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Assessment of Bacteria Associated with Ready-to-Eat Food Sold at Federal University Dutse, Jigawa State, Nigeria

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Abstract

Today the issue of food safety is a global problem that gets main concern in setting public health policy. The eruption of diseases caused by food contamination occurs in places where sanitation and hygiene conditions are generally poor. Reliable identification of bacteria remains to be an important task in food microbiology. In this study, five different ready-to-eat foods from Federal University Dutse (FUD) canteens and cafeterias were collected and analyzed immediately through serial dilution, inoculation, incubation, subculture, microscopy and biochemicals to confirm the isolated organisms. A total of five pathogenic bacteria were isolated: *Staphylococcus aureus* (42.3%), *Escherichia coli* (40.8%), *Salmonella* (5.6%), *Streptococcus pneumoniae* (4.2%) and *Bacillus cereus* (4.2%). This indicates the poor hygiene level of the food vendors as majority of the food vendors lacks western education. These vendors have to receive education and training on food hygiene to improve the safety of foods in FUD and thereby heighten the safety of consumer.

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Introduction

Ready-to-eat food (RTE) is defined as food that is ordinarily consumed in the same state as that which it is sold and does not include nuts in the shell and whole, raw-fruits and vegetables that are intended for hulling, peeling or washing by the consumer (New South Wales, 2009). RTE food can be described as the status of food being ready for immediate consumption at the point of sale. RTE could be raw or cooked, hot or chilled, and can be consumed without further heat treatment (Tsang, 2002). Different terms have been used to describe such ready-to-eat food; these include convenient, ready, instant, and fast foods. Examples of such RTE foods include moi-moi, jallof-rice, fried meat, pastries, meat-pie, etc. RTE foods usually include a number of ingredients which may or may not be cooked. Some RTE foods also are regarded as potentially hazardous, such foods can support the growth of pathogenic (food poisoning) bacteria and must be kept at certain temperatures to minimize the growth of any pathogen that may be present in the food or to prevent the formation of toxins in the food (NSW, 2009). Although it's extremely difficult to pinpoint the precise beginning of human awareness of the presence and role of micro-organisms in foods, the available evidence indicates that this knowledge preceded the establishment of bacteriology or microbiology as a science (Jay, 2006). Due to the variety of RTE foods, the interpretation of microbiological results obtained from testing must

account for the method of processing and the individual components of the food (NSW, 2009).

Because human food sources are of plant and animal origin, it is important to understand the biological principles of the microbial biota associated with plants and animals in their natural habitats and respective roles (Jay, 2006). Although it sometimes appears that micro-organisms are trying to ruin our food sources by infecting and destroying plants and animals, including humans, this is by no means their primary role in nature (Jay, 2006). In our present view of life on this planet, the primary function of micro-organisms in nature is self-perpetuation. The microbial spoilage of foods may be viewed simply as an attempt by the food biota to carry out what appears to be their primary role in nature. Outbreaks of food borne diseases are caused by foods that are contaminated intrinsically or that become contaminated during harvesting (Torok et al., 1997).

The consumption of food contaminated by micro-organisms will result in food- borne illnesses; these are usually either infectious or toxic in nature caused by agents that enter the body through ingestion of food (World Health Organization, 2007). According to the U.S. department of Health and Human Services (USDHHS) website, food -borne illnesses are diseases that results from eating contaminated food (USDHHS, 2013). Food- borne illnesses have continued to form a significant part of the morbidity and mortality of Nigerians, and have on the increase in recent times. In Nigeria and many developing countries, there are inadequate diagnostic facilities leading o inadequate investigation of outbreaks and the subsequent gross under-reporting of food-borne illnesses. Bacteria are the causative agents of food-borne illness in 60% of cases requiring hospitalization (Mead et al., 1999). The International impact of food-borne illness is difficult to estimate. However, about 2.1 million children in developing countries die due to diarrheal related illnesses annually, it is suspected that food or water is the vehicle for many of these illnesses (WHO, 2002). Because food is biological in nature and is capable of supplying consumers with nutrients, it is equally supporting the growth of contaminating micro-organisms. In Nigeria, a number of foods have been reported to have high incidence of bacteria (Adesiyun, 1995; Okonko et al., 2009; Adesetan et al., 2013; Bello et al., 2013).

