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Microbial and Physicochemical Screening of Ready to Eat Street Foods

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ABSTRACT

Food samples: African salad, fried yam, fried potato, fried plantain, bole and suya meat retailed in three locations along Choba, Aluu and Alakahia were analyzed for their microbial load. Analysis of the food samples revealed Total viable count ranging from 3.8×10^7 cfu/g to 5.2×10^7 cfu/g (African salad), 2.6×10^7 cfu/g to 3.3×10^7 cfu/g (Bole), 3.0×10^7 cfu/g to 3.4×10^7 cfu/g (Plantain), 3.4×10^7 cfu/g to 3.6×10^7 cfu/g (Potato), 2.9×10^7 cfu/g to 3.3×10^7 cfu/g (Yam) and 4.8×10^7 cfu/g to 5.1×10^7 cfu/g (Suya meat) from the various locations. The organism isolated includes, *Staphylococcus aureus (25%), Escherichia coli (25%), Pseudomonas (15%), Streptococcus (15%), Bacillus cereus (12%)* and *Salmonella spp (8%).* The TVC count in these food samples exceeds the standard set by International Commission for Microbiology Specification for Food (ICMSF) for ready-to-eat food which states that TVC count between 0-10^7 cfu/g is acceptable, 10^4 to 10^5 cfu/g is tolerable and >10^7 cfu/g is unacceptable. Therefore, these foods are not bacteriologically fit for consumption. The occurrence of these bacterial isolates in the foods constitutes public health risk to consumers as these pathogens have been associated with foodborne infections Therefore, government should enforce strong food safety regulations for street foods vendors. In addition, street food vendors need to be educated on food safety and hygienic practices

Keywords: *Ready-to-eat foods, Foodborne pathogen, Microbiological quality, Food safety.*

1. Introduction

Street foods are "ready-to-eat" foods and beverages prepared and sold by vendors and hawkers especially in the street and other similar public places. Street foods are an extremely heterogeneous food category encompassing meals, drinks and snacks. They also show great variation in terms of ingredients, methods of retail, processing and consumption and are sold on the streets from pushcarts or basket or balance poles or form stalls or shops having fewer than four permanent walls (FAO, 1997).

Nigeria had an history of developed supermarket industry until social and economic changes in early 1980s diminished the country's middle class significantly, since then most Nigerians shop are traditional open air markets or purchase their goods from traders and street vendors (Nzeka, 2011). Extensive street- vending of foods in Nigeria as in most other cases arises from multiple causes; deterioration of rural living conditions, migration to the cities and accelerated urbanization leading to enormous urban congestion, long commuting distance between workplace and home, unemployment, lack of cooking skills, changes in family cohesion and shortage or absence of establishment that serves reasonable priced food close to the workplace (Tinker, 1997; Maxwell, 2000). Street-vended food provides a major source of income for vast number of persons particularly women; a chance of self-employment and opportunity to develop business skills with low capital investment, least expensive and most accessible means of obtaining a nutritionally balanced meal outside the home for many low-income earners.

Despite the economic and nutritional benefits of street foods, the consumption of these roadside foods has been suggested to potentially increase the risk of foodborne diseases as street foods are readily contaminated from different sources (Tambekar et al, 2000). In fact streets foods have often been associated with traveler's diarrhea and other foodborne diseases. Many studies have revealed the frequent contamination of street foods in many

developing worlds including Nigeria. Studies by Rath and Pathra 2012, Suneetha et al, 2011 and Arijit et al., 2010 have revealed high loads of bacteria pathogens on popular street foods in different parts of India. In Africa, Gitahi M. Githaiga (2012) reported the presence of *Bacillus cereus, Staphylococcus aureus, Shigella sonnei, Escherichia coli and Salmonella arizonae* on different foods sold on the street of Nairobi, Kenya.

In Nigeria, study on the microbial safety of ready-to–eat foods; meat pie, beef sausage roll, egg roll, pealed orange, walnut and apple vended on high way, Onitsha-Owerri South-East Nigeria, revealed the contamination of these foods by pathogens which include, *Salmonella spp, Staphylococcus aureus, Bacillus cereus, Shigellaspp, Enterococci, Aspergillus niger and Pseudomonas sp* (Oranusi and Braide, 2012). Other researchers include Osasi (2012), Falola *et al*: (2011) and Mbah *et al*: (2012) have reported contamination of street foods by pathogen in different parts in Nigeria.

Although government throughout the world are attempting to improve the safety of the food supply, the occurrence of food borne disease remains a significant health issue in both developed and developing countries (WHO, 2011).

