International Scholars Journals

International Journal of Microbiology Research and Reviews ISSN 2329-9800 Vol. 6 (4), pp. 225-229, April, 2017. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Bacteriological quality of street vended ready–to-eat foods in Ago-Iwoye, Nigeria: A study of University environment

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Accepted 13 July, 2015

Investigation was carried out into the bacteriological quality of street vended ready- to-eat foods sold around Olabisi Onabanjo University, Ago-Iwoye. Ten different foods consisting of 9 fully processed and 1 no heat processed foods were analyzed for the presence of bacteria. The food samples were collected from food vendors at car parks and canteens around the University campus and were determined by serial dilution using the spread plate method on Plate Count agar (PCA), Nutrient Agar and Mannitol Egg Yolk Polymyxin Agar (MYP). The mean count for all food examined exceeded the maximum acceptable limit of 10^5cfu/g set by the Food and Agricultural Organization (FAO) of the United Nation. The food with the highest mean microbial count of $5.5x10^6$ was fufu while the least count of $2.7x10^6$ was recorded for semovita. Bacteria isolated with the highest incidence was *Bacillus cereus* (21%), followed by *Staphylococcus aureus* (18.9%), *Klebsiella* sp. (18.2%), *Micrococcus* spp. (16.8%), *Escherichia coli* (11.9%), *Bacillus subtilis* (6.3%), *Enterobacter* spp (4.2%), *Lactobacillus* spp (1.4%), while *Salmonella* and *Pseudomonas aeruginosa* the lowest incidence of 0.7% each. All these bacteria are known agent of food borne diseases. Mishandling and disregard of hygienic measures (personal and environmental hygiene) on the part of the food vendors and lack of portable water at preparation venues contributed to the contamination rates of microorganisms observed in this study. The food vendors should be subjected to various seminars on food safety and quality control.

Keywords: Street vended, ready-to-eat food,food vendors, car parks, canteen, bacteria.

INTRODUCTION

Street foods are ready-to-eat foods and beverages prepared and/or sold by vendors and hawkers especially in streets and other similar public place (FAO, 1989). Ready-to-eat foods can be described as the status of food being ready for immediate consumption at the point of sale, it could be raw or cooked, and can be consumed without further treatment (Tsang, 2002).

Street vended foods are not only appreciated for their unique flavors, convenience and the role which they play in the cultural and social heritage of societies, they have also become important and essential for maintaining the nutritional status of the populations (FAO, 1997; Ekanem, 1998).

There is an increase in the consumption of ready-to-eat food because of a change in social patterns characterized by increased mobility, large numbers of itinerary workers and less family centered activities. Thus, good manufacturing practices of foods taken outside the home such as good sanitation or sanitary measure and proper food handling have been transferred

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from individuals/families to the food vendor who rarely enforces such practice (Musa and Akande, 2002).

In the United States, it has been estimated that seven pathogens found in animal products such as *Escherichiacoli* 0157:H7, *Listeria monocytogenes*, *Campylobacter jejuni*, *Clostridium perfringens*, *Salmonella* spp., *Toxoplasma gondii* and *Staphylococcus aureus* account for approximately 3.3 - 12.3 million cases of food borne illnesses and a record of 3900 deaths each year (Talaro and Talaro, 1996; Buzbyand Roberts, 1997). According to surveys carried out in 2006 and 2007 by the department of Public Health of the Federal Ministry of Health, Nigeria, there were more than two million recorded cases of food borne diseases in the country with the number of death put at over five hundred. Some of these cases could be linked to consumption of contaminated street vended foods (Agu, 2011).

Street foods are perceived to be a major public health risk due to lack of basic infrastructure and services, difficulty in controlling the large numbers of street food vending operations because of their diversity, mobility and temporary nature (Ghosh *et al.*, 2007; deSousa, 2008). The traditional processing methods that are used in the preparation, inappropriate holding temperature and poor personal hygiene of food handlers are some of the main causes of contamination of ready-to-eat foods (Barro *et al.,* 2006; Mensah *et al.,* 2002). Diseases that spread through consumption of contaminated food or water principally in areas of poor sanitation include hepatitis A, hepatitis E and typhoid fever, diarrhea and dysentery (Light, 2000).