A number of observational studies have shown that RTE 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). Lacking personal hygiene among food handlers is one of the most commonly reported practices contributing to food-borne illness and poor hand and surface hygiene is also a significant contributory factor (Bryan, 1997; WHO, 2000). Contamination of food premises has been shown to be associated with poor hygiene standards (Cogan et al., 2002). The hands of food handler can be pivotal as vector in the spread of food-borne diseases due to poor personal hygiene or cross-contamination. Hand washing, a simple and effective way to cut down on cross-contamination is too often forgotten. It was reported that 42% of food-borne diseases outbreaks which took place in America have been caused by food handlers (Sadiq, 2008). The risk of food-borne illness due contact with hand or surface depends on both the level of contamination as well as the probability of transfer, and the importance of contaminated surface in relation to potential transmission of pathogens to food is apparent in food processing (Lynch et al., 2000). Most of the food sellers and RTE food handlers have either no formal education or few years of schooling and therefore, lack knowledge on proper food handling and play role in the transmission of pathogens (Mensah et al., 2002). A very good example of this food handler is "Typhoid Mary", Mary Mallon, who was the famous carrier of the typhoid bacteria. From the late 1980's till early 1990's, Mary Mallon worked as a cook and hence, she was continually spreading the disease (Willey et al., 2008). Therefore, the hygiene standard of the food preparation areas, utensils, as well as the personal hygiene practice in some of the kitchen personal is questionable (Ibrahim et al., 2013). In most countries, food-borne disease remain a public health predicament in spite of the improvement in hygiene standards, improved food processing practices, education of food handlers and consumer awareness (Collin, 2001).

Food safety is a growing concern for the consumers and professionals in food and food service industry (Adesiyun, 1995). Food safety is defined as the conditions and measures that are necessary during production, processing, storage, distributions and preparation of food to ensure that it is safe, sound wholesome and fit for human consumption (Adesiyun, 1985). Food hygiene is essentially aimed at producing food which is safe for human consumption and of good keeping quality (Scheule, 2001).

Microbial contaminants such as bacteria constitute the major cause of severity ranging from mild indisposition

to chronic or life threatening illness or both (Ibrahim, 2013). In developing countries, such contaminants are responsible for food-borne disease such as cholera, *Escherichia coli* gastroenteritis, salmonelosis, shigellosis, typhoid fever, etc. Federal University Dutse cafeterias and canteens are commercial catering establishments that service the campus populace. This study was carried out to appraise the bacteriological quality and hygiene level of some food outlets within the University.

Safe food is basic human rights despite many foods are frequently contaminated with naturally occurring pathogenic micro-organisms, such pathogens cannot be detected organoleptically, but can cause diseases of varying severity including death especially in the way they are conserved during exposition for sales provides condition for those micro-organisms to grow and reach considerable levels of contamination . Thus, food safety issues are of major important issues to the World Health Organization. The study is aim at analyzing bacteria on ready-to-eat food sold at Federal University Dutse, Jigawa State, Nigeria, as very little or no information is available.

Materials and methods

Study area

This research project is focused at cafeterias and canteens within Federal University Dutse, Jigawa state, which accounts a population of 3,610 students for which 80% of their demands for daily consumption depend on these canteens and cafeterias.

Sterilization of materials

All materials used were adequately and appropriately sterilized before and after use. Glass wares such as test tubes, conical flasks, pipettes, etc were thoroughly washed with detergents, rinsed properly with water and drained. They were wrapped in aluminum foil and sterilized in hot air oven at 170ºC for 1 hr. All media used were prepared according to the manufacturer's instruction. Prepared media and distilled water were autoclaved at 121ºC for 15 minutes. Metal equipments like the inoculating loop were heated to redness in an open flame before and after use. The laboratory bench was always swabbed using 70% alcohol for disinfection before analysis was made. Every isolation and inoculation was done near the flame to reduce contamination of the agar plates tubes.

Collection of samples

Six different RTE foods (beans cake, beans pudding, Pita, local cheese and Pounded yam) were obtained at random five times from various canteens and cafeterias within the University campus for bacteriological analysis. This makes a total of 30 samples to be collected between April and June, 2015. The food samples were collected aseptically to avoid contamination, labeled appropriately and were immediately transported to the laboratory for analysis.

