding or washing by the consumer. They may be consumed where they are purchased or can be taken away and eaten elsewhere. A common observation has shown that some ready-to-eat food handlers may compromise quality in their bid to maximize profits. This may be done by holding food at improper temperatures, selling it at relatively insanitary environments and careless handling of the food by vendors (WHO, 2001, 2003; Agbodaze DPN et. al. 2005; Muinde O.K., and Kuria E., 2005; Ghosh M. et. al. 2007).

Food may contain a variety of micro-organisms many of which are harmless. Even those that can cause illness may be present in foods at low levels and if this food is consumed, especially as soon as prepared, illness is unlikely. Food-borne illness caused by microbial contamination of foods is an important public health problem and is known to be a major cause of diarrhoeal diseases especially in developing countries (Mensah P. 1997). However, since most infections are treated at home, estimates may be just the tip of the iceberg. A number of studies in Accra show the sorry state of food samples in Accra - it may not be any better in other parts of the country (Newman MJ 2005). The incidence of food related infections is grossly under-reported in the country, because only the very serious episodes are taken to hospitals. Usually, only severe outbreaks may be properly investigated to identify the causative agent (Newman MJ 2005).

In Ghana, ready-to-eat foods are prepared and or sold mostly in public places such as open markets and along the streets. These foods are sold at relatively cheaper cost and at easily accessible places. The preparation of these foods being sold is quite laborious, time consuming, and done under questionable environmental hygiene. Appropriate control measures during preparation such as efficient hygiene standards are expected to ensure that the end products are free from viable organisms that are capable of causing food-borne infection and that the foods are of good quality (Gilbert RJ et. al. 2000). However, this is not always the case due to the laborious nature involved in the preparation of the foods.

Microbial contamination is the most common form of contamination and perhaps the most potentially harmful. The bacteriological quality of food indicates the level of bacterial contaminants present in the food. Factors that may contribute to bacterial contamination

of food include temperature, moisture and the nature of the food itself. Bacteria causing food borne illnesses thrive best at room temperatures; thus it is advisable to keep food either hot or very cold. In recent times, technologies such as refrigeration have been introduced to prolong the storage, transport, shelf-life of prepared foods, and to minimize the risk of contamination by micro-organisms. However, many food vendors lack the necessary facilities to prevent food contamination. A survey conducted by the Food and Agriculture Organization (FAO) in 2001 recorded a higher incidence of food-borne illness in areas with increased food vendor activity (Ruel MT. et. al. 1998). In Ghana, one needs no special qualification or training to sell food on the street. With the increase in food selling points along the streets of major roads in Accra and other big towns in the country, vendors must be educated on food hygiene practices.

In October 2007, an outbreak of acute gastroenteritis was reported on the University of Ghana main campus that affected thirty four students. A preliminary investigation carried out revealed that all the affected individuals patronized a food item sold in one of the open markets. Some of the organisms isolated from the food included *E.coli, Klebsiella pneumonia, Streptococcus spp., Bacillus spp., Staphylococcus aureus,* and *Enterococcus faecalis* (Yeboah-Manu D. et. al. 2010). This study was therefore carried out with the aim of determining the bacteriological quality of ready-to-eat foods sold within the Korle-Bu teaching hospital and its immediate environs in order to boost customers' awareness on the dangers of consuming pathogen-contaminated ready-to-eat foods and to compare the quality of ready-to-eat foods being sold within the hospital premises with those being sold outside the hospital premises.

2. Materials and Methods

2.1. Study Area and Sample Collection

The study was carried out at Korle-Bu, and vendors of ready-to-eat foods within and around the immediate environs of Korle-Bu Teaching Hospital were recruited for the study. The immediate environs comprised those road-side food vendors on the main street/road facing the hospital and those on the two major sub-streets/roads leading into Korle Gonno.

The study area is located within the Dahomian ecological zone of West Africa and the vegetation is coastal savanna grassland. The climate is hot and humid and there is a bimodal rainfall pattern with a mean annual rainfall of about 1300mm. the mean daily temperature is 26^0C with a range of 18^0C – 35^0C. The relative humidity can be as high as 97% in the mornings of wet seasons and as low as 20% in the afternoons of the dry seasons.