According to WHO (1989), food handling personnel play important role in ensuring food safety throughout the chain of food production and storage. Mishandling and disregard of hygienic measures on the part of the food vendors may enable pathogenic bacteria to come into contact with and in some cases multiply in sufficient numbers to cause illness in the consumer.

When food handlers do not practice proper personal hygiene or correct food preparation, they may become vehicles for microorganisms through their hands, mouth, and skin among others (Silva *et al*., 2003: Bukar *et al*., 2009). In developing countries such as Nigeria, there are serious concerns about sanitation of ready– to–eat foods; particularly as potable water is seldom available at preparation venues and fast food stands, and also most food handlers lack basic knowledge of proper personal and environmental hygiene (Bukar *et al*., 2010).

Therefore, this work aims at isolating bacteria associated with some street vended ready-to-eat foods collected from different locations around Olabisi Onabanjo University (a non-residential University) in Ago-Iwoye, characterize the isolates using biochemical methods, assess the level of contamination and the implication on the consumers.

MATERIALS AND METHOD

Collection of samples

Seventy (70) samples of street vended ready-to-eat food comprising of white rice, fried rice, jollof-rice, salad, soup, spaghetti, fufu, semovita, meat and fish were collected from food vendors at car parks and canteens around Olabisi Onabanjo University. The samples were collected in sterile polythene bags to avoid contamination and immediately transported to the laboratory for analysis.

Sample Analysis

Ten grams (10g) of each food were mixed with 90 ml of buffered peptone water in sterile conical flask and then shaken vigorously to dislodge adhered bacteria. The liquid phase then forms the stock sample from which dilutions were made to obtain 10^{-1}, 10^{-2}, 10^{-3} up to 10^{-7} dilutions. After mixing, 0.1 ml of 10^{-5} and 10^{-6} dilution factors were spread onto the surface of sterile Plate Count agar (PCA), Nutrient Agar and Mannitol Egg Yolk Polymyxin Agar (MYP) (OXOID Ltd, Basingstoke Hants, England) and then incubated inversely at 37^0C in an incubator.

Viable Bacterial Count

After overnight incubation, growth on the PCA showing 30-300 colonies was counted. Bacterial counts were expressed as the number of colonies multiplied by the dilution factor.

Bacterial identification

Distinct colonies from the Nutrient Agar and Mannitol Egg Yolk Polymyxin Agar (MYP) plates were sub-cultured onto fresh Nutrient Agar plates to get a pure growth. Bacterial identification was done using the pure culture on the nutrient agar plates. The isolates were identified by comparing their morphological and biochemical characteristics with standard reference organisms of known taxa, as described by Bergey's Manual for Determinative Bacteriology (Buchanan and Gibbons, 1974).

RESULT

The microbial load in each of the street vended ready-to-eat food samples is shown on table 1. Fufu has the highest mean microbial load of 5.5 x 10^6, followed by fish with mean microbial load of 5.3 x 10^6, while semovita has the least microbial load of 2.7 x 10^6cfu/g.

Table 1. Microbial load in street vended ready-to-eat food samples (x10^6cfu/g).

Week	White rice	Jollof rice	Fried rice	Salad	Spaghetti	fufu	Soup	meat	Fish	Semovita
1	6.0	2.0	7.2	2.2	5.8	4.2	2.3	1.9	1.0	1.8
2	4.5	7.1	5.6	6.1	4.7	4.4	3.7	7.7	3.1	1.2
3	3.5	3.3	5.4	5.1	5.3	5.6	7.1	2.0	8.1	5.0
4	1.8	2.8	2.8	7.8	1.9	7.0	1.9	0.8	9.1	2.7
5	1.2	6.4	3.9	4.9	2.4	7.8	2.9	3.1	5.5	2.3
6	3.1	4.3	4.0	6.0	3.1	6.2	7.7	2.0	3.9	2.8
7	2.3	3.1	3.0	4.4	4.5	3.5	2.6	3.7	6.5	2.9
Mean	3.2	4.1	4.6	5.2	4.0	5.5	4.0	3.0	5.3	2.7

Table 2. Occurrence of bacteria isolate in street vended ready-to-eat-foods.