Sample preparations

(a) Serial dilution: One gram of each ready-to-eat food samples was weighed using a weighing balance and placed into a sterile blender, 9ml of sterile distilled water was also added and the mixture homogenized to obtain a thorough mixture. The homogenized food was aseptically transferred into a sterile beaker. One ml of the homogenized food sample was aseptically transferred using five ml sterile pipette into a test tube containing 9 ml sterile distilled water. Eight fold dilutions of the homogenates were prepared (Odu and Assor, 2013).

(b) Plating, culture and incubation: One ml of the 10^{-4} and 10^{-5} dilution factors of the homogenate were plated using pour plate technique. The samples were suspended in to sterile Petri-dishes and molten agar cooled at approximately 40-45ºC was poured. After the nutrient agar solidifies, the plates were inverted and incubated at 37°C for 24 - 48 hrs. Subculture was made at the end of each incubation period to obtain pure culture of the colonies isolated. This was carried out on MacConkey and Nutrient agar.

(c) Viable cell count: At end of the incubation periods, the counts for each plate were counted and then expressed as colony forming unit millilitre of the sample (cfu/ml). It was achieved by dividing the plate in to four, then colonies were counted for one side and multiplied by four. Number of colonies depends on their size: typically from 30 to 300 is appropriate on a standard 10cm Petri dish. CFU/ml is mathematically expressed as:

$$\text{CFU/ml} = \frac{\text{No of colonies}}{\text{Diluting x vol. (ml)}}$$

Macroscopic and microscopic identification

Colonies identifiable as discrete on the Nutrient Agar were carefully examined macroscopically for cultural

characteristics such as shape, size, colour and consistency by comparing their morphological and biochemical characteristics with standard reference organisms (Buchanan and Gribbons, 1974; Cowan and Steel, 1985; Cheeshrough, 2003; Mboto et al., 2012; Olutiola et al., 1991). For morphological characteristics, a small portion of the discrete colonies on each plate was smeared on a microscope slide with a drop of Normal saline added. The smear was gently fixed by heat and immersion oil was dropped on the surfaces, and then viewed under the ×100 objective lens of the microscope (Bello and Osho, 2013).

Statistical analysis

Data obtained was analysed using Chi- square to find the significance of each of the organism isolated.

Results and discussion

The most predominant bacterial pathogens isolated in the present study include *Staphylococcus aureus*, *Bacillus cereus*, *Escherichia coli* and *Salmonella, Streptococcus pneumoniae.* The isolation of similar pathogens has also been reported by previous workers from various foods (raw and ready-to-eat foods) (Fang et al., 1999). A study on street vended foods in Atbara City in the Naher Elneen state of Sudan showed that the most prevalent bacteria contaminating cooked meals, bottled drinks and fresh fruit *were Escherichia coli, Staphylococcus aureus* and *Bacillus* sp. (Abdalla et al., 2009; Elfaki and Elhakim, 2011; Ameko et al., 2012). Various origins are an indication of poor hygienic practices in the study area.

The bacterial species isolated in the present study, in six different RTE are provided in Tables 1 to 5. *Staphylococcus aureus* is the most predominated organism (43.5%) isolated from all the food samples, a well-known food-borne pathogen, this bacterium may be contributed through human handling of the raw food and products. Nevertheless, adequate precautions can prevent *S. aureus* contamination, growth and enterotoxin production from occurring in food products (Himelbloom et al., 2008; Amusan et al., 2010). Contamination of ready-to-eat products can be prevented through the use of latexgloves to reduce excessive human hand contact (ICMSF, 2000; Amusan et al., 2010). Open-air markets have been implicated in direct transfer of *S. aureus* during handling between traders and customers of ready-to-eat cooked, smoked, dried, or fried fish and shellfish (Amusan et al., 2010). *Staphylococcus aureus* is a Gram positive coccus resistant to heat, drying and radiation. Its strains can be pathogenic and relatively nonpathogenic. They produce some enzymes which are implicated with *Staphylococcal* invasiveness and many extracellular substances some of which are heat stable enterotoxins that render the foods dangerous even though it appears normal (Prescott *et al.,* 2005). Some signs and symptoms of *Staphylococcal* food poisoning include nausea, vomiting, abdominal cramp and diarrhea.

