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Microbiological quality assessment of foods sold in student's cafeterias

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The microbiological quality of ready-to-eat food (Street foods (SFs) products sold in a University Campus was assessed. A total of forty eight RTE food samples, including coleslaw, fried rice, jollof rice and moi-moi were collected from two food vending sites which serves as the major ready to eat food vending centres to the student community. A total of nine species (spp) of microorganisms including *Bacillus* spp, *Escherichia coli*, *Klebsiella* spp, *Proteus* spp, *Staphylococcus aureus*, *Aspergillus niger*, *Aspergillus fumigatus*, *Penicillium* spp and *Mucor* spp were isolated from the food samples. The mean total aerobic plate count, coliform count and fungal count from SITE I range from 2.5×10^3 to 9.1×10^6 , 3.2×10^3 to 3.4×10^4 , and 6.0×10^2 to 7.3×10^4 respectively. SITE II had aerobic plate count, coliform count and fungal plate count ranging from 2.7×10^3 to 9.8×10^6 , 5.2×10^3 to 7.8×10^4 , and 9.0×10^3 to 9.3×10^6 respectively. Based on the specifications by International Commission for Microbiological Specification for Foods (ICMSF), the level of contaminations was within acceptable microbiological limits except for coleslaw; this could be attributed to extensive handling, mixing and to the fact that it is consumed as raw food. It is recommended that a closer and stringent supervision of ready-to-eat foods sold to students in the University should be carried out by relevant authorities to prevent possible outbreak food borne illness.

Keywords: Food borne illness; Microbiological quality; Ready-to-eat foods, stringent supervision.

INTRODUCTION

Safe food is a basic human right despite many foods are frequently contaminated with naturally occurring pathogenic microorganisms. Such pathogens cannot be detected organoleptically (seen, smelled or tasted), but can cause disease of varying severity, including death specially if the way they are conserved during exposition for sales provides conditions for those microorganisms to grow and reach considerable levels of contamination. Thus, food safety issues are of major importance to world health (WHO, 2000).

The global incidence of food borne illnesses is difficult to estimate but it has been reported that in 2000 alone 2.1 million people died from diarrhoeal diseases. A great proportion of these cases can be attributed to contamination of food and drinking water (WHO, 2000). Illness resulting from the consumption of contaminated food has become one of the most widespread public health problems in contemporary society (Notermans *et al.*, 1995). In Nigeria, as in many developing countries, a major source of ready-to-eat foods (Street foods (SFs) are prepared and or sold at public places such as schools, markets places, along the streets. The SFs offer food at relatively cheaper rate and at easily accessible places (Mensah *et al.*, 2002; Oranusi and Braide, 2012). Furthermore, it offers the traditional meals and preparations of a number of them are quite laborious and time consuming. Thus, with the increase in the number of hours spent at work places by parents

and schools, the importance of SFs in the human feeding is increasingly becoming very important among all socio-economic groups (Amoah, 1992; Chakravarty and Canet, 2002).

A number of observational studies have shown that these foods are sometimes held at improper temperatures, excessively handled by food vendors and sold at very dirty surroundings (WHO, 2001, 2003; Muinde and Kuria, 2005; Ghosh *et al.*, 2007). In addition, the vendors practice poor personal hygiene and reports of food vendors being carriers and therefore could serve as a potential source of transmission of enteric fevers are many. Most of the vendors have either no formal education or few years of schooling and therefore, lack knowledge on proper food handling and their role in the transmission of pathogens (Mensah *et al.*, 2002). At the same time, most people who use these food services are more interested in its convenience than the question of microbiological quality and hygiene. The microbiological quality of food indicates the amount of microbial contaminants it has, a high level of contamination indicates low quality of food storage and its handling and more likely to transmit infection and the reverse is true (Anonymous, 1988). Thus concerns have been raised by the Food and Agricultural Organization (FAO) and others about these foods serving as a potential source of food poisoning outbreaks (Chakravarty and Canet, 2002).

Ready-to-eat (RTE) foods refer to foods that do not require further significant preparation other than reheating or completion of a cooking process (FEHD, 2001; FSAI, 2001). It has been reported that RTE take-away foods accounts for a large volume of sales of the food service sector, representing more than a third of the food service volume outputs (Powers and Barrow, 1999).