In countries where street food vending is prevalent, there is commonly a lack of information on the incidence of food borne diseases related to street vended foods (WHO, 2011). Due to lack of proper knowledge and guidance on street food vending, vendors prepare their foods in explicitly unhygienic and unsanitary conditions. Consumers who depend on such foods are more interested in its convenience and usually pay little attention to its safety quality and hygiene (Mensal *et al*; 2002). There is lack of knowledge on the epidemiological importance and public awareness of street foods which hampers precise scientific approach of food safety problem (Rane, 2011).

The following are organism that are commonly encountered in street foods: *Staphylococcus aureus, Escherichia coli, Clostridium botulinum, Listeria monocytogenes, Vibrio vulnificus, Clostridum perfringes, Bacillus cereus, Vibrio cholera, Streptococcus spp, Enterococcus spp, Shigella dysenteriae, Klebsiella pseudomonas, Micrococcus spp, Flavobacterium, Mucor, Penicillium spp, Aspergillus niger, Aspergillus flavus, Fusarium spp, Proteus vulgaris, Salmonella spp (*Asiegbu, *et al.*,2020) (Ayhan Dağ 2020). Despite the availability of food safety strategies for public health and economic development in many countries, food safety policies, plan of action and legislation have been implemented especially in developing countries.

In recent times, food safety issues have assumed a wider dimension because of the reliance on fast food whose preparation the consumer has no control over. In developing countries, a large portion of ready-to-eat food is sold on the street. If this food is not properly hygienically handled or not stored at the right temperature, foodborne illnesses are bound to occur. The aim of this research is to determine the sanitary quality of Ready to eat street food in Port Harcourt Rivers state Nigeria.

2. Materials and method

2.1. Study area and sample collection

The study locations are Choba, Aluu and Alakahia axis along East-West Road, University of Port Harcourt Choba, Rivers state. These locations are where the students from the institution buy their food before and after lectures. Food samples: The food samples analyzed were fried yam, fried plantain, fried potatoes, bole (roasted plantain),

suya and African salad. The samples were aseptically collected and kept in a cool box, transported to the laboratory and analyzed within 12 hours.

2.2. Sample processing

25g of the food sample were homogenized in 225ml of sterile peptone water and stomached using a stomacher at 360rpm for 1 minute, after which the homogenized samples were serially diluted to 10^6 (Clarence et al; 2009).

2.3. Physiochemical analysis

Moisture content of the food samples was determined as describe by Cole (2002). The pH values of homogenized samples (20 g; Stomacher Lab-Blender 400, PBI) were measured with a digital pH meter (Hannah model: HP 221 pH/ORP meter).

2.4. Determination of the Total Viable Count (TVC) from the different samples

0.1ml of 10^{-6} and 10^{-5} dilution of each food samples were inoculated on plate count agar for Total viable count using pour plate technique. The plates were prepared in duplicates and incubated under aerobic condition at 37^0C for 24-48 hours. The number of colonies were counted using colony counter and expressed as Colony Forming Unit per ml of sample homogenate (cfu/ml) (Clarence et al; 2009). Counts of 30-300 colonies are accepted for a single plate.

2.5. Determination of Total coliform count

From the pre-enriched culture (stock culture), serial dilution was carried out and 0.1ml was plated out from dilutions 10^{-5} and 10^{-6} in duplicates on MacConkey agar by spread plate method and incubated at 37^0C for 24 hours. The plates are then examined colonies. The suspected colonies were confirmed with conventional biochemical techniques

2.6. Determination of Escherichia coli in the different food samples

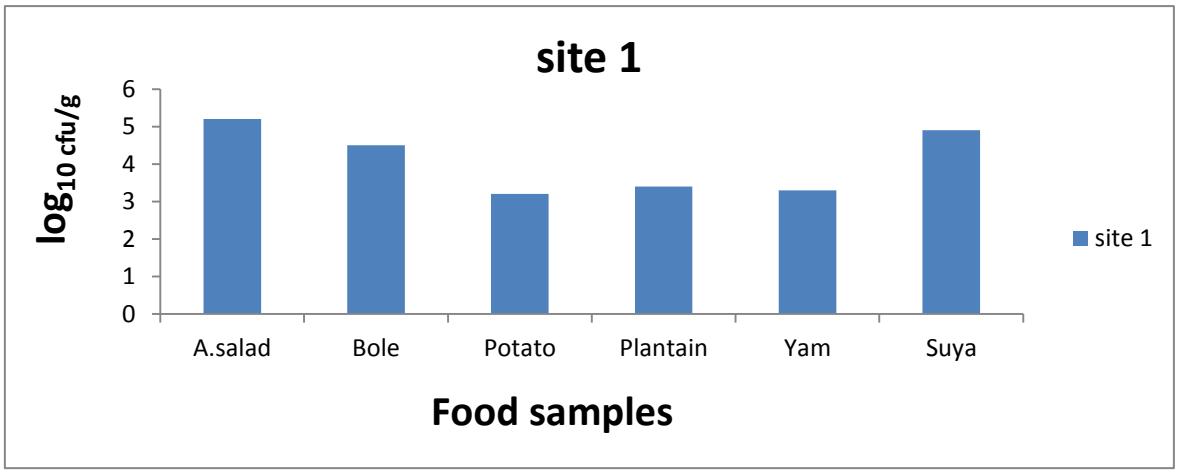
25g of the sample was added to 225ml of buffered peptone water. All samples were incubated for 16-20 hours (overnight) at 37^0C.