E. coli was also present in all the food samples (42.0%). *Escherichia coli* is a member of the genus *Enterobacteriaceae*. Members are widely distributed in the environment. Contaminated food and water are the major sources by which the bacterium is spread. Selected strains can cause a wide variety of infections in hospitals and community settings (Donnenberg, 2005). These include diarrheal illness, urinary tract infections, meningitis, sepsis, wound infections, nosocomial pneumonia and dysentery. A subgroup called Enterohaemorrhagic *Escherichia coli* (EHEC) can cause food borne illness as the *Escherichia coli* 0157:H7 strain which cause severe and potentially fatal illness known as Haemorrhagic colitis which is characterized by bloody diarrhea and severe abdominal pain (Dolores and Doyle, 2001). *Escherichia coli* is commonly used as a surrogate indicator; its presence in food generally indicates direct or indirect fecal contamination. However, in Nigeria, a number of foods have been reported to have a high incidence of the bacteria (Adeyisun, 1995; Okonko *et al.*, 2009).

Bacillus cereus (4.3%) was another bacterial isolates in this study. This consistent with what was earlier reported by Odu and Ameweiye (2013). *Bacillus sp.* produces toxins that withstand high temperatures and are spore forming which germinate and release enterotoxins. Engestion of bacillus toxin- containing food also causes nausea, vomiting, abdominal cramps and diarrhea (Adebayo-Tayo et al., 2006, 2009, 2012a,b; Kapute et al., 2012). Since some species of *Bacillus* are airborne and dust- borne contaminant, poor handling can lead to contamination. The presence of aureus from street food samples implicated the ubiquitous nature of bacterial spores especially in dusty side location *Streptococcus pneumoniae* also predominate at 4.3%. This may be as a result of contamination from a sick person suffering from such disease especially the food handler, therefore adequate and proper handling is needed. *Salmonella* is also organism isolated in this study. From the Chi-square expressed above, none of the organism isolated appeared to be significant.

Table 1. Bacterial isolates in RTE food Pita collected from Federal University Dutse (dilution used: 10^{-5}).

Day	No. of colonies	cfu/ml	Isolate	Colony morphology	Microscopy	Gram reaction	Biochemical Test	Organism isolated
Day 1	104	$1.04x10^{7}$	G1	Shiny, round colonies	Diplococci	+ve	Cat. –ve, oxi. +ve	*S. pneumoniae*
			G2	Pale yellow, opaque	Cocci in clusters	-ve	Coag. +ve, cat. +ve	*S. aureus*
			G3	Mucoid, pink/red colony	Bacilli	-ve	Cat. +ve, oxi. –ve.	*E. coli*
Day 2	96	$9.6x\ 10^{6}$	G1	Pink/red colonies, mucoid	Bacilli	-ve	Cat. +ve, oxi. –ve.	*E. coli*
			G2	Yellow colonies	Cocci in clusters	+ve	Cat +ve, coag +ve	*S. aureus*
			G3	Shiny, round colonies	Diplococci	+ve	Cat. –ve, oxi. +ve	*S. pneumoniae*
Day 3	64	$6.4x\ 10^{6}$	G1	Yellow colonies	Cocci in clusters	+ve	Cat. +ve, coag. +ve.	*S. aureus.*
			G2	Pink/red colonies, mucoid	Bacilli	-ve	Cat. +ve, oxi. –ve.	*E. coli*
Day 4	72	$7.2\ x\ 10^{6}$	G1	Pink/red colonies, mucoid	Bacilli	-ve	Cat. +ve, oxi. –ve.	*E. coli*
			G2	White/colourless colonies	Bacilli	-ve	Cat. +ve,	*Salmonella*
			G3	Yellow colonies	Cocci in clusters	+ve	Cat. +ve, coag. +ve.	*S. aureus*
Day 5	52	$5.2\ x10^{6}$	G1	Pink/red colonies, mucoid	Bacilli	-ve	Cat. +ve, oxi. –ve.	*E. coli*
			G2	Yellow colonies	Cocci in clusters	+ve	Cat. +ve, coag. +ve.	*S. aureus.*
Day 6	100	$1.0x\ 10^{7}$	G1	Colourless colonies	Bacilli	-ve	Cat. +ve,	*Salmonella*
			G2	Yellow colonies	Cocci in clusters	+ve	Cat. +ve, coag. +ve.	*S. aureus.*
			G3	Pink/red colonies, mucoid	Bacilli	-ve	Cat. +ve, oxi. –ve.	*E. coli*

+ve = positive, -ve = negative, cat. = catalase, coag. = coagulase, oxi. = oxidase.