Food borne disease outbreaks linked with RTE foods have been associated with various foodborne pathogens (Gilbreth *et al.*, 2005; Gibbons *et al.*, 2006). The initial microbiological load on RTE food ingredients is important, however, factors such as handling, processing, storage and display may influence the microbiological load of RTE foods at the point of sale (Beuchat and Ryu, 1997; Angelidis *et al.*, 2006). Ready to eat foods such as salads and sandwiches from food canteens have also been implicated in food borne illness outbreaks. These foods are often prepared by hand and this direct contact may lead to an increased incidence of contamination with potential food borne pathogens, such as *Staphylococcus* spp (Christiansen and King, 1971; Colombari *et al.*, 2007). The microbiology of RTE foods during preparation in factories, in domestic kitchens, in canteens and on street corners by street vendors has previously been investigated (Von Holy and Makhoane, 2006).

The majority of students on Campus do not prepare food themselves or take it along with them to the University. This demand for food gives opportunity to the Cafeterias and canteens to serve as the major vending sites where students purchase food daily.

The aims and objectives of this study is to assay for microorganisms in ready-to-eat foods, obtained from the major food vending centres in the University and environ to determine whether these foods meets the acceptable microbiological standards and specification for foods.

MATERIALS AND METHODS

Sample collection

A total of 48 samples comprising of twelve each of four ready to eat foods (fried rice, Jollof rice, moi-moi and coleslaw) were obtained from two major food vending sites in Federal University of Technology, Owerri. The samples were collected over a two weeks period in July and August. Samples were purchased when freshly prepared and into sterile specimen containers, and were taken in cold packs under aseptic condition to the laboratory for microbiological analysis within one hour of collection.

Microbiological analysis

Ten (10) grams of each food sample was mixed with 90 ml Nutrient Broth (Biotec, UK) and serial dilutions of each food sample homogenate were made to 10^5 dilutions. Approximate 0.1 ml aliquot portions of the dilutions were spread onto duplicate sterile plates of Nutrient Agar, MacConkey Agar, Selenite Broth Base, Bismuth Sulphite Agar (all from Biolab, Hungary), for

total aerobic plate count, coliform count, isolation of salmonellae and Shigella and into Lactose Broth (Fluka, Germany), Eosin Methylene Blue Agar (Oxoid, England), Saboraud Dextrose Agar (SDA., Oxoid, England) to which Penicillin and Streptomycin had been incorporated, Manithol Salt Agar (Oxoid, England), for the isolation of coliform, fungi count, and *Staphylococcus aureus*. Cultures were incubated at 37°C for 24 to 48 hrs except for SDA that was incubated for 3 to 5 days at 28±2°C.

After the incubation time, the different culture plates were examined for microbial growth. Colonies were counted using the colony counter (Gallenkamp, England), counts were expressed as colony forming unit per ml of sample homogenate (cfu/ml). Different morphological attributes of the colonies were observed and recorded. Discrete colonies were isolated and purified by repeated sub-culturing. Pure cultures were stored on slants at 4°C for further characterization.

Coliform test

Presumptive test: One (1) gram of each sample was transferred to sterile McCartney bottles containing Lactose broth and inverted Durham tubes. Incubation was for 24-48hrs at 37°C. Tubes showing gas production and/or colour change of dye were streaked on EMB plates. Incubation of plates for **Confirmatory test** was at 37°C and 44°C for 24hrs; colonies from EMB plates were picked and inoculated into tubes containing lactose broth for **completed test** and onto Nutrient agar slants for further characterization. Inoculated tubes and slants were incubated for 24hrs at 37°C (Oranusi *et al.*, 2004).

Identification of isolates

The bacteria isolates were identified based on standard microbiological methods. Cultural characteristics and biochemical tests:- catalase, IMViC test, carbohydrate utilization, reaction on Tri-Sugar Iron (TSI) medium, gelatin liquefaction, starch hydrolysis, nitrate reduction, coagulase, phosphatase production, motility, Oxidase and Urease production were carried out as preliminary test. Further characterization of cultures was by the methods as described by Speck (1976); Jolt *et al.*(1994)

Identification of fungal isolates was based on their macroscopic and microscopic characteristics. Reference was made to standard identification keys and atlas (De Hoog *et al.*, 2000, Tsuneo, 2010).