The table below describes the samples collected for the study

S/N	Food	Description	Cooking Method
1	Salad	Mixture of fresh vegetables	No cooking
2	Talia (home-made macaroni)	Extruded wheat flour	Boiling
3	Kenkey	Fermented maize dough dumplings.	Wrapped in corn husk or plantain leaves and boiled
4	Rice	Boiled rice	Boiling
5	Waakye	Rice and beans	Boiling
6	Fried rice	Half boiled plain rice, fried and spiced with carrot, spring onions, salad leaves and soya sauce.	Boiling and frying
7	Plantain	Boiled or fried	Boiling or frying
8	Beans	Cooked beans	Boiling
9	Groundnut soup	Mixture of tomatoes, onions, pepper, fish or meat, and groundnut paste.	Boiling
10	Okra soup	Mixture of tomatoes, onions, pepper, fish or meat, okra and palm oil.	Boiling
11	Tomato stew	Gravy made with onions, tomatoes, pepper and vegetable oil. Fish, meat or chicken is used.	Boiling
12	Nkontomre (cocoyam leaves) stew	Gravy with palm oil and fish. Nkontomre added	Boiling

Table 1: Description of samples collected

2.2. Laboratory Analysis

The food samples were analyzed for Total Pate Count (TPC), Enterobacteriaceae Count (EC), and Faecal Coliform Plate Count (FCPC).

2.3. Bacteriological Examination

Bacteriological examinations were carried out on the food samples by direct culture methods (Greig J.D et. al. 2007)

2.4. Total/Standard Plate Counts

This procedure provides a standardized means of determining the quantity of bacteria in food samples. This is an empirical measurement because organisms occur singly, in pairs, clusters, or packets, and no single growth medium or set of physical and chemical conditions can satisfy the physiological requirements of all organisms in a sample.

Ten grams portion of each solid food sample was macerated in 20 ml of phosphate buffered saline (PBS) and afterwards filled up to 100 ml and a 1:10 dilution was made from this, while 1ml of liquid samples were introduced into 9 ml of the PBS in a test tube to give a total volume of 10 ml which gives a 1:10 dilution. Furthermore, tenfold serial dilution was made and examined by means of the pour plate method (Mensah P. et. al. 2002). Each plate was carefully labeled and 1ml of diluted sample from each dilution to be analyzed was transferred using a pipette into the plates and 25ml of cooled molten agar (Plate Count Agar (PCA)) was then poured over it, giving a total of twenty six milliliters. The sample was mixed thoroughly with the medium and then allowed to set on a flat-top bench. Solidified plates were then incubated at 37°C for 18-24 hours. All platings were performed in duplicate. After overnight incubation, counts were made using a colony counting device that allowed viewing of individual colonies. All discrete colonies were counted where possible and expressed in colony forming units per gram (cfu/g) for solid foods and colony forming units per milliliter (cfu/ml) for liquid food samples.

2.5. Enterobacteriaceae Count (EC)

0.1 ml of sample from each dilution to be analyzed was transferred using a pipette onto 25ml of solidified MacConkey agar with bile salt after which an L-rod spreader was used to spread the inoculum evenly over the surface of the agar to ensure confluent growth. The plates were incubated at 37°C for 18-24 hours. All platings were performed in duplicate. After incubation, counts were made using a colony counting device that allowed viewing of individual colonies. All discrete colonies were counted where possible and expressed in colony forming units per gram (cfu/g) for solid foods and colony forming units per milliliter (cfu/ml) for liquid food samples.

2.6. Faecal Coliform Plate Count (FCPC)

Because enterobacteriaceae counts are inadequate to differentiate between faecal and nonfaecal contamination, a faecal coliform plate count was performed. Faecal coliforms are facultatively anaerobic, rod-shaped, Gram negative, non-sporulating bacteria that produce acid and gas from lactose within 48 hours at 45.5ºC. This elevated temperature heat-shocks non-faecal bacteria and suppresses their growth (Doyle MP. 2006). Fecal coliforms are considered to be more directly associated with faecal contamination from warm-blooded vertebrates than are other members of the coliforms. *E. coli* usually makes up 75-95% of the fecal coliform count, but at times can represent less than 1% of the coliform count (APHA, 1970; Greenberg AE. and Hunt DA., 1985; Paille D. et al., 1987). 0.1 ml of sample from each dilution to be analyzed was transferred using a pipette onto 25ml of solidified Eosin Methylene Blue agar (EMB agar) after which an L-rod spreader was used to spread the inoculum evenly over the surface of the agar to ensure confluent growth. The plates were incubated aerobically at 45.5°C for 24-48 hours. All platings were performed in duplicate. After incubation, counts were made using a colony counting device that allowed viewing of individual colonies. All discrete colonies were counted where possible and expressed in colony forming units per gram (cfu/g) for solid foods and colony forming units per milliliter (cfu/ml) for liquid food samples.