From the pre-enriched culture (stock culture), serial dilution was carried out and 0.1ml was plated out from dilutions 10^{-2} and10^{-3} in duplicates on Eosin methylene blue MB agar by spread plate method and incubated at 37^0C for 24 hours for enumeration of *Escherichia coli* count from different samples.

The plates are then examined for typical *Escherichia coli* colonies i.e., colonies with green metallic sheen. Suspected colonies are confirmed with conventional biochemical techniques.

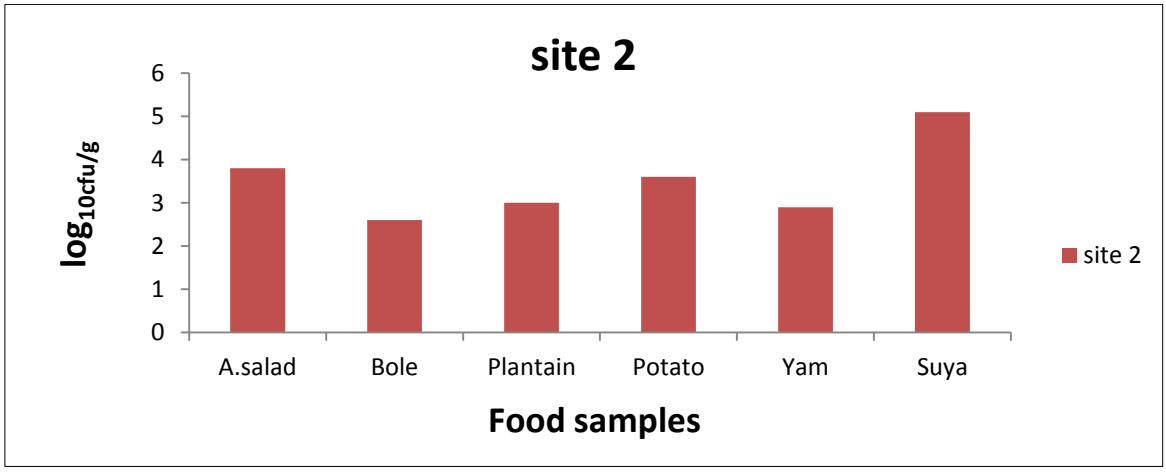
Following the incubation period, representing colonies from both the Total viable count and Total coliform count were picked from the different plates based on different colonial characteristics, colonies are sub-cultured on Nutrient agar for purification and transferred onto Nutrient agar slant and incubated at 37^0C.The isolates are characterized presumptively by colonial morphology, pigmentation, Gram staining. Biochemical testing includes Motility test, Indole test, Methyl-red test, Voges-proskauer test, Reaction on Triple Sugar Iron Agar (TSIA).