Table 2. Bacterial isolates in RTE food Beans pudding collected from Federal University Dutse (dilution used: 10^{-5}).

Day	No. of colonies	cfu/ml	Isolate	Colony morphology	Microscopy	Gram reaction	Biochemical Test	Organism isolated
Day 1	72	$7.2x\ 10^{6}$	Moi 1	Pink/red colonies	Bacilli	-ve	Cat +ve, oxi. –ve.	*E.coli*
			Moi 2	Golden yellow colonies	Cocci in clusters	+ve	Cat. +ve, coag. +ve	*S.aureus*
Day 2	56	$5.6x\ 10^{6}$	Moi	Golden yellow colonies	Cocci in clusters	+ve	Cat. +ve, coag. +ve	*S.aureus*
			Moi 2	Pink/ red colonies	Bacilli	-ve	Cat +ve, oxi. –ve.	*E.coli*
			Moi 3	Milk round colonies with undulating margin	Bacilli	+ve	Cat. +ve,	*B.cereus*
Day 3	84	$8.4x\ 10^{6}$	Moi 1	Pink/ red colonies	Bacilli	-ve	Cat +ve, oxi. –ve.	*E.coli*
			Moi 2	Golden yellow colonies	Cocci in clusters	+ve	Cat. +ve, coag. +ve	*S.aureus*
			Moi 3	Milk colonies with undulating margin	Bacilli	+ve	Cat. +ve	*B.cereus*
Day 4	52	$5.2\ x\ 10^{6}$	Moi 1	Pink/ red colonies	Bacilli	-ve	Cat +ve, oxi. –ve.	*E.coli*
			Moi 2	Golden yellow colonies	Cocci in clusters	+ve	Cat. +ve, coag. +ve	*S.aureus*
Day 5	56	$5.6\ x\ 10^{6}$	Moi 1	Golden yellow colonies	Cocci in clusters	+ve	Cat. +ve, coag. +ve	*S.aureus*
			Moi 2	Pink/ red colonies	Bacilli	-ve	Cat +ve, oxi. –ve.	*E.coli*
Day 6	32	$3.2\ x\ 10^{6}$	Moi 1	Golden yellow colonies	Cocci in clusters	+ve	Cat. +ve, coag. +ve	*S.aureus*
			Moi 2	Pink/ red colonies	Bacilli	-ve	Cat +ve, oxi. –ve.	*E.coli*

+ve = positive, -ve = negative, cat. = catalase, coag. = coagulase, oxi. = oxidase.

Table 3. Bacterial isolates in RTE food Pounded yam collected from Federal University Dutse (dilution used: 10^{-5}).

Day	No. of colonies	cfu/ml	Isolate	Colony morphology	Microscopy	Gram reaction	Biochemical Test	Organism isolated
Day 1	80	8.0 x 10^6	P1	Pink colonies	Bacilli	-ve	Cat. +ve, oxi.-ve	*E. coli*
			P2	Pale yellow colonies	Cocci in clusters	+ve	Cat. +ve, coag.+ve	*S. aureus*
Day 2	36	3.6 x 10^6	P1	Pinkish colonies	Bacilli	-ve	Cat. +ve, oxi.-ve	*E. coli*
			P2	yellow colonies	Cocci in clusters	+ve	Cat. +ve, coag.+ve	*S. aureus*
Day 3	64	6.4 x 10^6	P1	Pale yellow colonies	Cocci in clusters	+ve	Cat. +ve, coag.+ve	*S. aureus*
			P2	Pink/ re colonies	bacilli	-ve	Cat. +ve, oxi.-ve	*E. coli*
			P3	Shiny round colonies with entire margin	Cocci in pairs	+ve	Cat. – ve, oxi.-ve	*S. pneumoniae*
Day 4	56	5.6 x 10^6	P1	Yellow colonies	Cocci in clusters	+ve	Cat. +ve, coag.+ve	*S. aureus*
			P2	Pinkish colonies	Bacilli	-ve	Cat. +ve, oxi.-ve	*E. coli*
Day 5	112	1.12 x10^7	P1	Pink colonies	Bacilli	-ve	Cat. +ve, oxi.-ve	*E. coli*
			P2	Pale yellow colonies	Cocci in clusters	+ve	Cat. +ve, coag.+ve	*S. aureus*
			P3	Colourless/white colonies	Rod shape (bacilli)	-ve	Cat. +ve	*Salmonella*
Day 6	44	4.4 x 10^6	P1	Pink/ red colonies	Bacilli	-ve	Cat. +ve, oxi.-ve	*E. coli*
			P2	Colourless colonies	Rod shape (bacilli)	-ve	Cat. +ve	*Salmonella*