2.7. Isolation of Organisms

Bacterial isolation, purification and identification are the first steps to bacteriological studies. Isolation was done to obtain pure bacterial cultures.

5ml portion of the macerated sample was centrifuged at 11000 rpm for 30 minutes in a refrigerated centrifuge and the supernatant decanted. A loop full of the sediment was inoculated into Selenite F broth for the growth of *Salmonella spp*. and *Shigella spp*. and incubated at 37^0C for 18-24 hours after which it was sub-cultured on Salmonella/Shigella Agar (SSA). Another loop full of the sediment was inoculated into Deoxycholate Citrate Agar (DCA) and MacConkey agar for the detection of *Salmonella spp, Shigella spp, Escherichia coli, Klebsiella spp*, and other Enterobacteriaceae. An enriched medium (Blood Agar specifically) was used to culture the sediment to enable other organisms (e.g. Gram positive organisms) to grow and Thiosulfate-Citrate-Bile-Sucrose (TCBS) was used for selective isolation of *Vibrio spp* after initial inoculation into Alkaline Peptone Water for enrichment. All incubations were done at 37^0C under aerobic conditions for 18-24 hours. In cases of mixed growth, purity plating was carried out.

2.8. Identification of Organisms

Bacterial isolates were identified using biochemical methods and microscopy. When routine biochemical test for identification of enterobacteria failed to identify isolated organisms, the BBL crystal method was employed. The BBL Crystal Enteric / Non-fermenter identification system is used for the identification of aerobic Gram negative bacteria that belongs to the family Enterobacteriaceae as well as some of the more frequently isolated glucose fermenting and non-fermenting Gram-negative rods. It is a miniaturized identification method that uses modifications of classical methods. The tests used in this system are based on microbial utilization and degradation of specific substrates detected by various indicator systems.

3. Results and Analysis

3.1. Environmental Analysis of Samples

Twelve (12) different food types were used in this research and a total of sixty four (64) foods were sampled from twenty nine (29) vendors. A minimum of 4 samples for each food type was obtained from the vendors. 48 samples out of the total sixty four (64) samples were obtained during the day time while 16 samples were obtained during the night. 24 samples out of the 48 samples obtained during the day were collected from within the hospital premises whiles the other 24 samples were collected from outside the hospital premises (Korle gonno). Thus, a total of 40 samples comprising both day and night were obtained from outside the hospital premises. 30% (19/64) of the vendors operated in enclosed canteens whiles 70% (45/64) operated in open canteens. Of the 64 samples collected, 42 (65.6%) were solid in nature, 17 (26.5%) were liquid in nature, and 5 (7.8%) were semi-solid in nature. 43 (67.2%) of the samples were vended in neat environments whiles 21 (32.8%) of the samples were vended in dirty environments. 46 (71.8%) of the food samples were sold under hot temperature conditions, 4 (6.3%) under warm temperature conditions and, 14 (21.9%) under cold temperature conditions. 30 (47%) of the foods were kept in closed containers such as glass sieve, mesh, 'ice chest' and storage bowls during sale while 34 (53%) of the foods were left opened to the environment.