3. Result



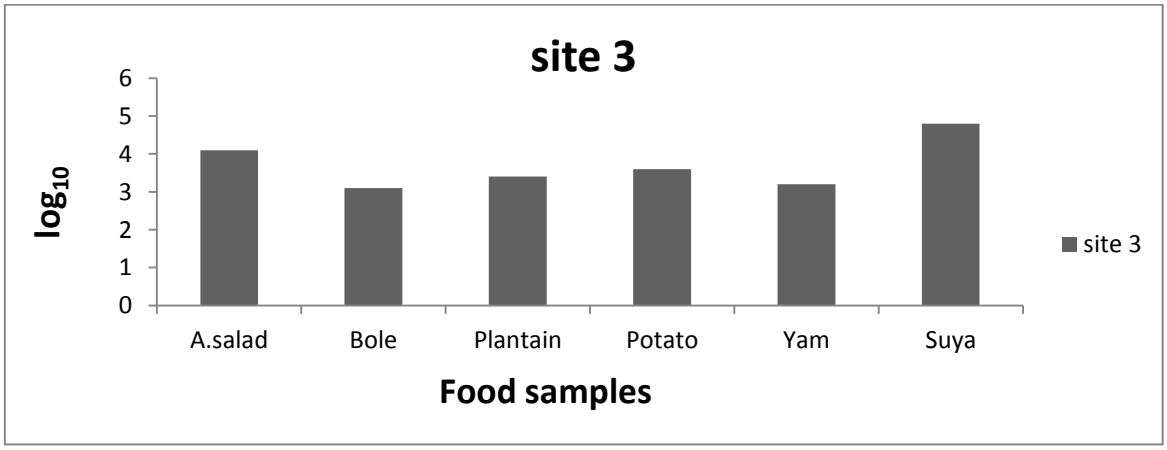
Key: Site 1= Choba

Fig.1. Total viable count for Ready to eat food sold in Choba



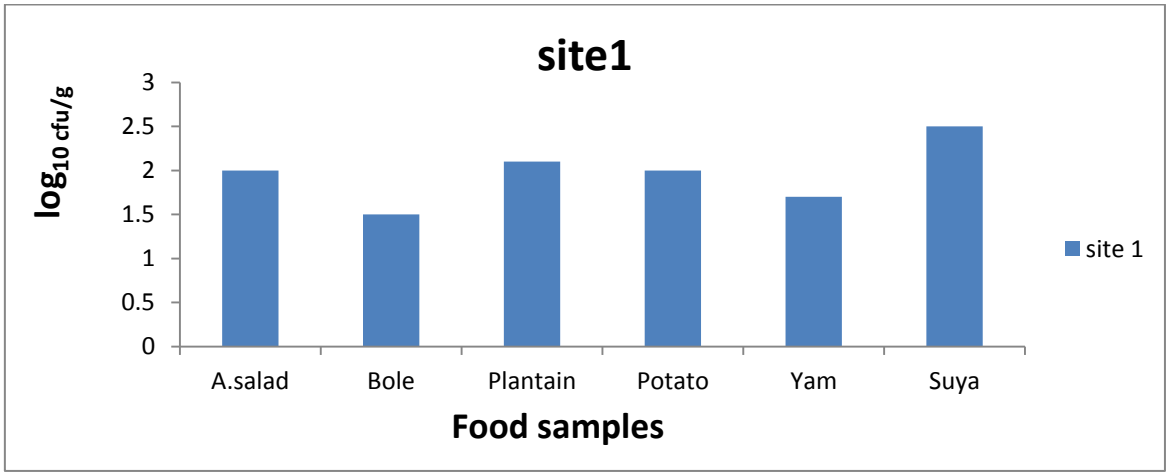
Key: Site 2= Aluu

Fig.2. Bar chart of the Total viable count for Ready to eat food sold in Aluu



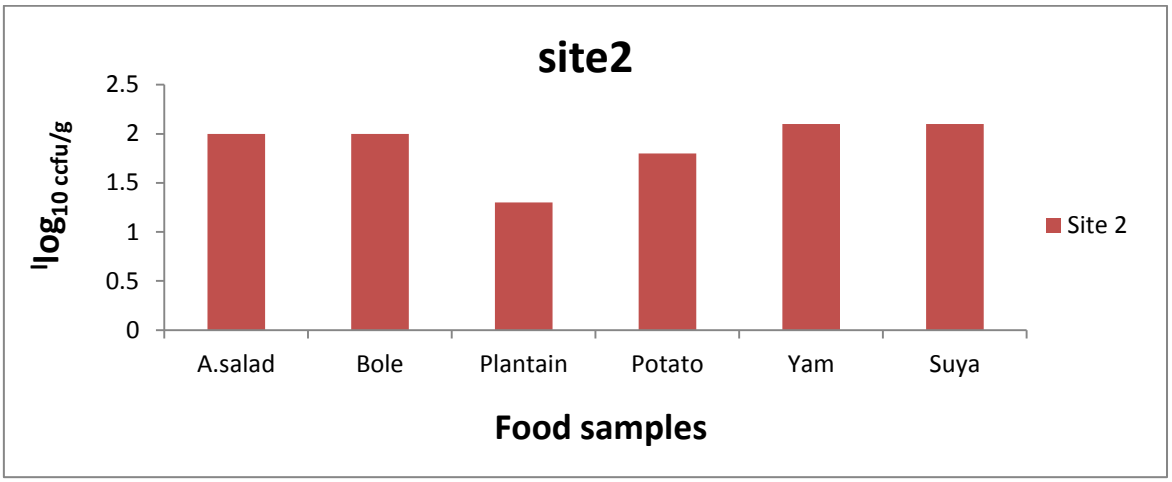
Key: Site 3= Alakahia

Fig.3. Total viable count for Ready to eat Street food sold in Alakahia



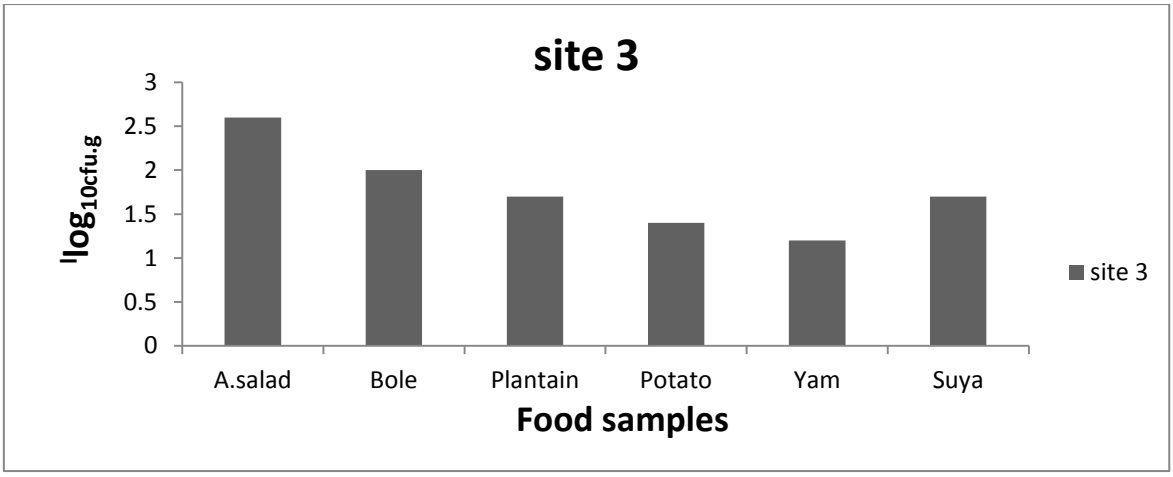
Key: Site 1= Choba