Statistical analysis The values obtained for total aerobic plate count, coliform and fungal counts were subjected to analysis of variance (Snedecor and Cochran, 1976).

RESULTS

The mean microbial population of the food samples analyzed is presented in Table 1. In site I, the total aerobic plate count ranged from 2.5×10^3 for jollof rice to 9.1×10^6 for coleslaw, fungal counts ranged from 6.0×10^2 for jollof rice to 7.3×10^4 for coleslaw; coliform

counts ranged from 3.2×10^3 for jollof rice to 3.4×10^4 for fried rice and coleslaw. Table 1 also reveal that in site II, total aerobic plate count ranged from 2.7×10^3 in jollof rice to 9.8×10^6 in coleslaw. Fungal count of 9.3×10^6 was highest in coleslaw while coliform count ranges from 5.2×10^3 in jollof rice to 7.8×10^4 in moi-moi.

Coleslaw and fried rice has the highest levels of contaminations in both sampling sites. With the exception of fungal counts in jollof rice, coleslaw, moi-moi and total aerobic plate count in fried rice, there was no significant difference in levels of contamination of foods from the two sites.

Table 1 Mean microbial population of the food samples (cfu/ml)

| Food samples | SITE I University campus community | | | SITE II University host community | | |
|--------------|---------------------------------------|---------------------|---------------------|--------------------------------------|---------------------|----------------------|
| | Total aerobic plate count | Fungal counts | Coliform count | Total aerobic plate count | Fungal counts | Coliform count |
| Jollof rice | 2.5×10^3 a | 6.0×10^2 a | 3.2×10^3 a | 2.7×10^3 a | 9.0×10^3 b | 5.2×10^3 a |
| Coleslaw | 9.1×10^6 b | 7.3×10^4 b | 3.4×10^4 a | 9.8×10^6 b | 9.3×10^6 c | 8.5×10^3 a |
| Fried rice | 8.2×10^4 a | 8.0×10^3 b | 3.4×10^4 a | 6.0×10^5 c | 7.8×10^4 a | 4.2×10^4 ab |
| Moi-moi | 7.0×10^4 a | 9.0×10^3 b | 5.1×10^3 a | 5.0×10^3 a | 4.5×10^4 b | 7.8×10^4 ab |

abc= Values with same alphabets for same foods and counts across the rows and same counts down the column are not significantly different.

Table 2 shows the microbial isolates from the food samples, it reveals that *Staphylococcus aureus*, *Bacillus* spp, *Escherichia coli* and *Aspergillus* spp are the predominant organisms. The table also show that all the food samples were contaminated with mixed microflora.

Table 2 Food samples and microorganisms isolated

| FOOD SAMPLES | MICROORGANISMS ISOLATED |
|--------------|---|
| Coleslaw | <i>Bacillus cereus</i> , <i>Escherichia coli</i> , <i>Staphylococcus aureus</i> , <i>Klebsiella</i> spp, <i>Proteus</i> spp, <i>Aspergillus</i> spp, and <i>Mucor</i> spp |
| Fried rice | <i>Escherichia coli</i> , <i>Bacillus cereus</i> , <i>Klebsiella</i> spp, <i>Aspergillus</i> spp, <i>Mucor</i> spp and <i>Penicillium</i> spp |
| Jollof rice | <i>Enterobacter</i> spp, <i>Bacillus</i> spp, <i>Staphylococcus aureus</i> , and <i>Penicillium</i> spp |
| Moi-moi | <i>Klebsiella</i> spp, <i>Escherichia coli</i> , <i>Aspergillus</i> spp, <i>Mucor</i> spp and <i>Penicillium</i> spp, <i>Bacillus</i> spp. |

Figures 1a and 1b shows the percentage occurrence of bacteria and fungi isolates from the food samples. *Bacillus* spp and *Staphylococcus aureus* were the predominant organisms with 30% and 25% respectively, followed by *E. coli* having 18%. *Klebsiella* (15%) and *Proteus* (12%). Also *Aspergillus* predominated amongst the fungal isolated having 42% although *Penicillium* and *Mucor* also had high occurrences with 33% and 25% respectively.