3.2. Enumeration of Bacterial Species

A total of 174 bacteria from eleven different species were isolated during the research. The eleven species include; *Staphylococcus spp.* (42), *Pseudomonas spp.* (42), *Citrobacter spp.* (36), *Citrobacter diversus* (4), *Bacillus spp.* (19), *Escherichia coli* (15), *Enterobacter aerogenes* (5), *Enterobacter cloaca* (4), *Proteus spp. (4), Klebsiella pneumoniae pneumoniae* (2), and *Salmonella spp.* (1). Thus, *Staphylococcus spp* and *Pseudomonas spp* were the most predominant species isolated with each constituting 24.13% of the total number of bacteria isolated during the study. 22.99% of the organisms isolated were *Citrobacter spp* and *Bacillus spp* amounted to 10.9% of the total bacteria isolated. *Escherichia coli, Enterobacter aerogenes, Enterobacter cloaca, Proteus spp., Klebsiella pneumoniae pneumonia and Salmonella spp.* constituted 8.6%, 2.9%, 2.3%, 2.3%, 1.2% and 0.6% respectively, of the total bacteria isolated.

3.3. Bacteria Load

24 (37.5%) of the samples had Standard Plate Count (SPC) values within the acceptable limits ($\leq 10^4$ cfu/g) while 40 (62.5%) of the samples had counts which were above the acceptable limits ($\geq 10^5$ cfu/g). On the other hand, 27 (42.2%) of the samples had Enterobacteriaceae Count (EC) values within the acceptable limits ($<10^4$ cfu/g) whiles 37 (57.8%) of the samples had counts above the acceptable limits ($\geq 10^4$ cfu/g). No coliform of faecal source was isolated during the study. Table 2 below illustrates these findings.

	Satisfactory	**Unsatisfactory**
SPC	24 (37.5%)	40 (62.5%)
EC	27 (42.2%)	37 (57.8%)

Table 2: Summary of bacterial counts

3.4. Comparison of Means

The difference observed between the means of satisfactory and unsatisfactory Standard Plate counts was found to be statistically significant (F calculated =7.702, df =1,53, confidence interval 95%, p=0.008). On the other hand, the difference observed between the means of satisfactory and unsatisfactory Enterobacteriaceae counts was not statistically significant (F calculated =1.077, df =1,42, confidence interval 95%, p=0.305). Furthermore, there was no statistically significant difference observed between the means of SPC values for foods sold within the hospital premises and those sold outside the premises (F calculated =0.018, df =1,53, confidence interval 95%, p=0.894) neither was there any significant difference for that of the EC (F calculated =1.163, df =1,42, confidence interval 95%, p=0.287). Figure 1 and 2 below illustrate the differences between the means.

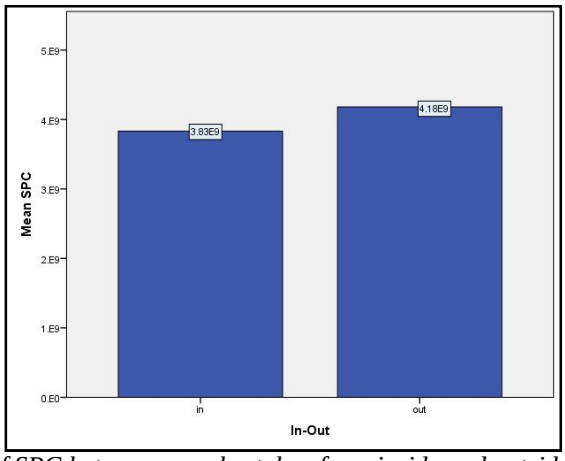

Figure 1: Mean plot of SPC between samples taken from inside and outside the hospital premises

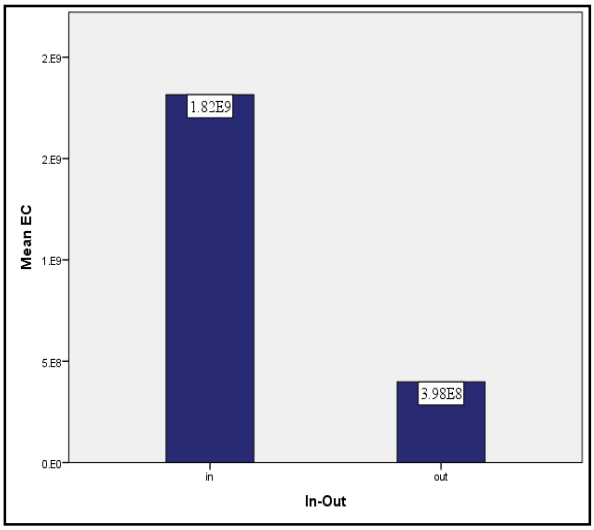

Figure 2: Mean plot of EC between samples taken from inside and outside the hospital premises