Fig.4. Total coliform count for Ready to eat food sold in Choba



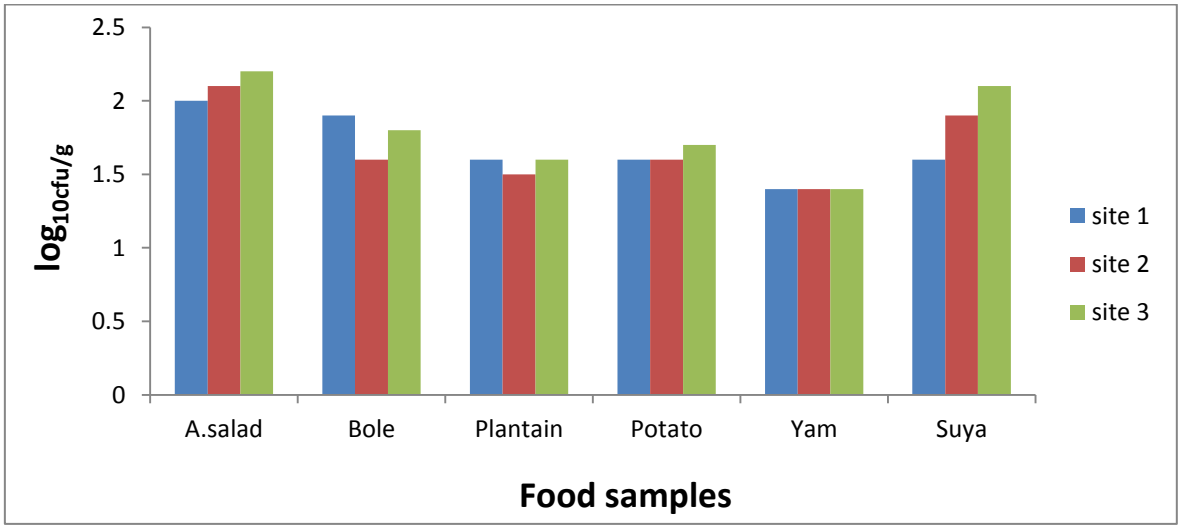
Key: Site 2= Aluu

Fig.5. Total coliform count for Ready to eat street food sold in Aluu



Key: Site 3= Alakahia

Fig.6. Total coliform count for Ready to eat street food sold in Alakahia



Key: Site 1 = Choba, Site 2 = Aluu, Site 3 = Alakahia

Fig.7. Comparison of *Escherichia coli* count in Ready to eat street food samples for the different sites