Isolate	White rice (n =7)	Jollof rice (n=7)	Fried rice (n=7)	Salad (n=7)	Sphagetti (n=7)	Fufu (n=7)	Soup (n=7)	Meat (n=7)	Fish (n=7)	Semovita (n=7)	Total N=70
B.cereus	2(1.4)	2(1.4)	3(2.1)	3(2.1)	4(2.8)	4(2.8)	5(3.5)	2(1.4)	5(3.5)	0(0)	30(21)
S.aureus	3(2.1)	3(2.1)	1(0.7)	4(2.8)	3(2.1)	3(2.1)	3(2.1)	3(2.1)	3(2.1)	1(0.7)	27(18.9)
Klebsiella	2(1.4)	3(2.1)	3(2.1)	2(1.4)	1(0.7)	4(2.8)	3(2.1)	3(2.1)	4(2.8)	1(0.7)	26(18.2)
Micrococcus	1(0.7)	4(2.8)	3(2.1)	3(2.1)	2(1.4)	1(0.7)	3(2.1)	3(2.1)	3(2.1)	1(0.7)	24(16.8)
E.coli	2(1.4)	2(1.4)	1(0.7)	2(1.4)	3(2.1)	(0(0)	4(2.8)	1(0.7)	1(0.7)	1(0.7)	17(11.9)
B.subtilis	0(0)	0(0)	0(0)	2(1.4)	2(1.4)	1(0.7)	2(1.4)	1(0.7)	1(0.7)	0(0)	9(6.3)
Enterobacter	0(0)	0(0)	1(0.7)	1(0.7)	0(0)	0(0)	0(0)	2(1.4)	2(1.4)	0(0)	6(4.2)
Lactobacillus	0(0)	1(0.70)	1(0.7)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2(1.40)
Salmonella	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.7)	0(0)	0(0)	0(0)	0(0)	1(0.70)
P.aeruginosa	0(0)	0(0)	0(0)	0(0)	1(0.70)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0.70)

The biochemical tests performed on the isolates revealed the presence of ten bacterial species namely: *Bacillus cereus*, *Bacillus subtilis, Staphylococcus aureus*, *Klebsiella*sp., *Micrococcus* spp., *Escherichia coli*, *Enterobacter* spp, *Lactobacillus* spp, *Salmonella* and *Pseudomonas aeruginosa.*

Table 2 below represents the level of bacterial contamination of the different samples of street vended ready-to-eat foods. *B. cereus* had the highest incidence of 21% followed by *S.aureus* with 18.9%. *Salmonella* and *P.aeruginosa* had the least value of 0.7% each.

The figure above shows the rate of contamination of the food samples by bacteria. Soup was the food mostly contaminated followed by fish. Semovita was the food least contaminated.

DISCUSSION AND CONCLUSION

The food we eat are rarely if ever sterile, they carry microbial associations whose composition depends upon which organisms gain access and how they grow, survive and interact in the food over time (Adams and Moss, 1995). The microbial load of white rice was in the range of 1.2-6.0 x 10^6cfu/g, jollof rice 2.0-7.1x 10^6cfu/g, fried rice 2.8 – 7.2 x 10^6, salad 2.2- 7.8 x 10^6, Sphagetti 1.9 – 5.8 x 10^6, fufu 3.5-7.8 x 10^6cfu/g,soup 1.9-7.7 x 10^6,meat 0.8-7.7 x 10^6cfu/g,fish 1.0-9.1 x $10^6$and semovita 1.2-5.0 x 10^6cfu/g (Table 1). Samples of food analyzed had level of contamination higher than the acceptable reference figures of FAO (1979).

Fufu in this work had the highest bacteria count of 7.8 x 10^6 which is supported by the work of Feglo and Sakyi (2012) who recorded a higher microbial count in fufu in Kumasi Ghana.

The bacteria isolated from the street vended ready-to-eat foods with their incidence are: *Bacillus cereus* (21%), *Staphylococcus aureus* (18.9%), *Klebsiella*sp (18.2%), *Micrococcus* (16.8%), *Escherichia coli* (11.9%), *B. subtilis* (6.3%), *Enterobacter* (4.2%), *Lactobacillus* (1.4%), *Salmonella* (0.7%) and *Pseudomonas aeruginosa* (0.7%) (Table 2). The incidence obtained for the bacteria isolates differ from those obtained by Yasin *et al*. (2012), Nyenje *et al*. (2012), Bukar *et al*. (2010) but slightly conforms to that of Feglo and Sakyi (2012) who reported incidence of 21.5% and 18% for *B. cereus* and *Klebsiella* respectively.