DISCUSSION

The foods provided to the students by the vending sites on campus and University host community are of acceptable microbiological quality, except however, for

coleslaw with tolerable to unacceptable microbial loads. The International Commission for Microbiological Specification for Foods (ICMSF,1996) states that ready-to-eat foods with plate counts between $0 - 10^3$ is acceptable, between $10^4 - \leq 10^5$ is tolerable and 10^6 and above is unacceptable. The high level of contamination of coleslaw could be associated to the fact that it is food that is eaten raw without heat processing; similarly the extensive handling and mixing during processing could have introduced contaminants via food handlers, utensils and from the environment. Food handling personnel play important role in ensuring food safety throughout the chain of food production, processing, storage and preparation. Mishandling and disregard to hygienic measures on the part of the food

vendors have been reported to introduce contaminant and pathogens that survive and multiply in sufficient numbers to cause illness in the consumer (WHO,1989; Greig *et al.* 2007; Todd *et al.* 2007a; 2007b). The well preparation of foods in advance of consumption, exposure, holding of food at ambient temperature conducive for microbial multiplication coupled with the rich medium of coleslaw could equally be a factor in the increased microbial loads of the

samples (Abdussalam and Kaferstein 1993; Food safety, 2003). The isolation of *B. cereus*, *S. aureus*, *E. coli*, *Klebsiella* spp, *Proteus* spp, *Aspergillus niger*, *Aspergillus fumigatus*, *Mucor* spp and *Penicillium* spp, corroborate the findings of Nichols *et al.*, 1999; Mensah *et al.*, 2002; Idowu, 2006; Taulo *et al.*, 2008 in which these organisms was implicated in ready- to- eat- foods.

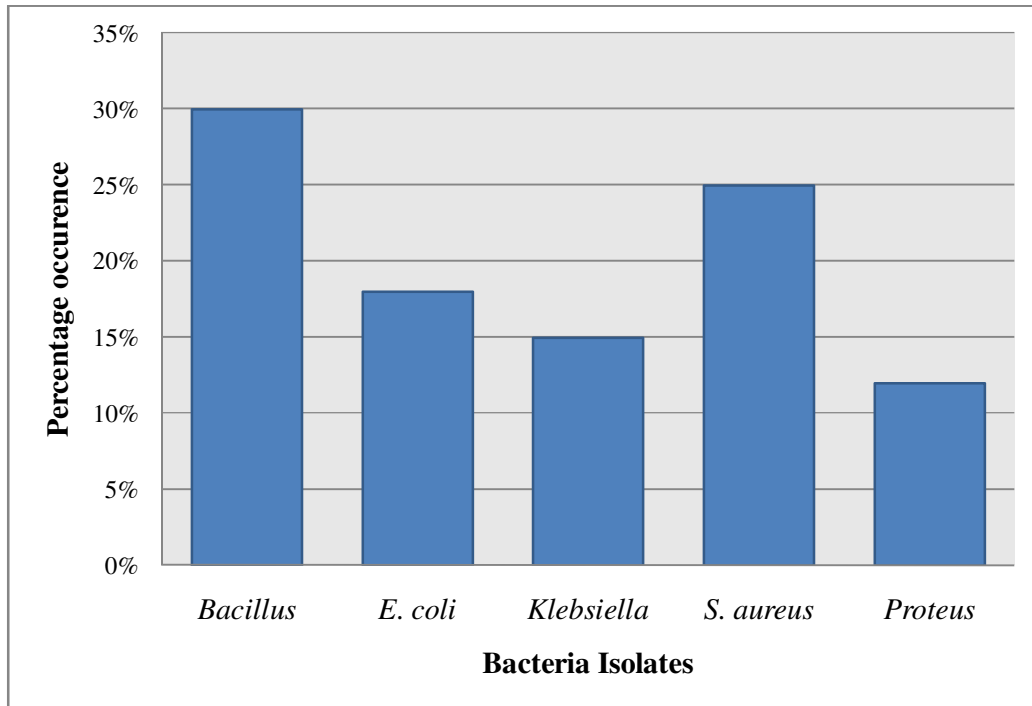


Figure 1a Percentage occurrence of bacteria isolates from food samples.