+ve = positive, -ve = negative, cat. = catalase, coag. = coagulase, oxi. = oxidase

Table 4. Bacterial isolates in RTE food-Local cheese collected from Federal University Dutse (dilution used: 10^{-5}).

Day	No. of colonies	cfu/ml	Isolate	Colony morphology	Microscopy	Gram reaction	Biochemical Test	Organism isolated
Day 1	64	6.4 x 10^6	A1	Gold/ yellow colony	Cocci in clusters	+ve	Cat. +ve, coag. +ve	*S. aureus*
			A2	Pink/ red colony	Bacilli	-ve	Cat. +ve, oxi. –ve	*E. coli*
			A3	Milk colony with undulating margin	Bacilli	+ve	Cat. +ve,	*B. cereus*
Day 2	52	5.2 x 10^6	A1	Pink/ red colony	Bacilli	-ve	Cat. +ve, oxi. –ve	*E. coli*
			A2	Gold/ yellow colony	Cocci in clusters	+ve	Cat. +ve, coag. +ve	*S. aureus*
Day 3	56	5.6 x 10^6	A1	Pink/ red colony	Bacilli	-ve	Cat. +ve, oxi. –ve	*E. coli*
			A2	Gold/ yellow colony	Cocci in clusters	+ve	Cat. +ve, coag. +ve	*S. aureus*
Day 4	28	2.8 x 10^6	A1	Gold/ yellow colony	Cocci in clusters	+ve	Cat. +ve, coag. +ve	*S. aureus*
Day 5	92	9.2 x 10^6	A1	Pink/ red colony	Bacilli	-ve	Cat. +ve, oxi. –ve	*E. coli*
			A2	Gold/ yellow colony	Cocci in clusters	+ve	Cat. +ve, coag. +ve	*S. aureus*
Day 6	76	7.6 x 10^6	A1	Pink/ red colony	Bacilli	-ve	Cat. +ve, oxi. –ve	*E. coli*
			A3	Gold/ yellow colony	Cocci in clusters	+ve	Cat. +ve, coag. +ve	*S. aureus*

+ve = positive, -ve = negative, cat. = catalase, coag. = coagulase, oxi. = oxidase

Table 5. Bacterial isolates in RTE food-Beans cake collected from Federal University Dutse (dilution used: 10^{-5}).

Day	No. of colonies	cfu/ml	Isolate	Colony morphology	Microscopy	Gram reaction	Biochemical Test	Organism isolated
Day 1	56	5.6 x 10^6	K1	Pinkish colony	Bacilli	-ve	Cat. +ve, oxi.-ve	*E. coli*
			K2	Pale yellow colony	Cocci in clusters	+ve	Cat. +ve, coag.+ve	*S. aureus*
Day 2.	68	6.8 x 10^6	K1	Pale yellow colony	Cocci in clusters	+ve	Cat.+ve, coag.+ve	*S. aureus*
			K2	Pinkish colony	Bacilli	-ve	Cat. +ve, oxi.-ve.	*E. coli*
Day 3.	52	5.2 x 10^6	K1	Pale yellow colony	Cocci in clusters	+ve	Cat. +ve, coag.+ve	*S. aureus*
			K2	Pinkish colony	Bacilli	-ve	Cat. +ve, oxi.-ve.	*E. coli*
Day 4.	48	4.8 x 10^6	K1	Pale yellow colony	Cocci in clusters	+ve	Cat. +ve, coag.+ve	*S. aureus*
			K2	Pinkish colony	Bacilli	-ve	Cat. +ve, oxi.-ve.	*E. coli*
Day 5.	64	6.4 x 10^6	K1	Light red colony	Bacilli	-ve	Cat. +ve, oxi.-ve.	*E. coli*
			K2	Pale yellow colony	Cocci in clusters	+ve	Cat. +ve, coag.+ve	*S. aureus*
Day 6.	72	7.2 x 10^6	K1	Pinkish red col	Bacilli	-ve	Cat. +ve, oxi. –ve.	*E. coli*
			K2	Yellow colony	Cocci in clusters	+ve	Cat. +ve, coag.+ve	*S. aureus*
			K3	Colourless colony	Rod shape (bacilli)	-ve	Cat. +ve	*Salmonella*