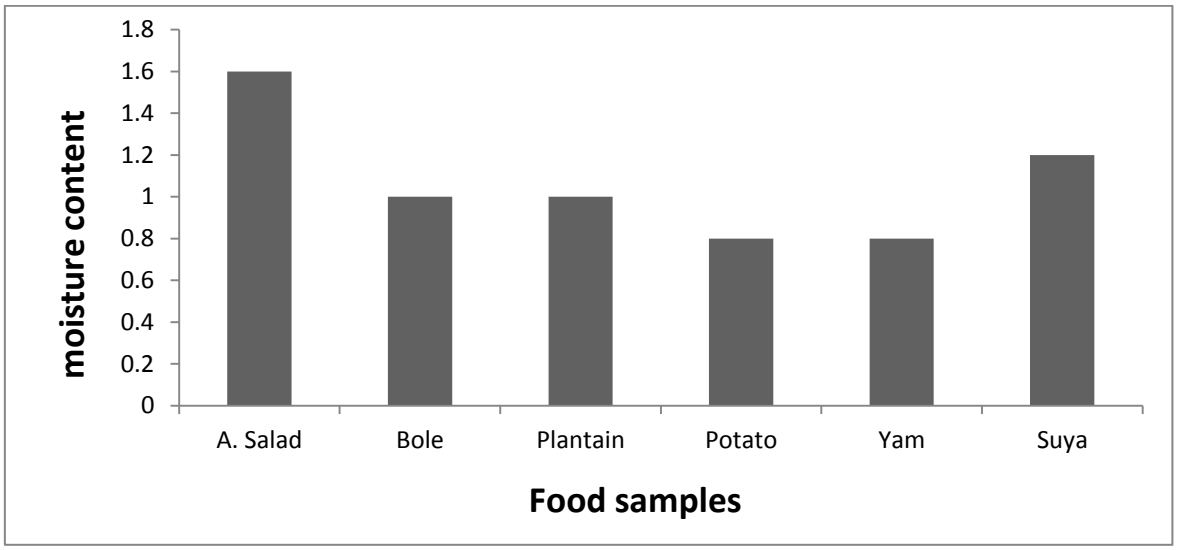


Fig.8. Mean Moisture content of the different Ready to eat street food samples

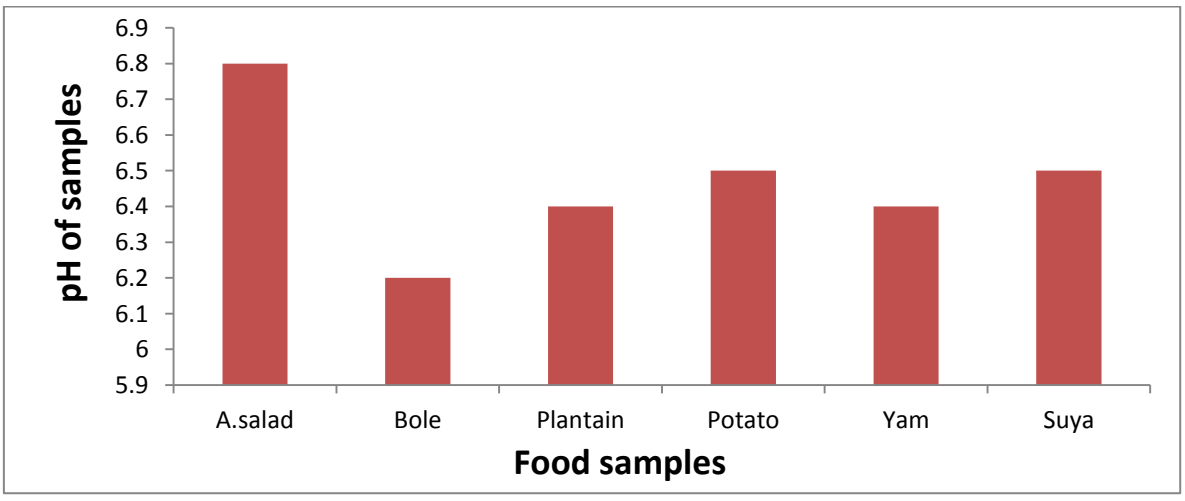


Fig.9. pH of the different Ready to eat street food samples

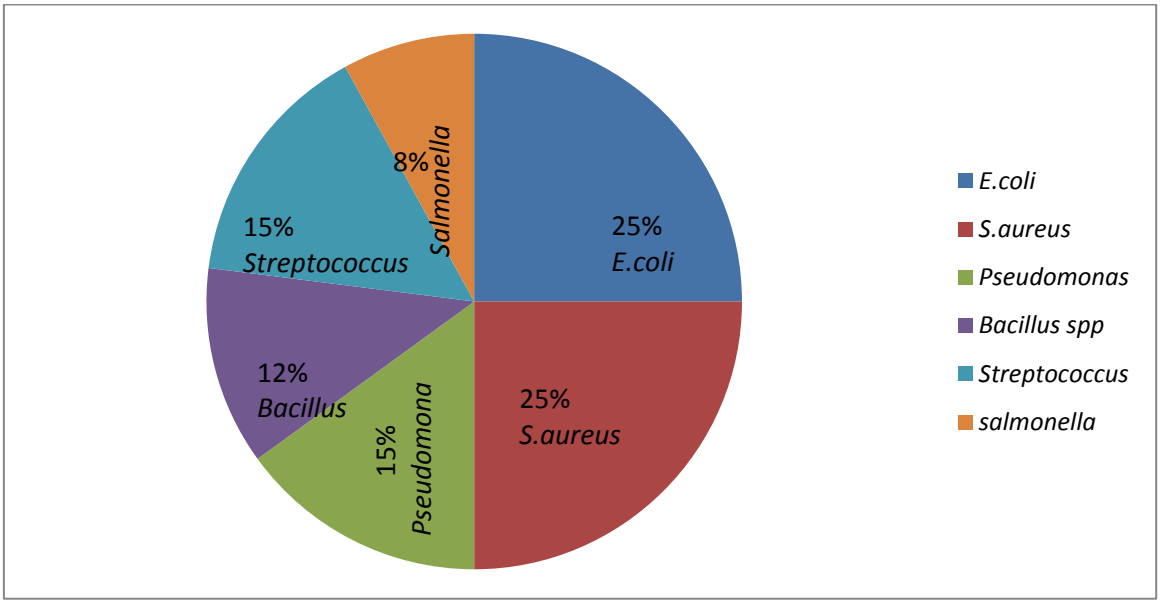


Fig.10. Percentage Occurrence of pathogenic organisms in the different food samples

Table 1. Presence/Absence of *E. coli* in the different food samples

Food samples	**SITE 1**	**SITE 2**	**SITE 3**
African salad	+	+	+
Bole	-	+	-
Plantain	-	+	+
Potato	-	-	-
Suya meat	-	+	+
Yam	+	+	-

4. Discussions

Ready-to-eat (RTE) foods have been described differently by various organizations and individuals. The food and Agriculture Organization defines street foods as RTE foods and beverages prepared and/or sold by vendors and hawkers, especially in streets and other similar public places, RTE foods could be raw or cooked, hot or cold and can be consumed without further heat treatment. RTE food also could be fruits bought directly from street vendors or hawkers or at local markets and eaten immediately i.e., without necessarily having to cut, peel or rinse them before consumption as RTE foods have already been prepared by the vendors (Oranusi and Olorunfemi 2011).

African salad and Suya meat were observed to have the highest microbial count in the three location and this could be due to the addition of fresh vegetables to food before serving and the packaging material used for serving food and could be as a result of the level of exposure of these products to the dirty environment (Oje et al 2016).

The International Commission for Microbiological Specification for Food (ICMSF) states that for ready-eat-food, TVC between 0-10^3cfu/g is acceptable, 10^4 to 10^5cfu/g is tolerable and $\geq 10^7$cfu/g is unacceptable. *E.coli* should be $<10^2$ cfu/g and *Salmonella spp* should not be detected in 25g (ICMSF, 1990).