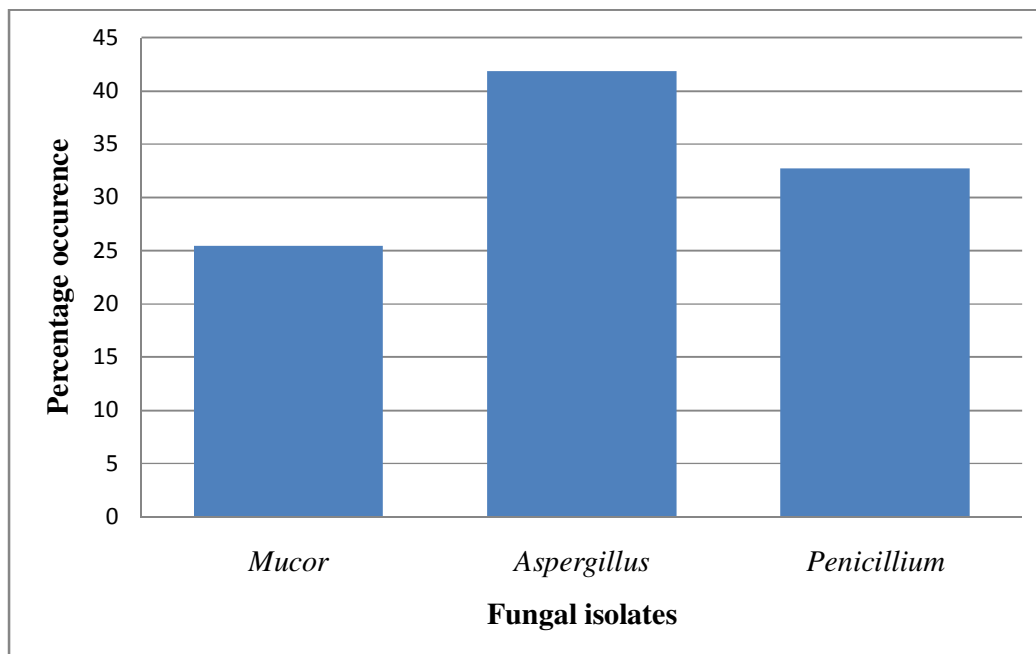


Figure 1b Percentage occurrence of fungi isolates from food samples.

The occurrence of *Bacillus* spp and the moulds *Aspergillus* spp, *Penicillium* spp and *Mucor* spp in the foods could be due to the fact that they are spore formers. These heat-resistant spores may have survived processing while vegetative cells were eliminated. Contamination of foods could have resulted from inappropriate processing, incomplete heating, or secondary contamination via contact with contaminated equipments and utensils.

Although *Salmonella* or *Shigella* species were not detected, the presence of *E. coli* and other Enterobacteria is an indication of possible faecal contamination of food, water or food workers and poor hygienic processing practices (Little *et al.*, 1998; Tambekar *et al.*, 2007). The presence of *S. aureus* is largely as a result of human contact and this suggests poor hygiene practices of the operators since this organism is a normal flora of the skin and nasal passage (Garret, 1988; Nichols *et al.*, 1999).

The fungi *Aspergillus* spp, *Penicillium* spp and *Mucor* spp are common environmental contaminants so is *Bacillus* spp. *S. aureus* commonly from man, thus there higher percentage prevalence is therefore not out of order (Aboloma, 2008, Kawo and Abdulmumin, 2009; Hazariwala, 2002).

It is mandatory that foods must be free from contaminations as much as possible. The presence of *E. coli*, *S. aureus* and *B. cereus* demonstrates a potential health risk as these organisms are pathogenic and have been implicated in food borne diseases (Granum, 2005; Wagner, 2009; CFIA, 2009). Foodborne illness can be prevented by good hygiene practices such as the use of Good Manufacturing Practices (GMP) and Hazard Analysis Critical Control Point (HACCP) application in the chain of food production and processing. Education of the food handlers/food vendors on food safety practices and a close and stringent supervision of ready-to-eat foods sold in the schools should be carried out by relevant authorities to prevent foodborne illness.

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