Soup was mostly contaminated followed by fish while semovita was the food least contaminated (fig 1). The results obtained in this study are slightly different from various similar studies conducted both locally and globally on ready –to-eat food.

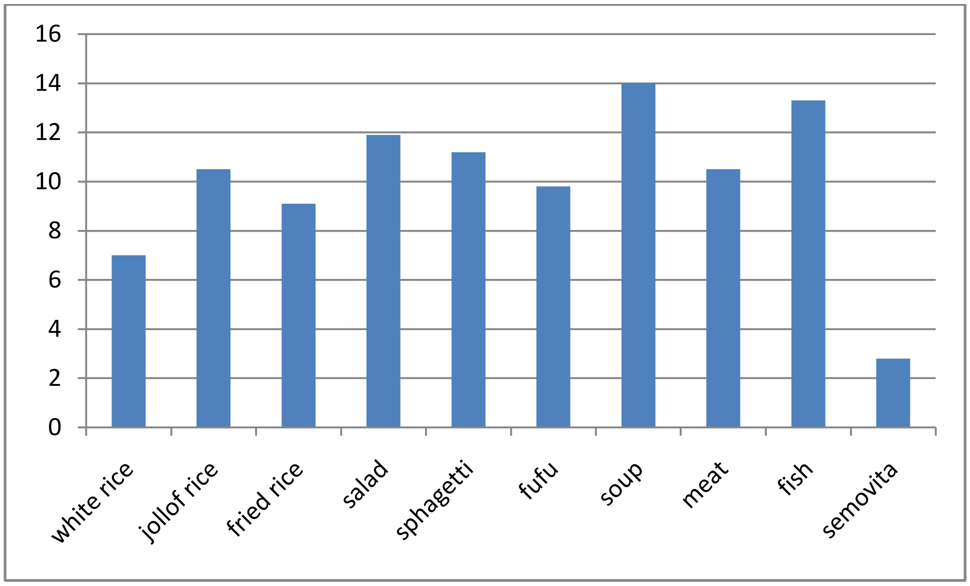

Fig 1. Rate of contamination of the street vended ready-to-eat food samples.

Yasin *et al*. (2012) isolated *E. coli, S. aureus* and *Salmonella* from ready-to-eat foods in Pakistan. Nyenje *et al*. (2012) isolated *Listeria*, *Enterobacter, P. mirabilis, K. oxytoca, S. aureus, A. hydrophila* and *P. luteola* from ready-to-eat foods.

B. cereus, *E. coli, Klebsiella, S. aureus* and *Micrococcus* were isolated from the different rice dishes analyzed. Mensah *et al.*(2002) isolated *E. coli, K. pneumoniae* with other bacteria from rice. Wogu *et al*. (2011) isolated *B. cereus, S.aureus, E. coli* and *K. pneumoniae* from ready-to-eat rice sold in Benin City, Nigeria. They also recorded high incidence of 37.5% for *B. cereus.* Oladipo and Adejumobi (2010) isolated *B. cereus* and *P. mirabilis* from rice.Nyenje *et al*. (2012) isolated *Enterobacter, P. mirabilis, K. oxytoca, S. aureus, A. hydrophila* and *P. luteola* from rice in South Africa.

Salad has a high mean microbial load of 5.2×10^7 and the bacterial pathogen isolated included: *E. coli, Klebsiella, S. aureus, B. cereus, Micrococcus, B.subtilis, Salmonella and Enterobacter.* This is similar to the study conducted by Mensah *et al.* (2002) who isolated *E. coli* from salad and Feglo and Sakyi (2012) who isolated *Bacillus, Klebsiella, Aeromonas, Enterobacter, Citrobacter*and *E. coli* from salad samples both in Ghana.
Sphagetti was contaminated with *B. cereus, Klebsiella, Micrococcus*, *E. coli, S. aureus, B. subtilis and P. aeruginosa.* Mensah *et al*. (2002) isolated *E. coli* and *Klebsiella* with other bacteria from macaroni (brand of sphagetti) while Feglo and Sakyi (2012) isolated *Klebsiella* and *S. aureus* with other bacteria from macaroni. Okolie *et al.* (2012) isolated *S. aureus, E. coli* and *Pseudomonas* sp. from rice, meat and sphagetti respectively.