This result shows that the food samples analyzed at the various locations are not bacteriologically fit for consumption since they exceeded the stipulated standard. The presence of coliform is an indication of poor sanitary of the hawkers and could also be a result of possible faecal contamination. These organisms are perhaps a threat associated with water used for food processing, drinking purposes and use for human consumption is contaminated by human excrement. The isolates were identified as *Staphylococcus* (25%), *Pseudomonas* (15%), *Streptococcus* (15%), and *Escherichia coli* (25%), *Bacillus cereus* (12%) and *Salmonella spp (*8%). The most frequently isolated organism was *Staphylococcus aureus and Escherichia coli (*Anna Łepecka *et al*, -2020), (Sabuj *et al*., (2020). The presence of Staphylococcus aureus, in these RTE food products might have contaminated the processed food products from source as a result of improper handling practices by processors. Improper handling and improper hygiene might lead to the contamination of food and this might eventually affect the health of the consumers (Odu, and Assor 2013, Okonko et al., 2008). E. coli is a normal flora of the human and animal intestine and has been identified as a leading cause of foodborne illness all over the world [Mboto et al., 2003]. E. coli O157. H7 strain was not detected in any of the RTE food samples examined. However, diarrhea caused by E. coli is highly prevalent in young children in developing countries as well as travelers [Mboto et al., 2003]. The presence of indicator and other organisms examined in this study is of special concern. These organisms are perhaps a threat associated with water used for food processing, drinking purposes and for human consumption is contaminated by human excrement (Okonko et al., 2008). Some RTE foods also are regarded as 'potentially hazardous. Such RTE foods can support the growth of pathogenic (food poisoning) bacteria and must be kept at certain temperatures to minimize the growth of any pathogens that may be present in the food or to prevent the formation of toxins in the food (Hocking 2003). The presence of *Staphylococcus aureus* in the samples is indicative of human contamination after production. This could be from direct human contact such as fingers or indirectly through additives or utensils. The organism is associated with endotoxin characterized by short incubation period (1-8 hours), violent nausea, vomiting and diarrhea.