Unlike the mean SPC of foods sold under cold, warm and hot temperatures that showed no significant difference, there was significant difference between the means of EC for foods sold under cold, warm and hot temperatures (F calculated =2.959, df =2,41, confidence interval 95%, p=0.063). Figure 3 and 4 below illustrates the differences between the means

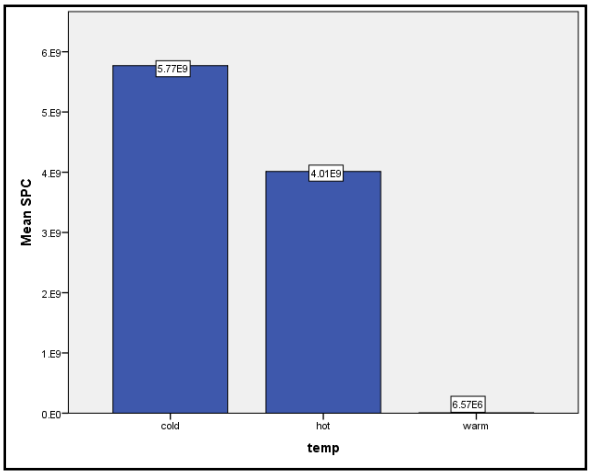

Figure 3: Mean plot of SPC between samples taken cold, hot and warm temperatures

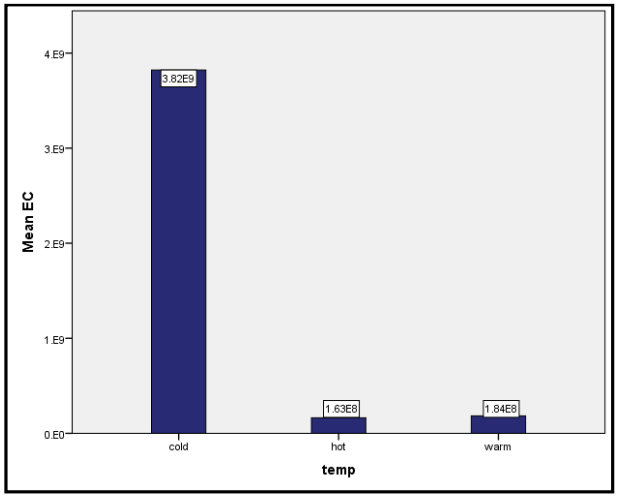

Figure 4: Mean plot of EC between samples taken cold, hot and warm temperatures

No significant correlation existed between temperature and SPC values whereas there was a significant weak negative correlation between temperature and EC values (p=-0.308 at 95% confidence level).

More organisms were isolated from foods vended in the open canteens, however there was no statistical significance in the differences observed between the two categories (F calculated = 2.174, confidence interval 95%, p=0.145). The figure below illustrates this further.

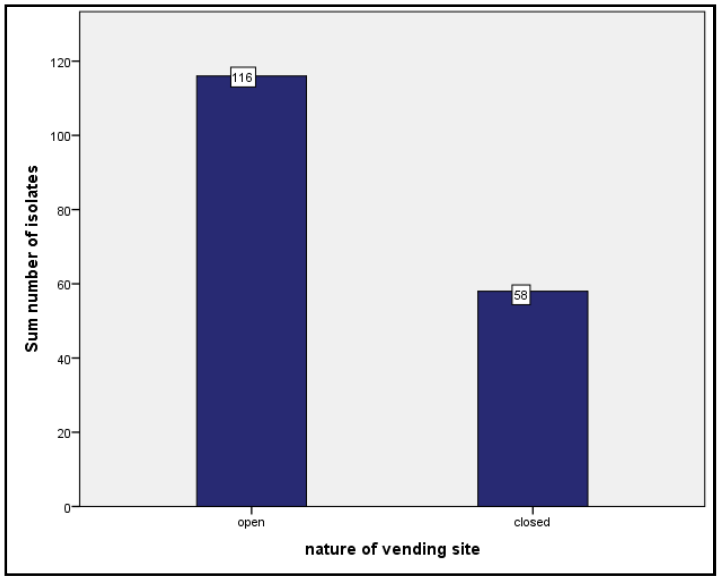

Figure 5: Sum of organisms isolated against the nature of vending site.