Fufu in this work has a mean microbial load of 5.5×10^7 and were contaminated with *B. cereus, S. aureus, Klebsiella, Micrococcus* and *Salmonella*. Feglo and Sakyi (2012) isolated *Bacillus, Klebsiella, Aeromonas, Enterobacter, P. aeruginosa* from fufu in Ghana.
Meat and fish were contaminated with *B. cereus*, *E. coli, Klebsiella, Micrococcus, B.subtilis, S. aureus* and *Enterobacter*. Yasin *et al.* (2012) detected *E. coli* and *Salmonella* in beef butchery. Mensah *et al.* (2002) reported contamination of fish with different species of bacteria among which *E. coli* and *K. pneumoniae* are present.
B. cereus, *E. coli, Klebsiella, Micrococcus, B. subtilis, S. aureus* are the bacteria isolated from soup. Mensah *et al.* (2002) isolated *E. coli, C. freundii* and *E. sakazakii* from tomato stew.
Klebsiella, Micrococcus and *E. coli* are the bacteria isolated from semovita.
The hands of the vendors come into contact with some of these foods during serving. Sometimes the utensils like spoons use in serving the food are exposed to dust and fly. According to Marks *et al.*(1998), Bryan (1988) and Gorris (2005) street foods are subjected to cross contamination from various sources such as utensils, knives, raw foodstuffs, flies that are sporadically landing on the foods, by vendors bare hand serving occasionally food handling by consumers. Mensah *et al.* (2002) reported that the contamination of foods was not surprising because after cooking the food, serving was performed with bare hands. The vendors sell and dish out food with bare hands and also simultaneously handle currency as they take money from the buyers a common practice implicated in introducing pathogens into the food (Kubhekar *et al*., 2001). It was reported in Manila Philippines

that the consumption of such food served with bare hands led to cholera outbreak (Barry, 2005). Hygiene and sanitation practices obtained during preparation and marketing of these foods provide ample opportunities for the proliferation of these food with food-borne pathogens (Desai and Varadaraj, 2009).

Escherichia coli are significant diarrhoeal causing organisms usually found in localities of poor sanitary conditions (Umoh and Odam, 1999). It has been associated with "travelers' diarrhoeal and hemorrhagic colitis. Therefore, consumption of this food could be associated with diarrhoeal diseases (Hanoshiro *et al.,* 2004). The presence of these bacteria in the food samples is an indication that, food hygiene and sanitation procedures were lacking during the preparation of the foods.

Staphylococcus species are found on the skin and in the nose and throat of most healthy people; they are also widespread in untreated water, raw milk and sewage. When *Staphylococcus aureus* is allowed to grow in foods, it can produce a toxin that causes illness (Ghosh *et al.,* 2004). Nichols (2002) also showed that pathogenic bacteria including *S. aureus*, *E. coli* and *Salmonella* in restaurants may be transferred to the cooked foods by its contaminated staffs' hands or dishes.

Bacillus cereus food poisoning is underreported, as both types of illnesses (emetic and diarrhoeal) are relatively mild and usually last for less than 24 h. On a few occasions, illnesses have become severe leading to hospitalization and/or even death (Dierick *et al.,* 2005). The unique properties of *B. cereus* like heat resistant, endospore forming ability, toxin production and psychotropic nature gives ample scope for this organism to be a prime cause of public health hazard (Griffiths and Schraft, 2002).

The preparation of food long before its consumption, storage at ambient temperature, inadequate cooling and reheating, contaminated processed food and under cooking were identified as the key factors in handling of food that contributed to food poisoning outbreaks in England and Wales (Roberts, 1982). According to Adolf and Azis (2012), the high level of microbial contamination could come from improper sanitation practices at the canteen during the processing and selling period.

The result of this research has showed the extent of bacterial contamination of foods. Government should make efforts to issue license to food vendors so as to control them. The public should be sensitized on food safety. Also, food vendors should be educated and subject to strict good personal hygiene by food regulatory bodies.

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