Bacillus cereus is another isolate that is associated with the production of toxin; diarrheal and emetic in food which causes food poisoning. It is found in dust, soil and raw food and can survives normal cooking as a heat resistant spore (Rajkowski and Bennett, 2003).The presence of *Escherichia coli* suggested faecal contamination.

Although some *E.coli* is harmless, Enterohaemorrhagic *E.coli* (EHEC) is capable of producing one or more toxin and a particular serotype O157: H7 have been associated with haemorrhagic colitis, haemolytic uraemic syndrome. Also, Enterotoxigenic *E. coli* (ETEC) is associated with traveller's diarrhoea. Streptococcus colonizes oral mucous membrane and skin of human and animal gut and has been associated with urinary tract, biliary tract, abdominal

wound infections and endocarditis. They can possibly find their way into food through contamination by human and animal faeces mostly through contaminated water, dirty environment and poor hygiene. They are also highly resistant to environmental and chemical agent and can persist in fomites for a long period.

The presence of these microorganisms in food causes food spoilage and food poisoning. This implies that these ready-to-eat foods are viable source of various diseases. Some of these diseases could spread and acquire epidemic status which poses serious health hazards. Food should not only be nutritionally balanced, but should be microbiologically safe as well. Good hygiene should be ensured during preparation and sales of these foods, to prevent illness as a result of consumption of contaminated foods. Most food pathogens are of soil or intestinal origin and are transmitted through poor food preparation, personal hygiene or public sanitation practices (Oje et al., 2016). Therefore, to ensure the safety of the foods, producer and hawkers must maintain a clean environment, minimize contact with the food samples after production and also maintain a high level of personal hygiene. Also, utensils should be properly clean at all stages of production.

Food handlers should be provided with basic education on the proper ways of handling food in order to prevent cross-contamination. Food handlers should also ensure to prepare food in a hygienic condition by ensuring that there is adequate supply water for cooking and washing, waste are disposed properly, and also ensure that left over food are properly preserved. The public should also be made aware of the health implication of consumption of street foods which pose serious health problems to individuals. It may be impossible to eradicate vending of ready-to-eat foods around motor parks in Nigeria. Therefore, government should enforce strong food safety regulations for street foods vendors. In addition, street food vendors need to be educated on food safety and hygienic practices. The government should set up legislations which ensure that street food vendors follow the standards and requirements for setting up a street food vending business.

High moisture content accelerates food spoilage and generally provides a good media for the growth and proliferation of microorganisms especially bacteria (Prescott *et al*., 2008). The moisture content obtained from the samples is generally low 0.61% to 2.79%. If these foods with low moisture content are held under humid condition, growth of molds will be supported and as water absorption continues to raise bacteria will be able to grow. The pH values 6.7 to 7.2 obtained indicate that the food was slightly acidic to neutral, this favours the proliferation and survival of bacteria. The bacteria count obtained are indicative of post contamination in the light of the amount of heating that goes into food production, similar post treatment contamination has been reported by Ogugbue *et al*. (2011). This can occur during cooling and exposure to the air which has been identified as the main source of microbial contamination of most street foods.

5. Conclusions

These results, showing that street food sold in these sites clearly requires adequate sanitary conditions for its preparation and sale, contribute to the development of good manufacturing practices (GMP) for street food. The occurrence of these bacterial isolates in the foods could result in a public health threat to consumers as all these bacterial pathogens have been associated with diarrheal illness and other foodborne infection. The identification of these bacteria in the food's samples could be attributed to poor personal hygiene, noncompliance to hazard analysis

and critical control point's scheme. To minimize this unwholesome trend of ready-to-eat food contamination, it is important for appropriate agencies in food safety and public health to organize training on hygiene and food safety for food vendors.

Declarations

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Competing Interests Statement

The authors declare no competing financial, professional and personal interests.

Consent for publication

Authors declare that they consented for the publication of this research work.

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