The mean SPC and mean EC for foods sold in enclosed canteens were found to be both higher than those sold in open canteens. The differences observed were however not statistically significant (for SPC, F calculated =0.782, df =1,53, confidence interval 95%, p=0.380 and for EC, F calculated=2.903, df=1,42, confidence interval 95%, p=0.096).
A total of 120 organisms were isolated from foods vended under neat environmental conditions whiles 54 organisms were isolated from foods vended under dirty environmental conditions. However, there was no statistical difference observed between the mean SPC of those vended under dirty environmental conditions and those vended under neat environmental conditions (F calculated =0.884, df =1, 53, confidence interval 95%, p=0.351) neither was there any statistical difference between the mean EC of those vended under dirty environmental conditions and those vended under neat environmental conditions (F calculated =0.710, df =1,42, confidence interval 95%, p=0.404). No significant difference was observed between the mean SPC and EC of foods sold in covered containers and those left open to the environment (p=0.240 for SPC, p=0.316 for EC).

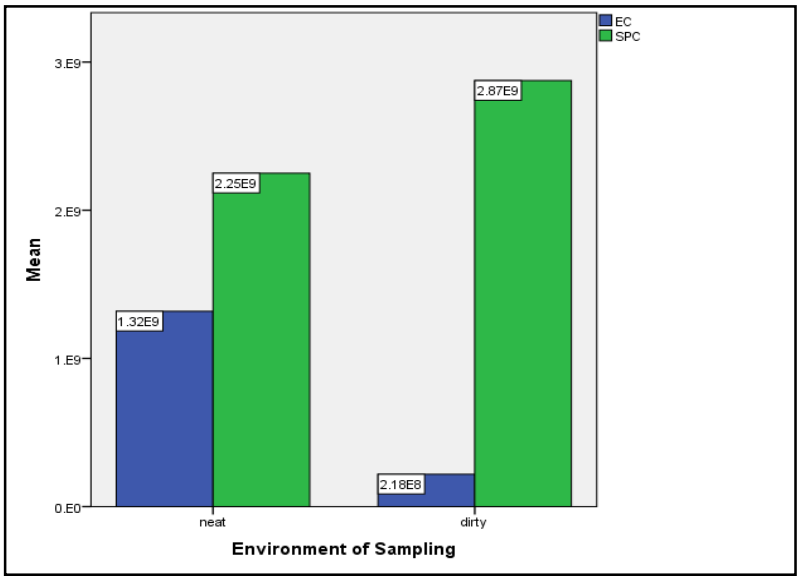

Figure 6: Mean SPC and mean EC of isolated organisms with environment of sampling

There was no statistical significant difference between the mean SPC values for samples taken at night and those taken during the day (F calculated =0.580, df =1,53, confidence interval 95%, p=0.450) neither was there any statistically significant difference between the mean EC values for samples taken at night and during the day (F calculated =0.121, df =1,42, confidence interval 95%, p=0.730). More so, there was no significant correlation between the time of day sample is collected and the mean SPC and EC values.