+ve = positive, -ve = negative, cat. = catalase, coag. = coagulase, oxi. = oxidase

Table 6. Occurrence and percentage of each organism isolated in the food samples.

Organism isolated	No. of samples examined	Food sample					Total no. of each isolated	%
		Gurasa	Moi-moi	Awara	P.yam	Beans cake		
E. coli	30	6	6	5	6	6	29	42.0
S. aureus	30	6	6	6	6	6	30	43.5
S. pneumoniae	30	2	-	-	1	-	3	4.3
B. cereus	30	-	2	1	-	-	3	4.3
Salmonella	30	2	-	-	1	1	4	5.8
Total organisms in each sample		**16**	**14**	**12**	**14**	**13**	**69**	

Table 7. Comparison of number of food samples examined with bacterial isolates using Chi-square.

Food samples	No. of food samples examined	*S. pneumoniae* (%)	*S. aureus* (%)	*E. coli* (%)	*Salmonella* (%)	*B. cereus* (%)
Pita	6	2 (33.33)	6 (100.00)	6 (100.00)	2 (33.33)	0 (0.00)
Beans Pudding	6	0 (0.00)	6 (100.00)	6 (100.00)	0 (0.00)	2 (33.33)
Pounded Yam	6	1 (16.67)	6 (100.00)	6 (100.00)	2 (33.33)	0 (0.00)
Local Cheese	6	0 (0.00)	6 (100.00)	5 (83.33)	0 (0.00)	1 (16.67)
Beans Cake	6	0 (0.00)	6 (100.00)	6 (100.00)	1 (16.67)	0 (0.00)
Total	**30**	**3 (10.00)**	**30 (100.00)**	**29 (96.70)**	**6 (20.00)**	**3 (10.00)**
Chi-sqaure		**5.926**		**4.138**	**4.038**	**5.926**
df		**4**		**4**	**4**	**4**
***p*-value**		**0.205ns**		**0.388ns**	**0.401ns**	**0.205ns**

Conclusion

This study has demonstrated that some of the most popular types of ready-to-eat foods that are sold in canteens and cafeteria of FUD are contaminated, and do not meet the required quality and safety levels. Some of the bacteria isolated especially *Staphylococcus aureus* and *Escherichia coli that* are isolated in almost each and every collection of the food sample are potential enteric pathogens and are known to cause gastroenteritis. This clearly depicts poor handling and management leading to cross contamination as *S.aureus* is a normal flora of the skin and *E.coli* demonstrate feacal contamination. This pose a health threat to the patron and efforts to reduce level of contamination in this canteens and cafeterias are highly recommended as no only student from FUD rely on the food, but also some individuals from the community as most dwellers of Dutse City are Workers.

Recommendations

This study recommends that every vendor, helper or food handler has to undergo proper training with regard to basic food hygiene, knowledge of preservation, storage of food, lapse time between preparation and dispensing of food items to the consumers. This is to ensure that they follow the required rules of food safety, hygiene practices and sanitation. There is a need for stricter implementation of the food sanitation code, licensing of food vendors within school campus and issuing health cards. In order to maintain the benefits of vended food system while assuring the safety of the food sold authorities need to develop a policy aimed at assisting, controlling and maintaining the food sector. The policy developed has to respond to an integrated consultation with vendors and consumers if it is to meet the needs of each of the partners in food safety (government, school management, consumers and vendors).

There is a need for further study on foods classified as medium to high risk that include the total counts of coliform, *S. aureus*, *E. coli*, *B. cereus*, *Salmonella* and other food-borne microorganisms. Determinations of these types of bacteria act as a quick index of acceptability of food for human consumption.

Conflict of interest statement

Authors declare that they have no conflict of interest.

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