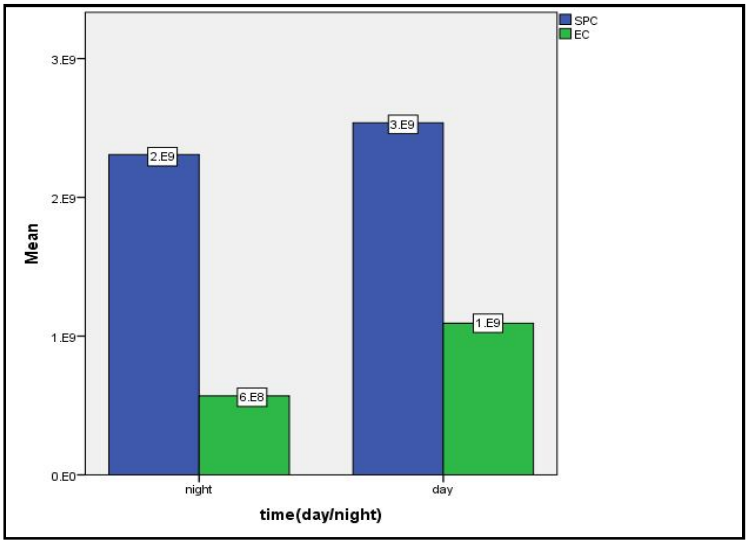

Figure 7: Mean SPC and mean EC of isolated organisms against the time of day

3.5. Mode of Serving Food

49 (76.6%) of the food samples were served with spoons, 8 (12.5%) with hands, 6 (9.4%) with forks, and 1 (1.6%) with a combination of both hands and spoons.

3.6. Educational Status of Vendors

14 (48.3%) of the vendors who participated in this research had received education up to the middle school level and 9 (31%) had received education up to the primary school level. Only 1 (3.4%) vendor had received tertiary education.

4. Discussion

Food contamination can be microbial or environmental, with the former being more common. Environmental contaminants that can enter the food supply chain include pesticides, heavy metals, and other chemical agents. Many opportunities exist for food to become contaminated as it is produced and distributed. To begin with, bacteria are present in the animals raised for food. Meat and poultry can become contaminated during slaughter through cross-contamination from intestinal faecal matter. Similarly, fresh fruits and vegetables can be contaminated if they are washed using water contaminated with animal manure or human sewage. During food processing, contamination is also possible from infected food handlers. Lastly, poor hygiene in the home is also a factor (Leon W. 2002).

Pathogenic bacteria are the most common known causes of food contamination and food borne illnesses. This study therefore, aimed to analyze the bacteriological quality of ready-to-eat foods sold within Korle-Bu Teaching Hospital and its immediate environs.

Staphylococcus spp., Pseudomonas spp., Citrobacter spp., Citrobacter diversus, Bacillus spp., Escherichia coli, Enterobacter aerogenes, Enterobacter cloaca, Proteus spp., Klebsiella pneumoniae pneumoniae, and *Salmonella spp*. were isolated during the study with *Staphylococcus spp*. and *Pseudomonas spp*. being the most predominant organisms and *Salmonella spp*. being the least isolated organism. All the *Staphylococcus species* isolated were *Staphylococcus aureus* except for one coagulase negative *Staphylococcus spp.* The presence of *S. aureus,* an enterotoxin producer which can cause serious gastroenteritis (Balaban N. and Rasooly A., 2000) and *Ps. aeruginosa,* an opportunistic pathogen, is known to cause food spoilage and can lead to economic loss (Liao CH. , 2006). Thus, they must be of utmost concern to the general public. *Staphylococcus aureus* was isolated more frequently in foods such as fried rice, tomato stew and kenkey. Most staphylococcal foodborne disease outbreaks are caused by direct contamination of cooked food often while it is still warm, by hands contaminated (with secretions) from the nose, mouth, wounds or skin. Upon finding the subsequent storage conditions favourable, Staphylococci multiply and produce toxins (Jacob M. 1989). *Staphylococcus aureus* itself is fairly readily destroyed by the heat of normal cooking, but this procedure will not destroy the toxin. This makes them highly dangerous in foods. The toxins are destroyed by boiling the food for a period that would virtually lead to the disintegration of the food and this cannot be practiced in the preparation of ready-to-eat foods (Jacob M. 1989).

The ramifications of the various organisms of the Salmonella group are far and wide, the ecology is complex and the damage to animals as well as to man is immense. *Salmonella spp.* was isolated from one food sample taken at night and its isolation poses a severe health risk to ready-to-eat food consumers. The presence of *Salmonella spp* in ready-to-eat foods may be as a result of undercooking, poor handling practices and cross contamination. The bacteria frequently live in animals that are either clinically or subclinically infected and contaminate food in variety of ways (Jacob M. 1989). In the kitchen, they may be transferred from raw to

cooked food by hands, surfaces or utensils and other equipment. It is a very common cause of foodborne illness, mainly because they are easily spread through the environment to people.

The hygienic quality of the ready-to-eat foods being sold within Korle-Bu teaching hospital and the immediate environs was found to be within acceptable limits ($<10^4$) since the difference observed between the means of acceptable and unacceptable counts was not statistically significant. However, the case is not the same for the general bacteriological quality of these foods in which the mean unacceptable standard plate count was higher than the mean acceptable standard plate count and this difference was found to be statistically significant. Eric S et al in 2009 reported the general increased awareness of vendors on issues pertaining to food safety such as hygiene and disease control. Therefore, the low enterobacteriaceae count may be due to the increase in awareness of vendors on the need to improve hygienic conditions thus reducing person-to-food contamination while the high standard plate count may be as a result of environmental contamination of the food as most foods were vended under open environmental conditions. In addition, majority of the organisms might have survived the cooking process.

There was no significant difference between the quality of food being sold inside and outside the hospital premises. A significant difference was noticed between the mean EC of foods sold under hot, warm and cold temperature conditions. This was also reflected when the Pearson's correlation indicated a weak negative association between temperature and EC.

Majority of the foods are served using spoons and most of the organisms isolated during this study were obtained from samples served with spoons. Hobbs BC. et al in 1987 associated the words 'food hygiene' with personal cleanliness which is often limited to the care of the hands. This may be attributed to the possibility of the increase in awareness of vendors on the need to regularly wash their hands during food preparation and serving. This need may not have been replicated to the spoons. Secondly, there is the possibility of cross-contamination since the spoons are used on different kinds of food on daily basis without washing intermittently. Finally, the difference observed may be due to the fact that only few vendors sold the foods using their hands.

The nature of the vending site (open or enclosed) had no significant effect on the mean SPC and mean EC of the food samples. Although the mean SPC for samples obtained from vendors who operated under dirty environmental conditions was higher than that of those who operated under clean environmental conditions, the difference was not statistically significant. Likewise, there was no significant difference in the mean EC between foods vended under neat environmental conditions and those vended under dirty environmental conditions. Thus, the contamination may not necessarily be from the immediate environment of vending.

Most of the organisms isolated were from vendors below the mean age (37). This may have been due to lack of care for cooking and serving equipment or carelessness exhibited by the younger vendors towards maintaining high sanitary standards at vending points as observed during the process of sample collection.

The difference in the mean SPC and mean EC between samples taken during the day and those taken at night, though not significant, might have been due to the fact that more samples were collected during the day than during the night.

No faecal coliform was isolated during the study. This is an indication of good sanitary hygiene practiced by the vendors.

5. Conclusion

Hobbs BC et al 1987 reported foodborne illnesses to be on the increase. Therefore, improvement in methods of food preparation and education of those responsible for the provision of food, particularly in mass catering situations, would undoubtedly reduce the incidence of food poisoning (Getachew F. et al 1999).

For foodborne illness to occur, one of the following must take place:

- Either bacteria must be present on, or in, the contaminated food in sufficient numbers or concentrations to survive the growing period, harvesting, storage and processing;
- Bacteria on, or in, foods must multiply and reach sufficient quantities, or produce toxins in sufficient quantities to cause illness;
- Bacteria must enter the food preparation area on, or in, raw foods, and be transferred to workers' hands, or to the utensils and surfaces, which, if inadequately washed, will contaminate other foods.

If a number of pathogenic bacteria are consumed, but not enough to cause illness, an infected individual may become a carrier and may contaminate other foods that he or she comes in contact with. The number of organisms required to produce illness depends on the virulence of the organism, the age and the general health of the person. Infants, elderly or undernourished people, and people already affected by other illness are more susceptible to foodborne illness than healthy adults, and a dose lower than the normal minimum infective dose could cause illness, and even fatalities among them.

In conclusion, the bacteriological quality of ready-to-eat foods sold within Korle-Bu Teaching Hospital and its immediate environs is not safe for consumption as the total/standard plate counts were above acceptable limits. In the light of the outcome of this research and in order to reduce the level of contamination of ready-to-eat foods, the following practices are thus recommended;

- Food should not be prepared more than half a day in advance of need.
- Food should not be kept at ambient temperature for too long
- Inadequate cooling should be avoided
- Undercooking should be avoided
- Cross contamination from raw to cooked food should be prevented as much as possible
- Frequent hand washing by people handling food and frequently changing the water.
- People with open wounds on their hands or arms should not handle food before the infection is healed.

These, I believe are within the capability of the vendors to achieve.

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