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Evaluation of Bacterial Contamination of Ready-To-Eat Foods Sold in Ado-Ekiti, Ekiti State, Nigeria.

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Abstract

Vendors of ready-to-eat foods attach great importance to speed of service. None adherence to standard procedures in processing foods results to food contamination with pathogenic microorganisms. This study evaluated ready-to-eat foods in some restaurants in Ado-Ekiti, Nigeria for bacterial contamination. Ninety (90) samples consisting of thirty samples each of fried Rice, steamed beans pudding (Moimoi) and Cole-slaw were randomly collected from six different restaurants and transported aseptically under cold condition to the laboratory for evaluation using standard microbiological techniques. The total aerobic plate counts of organisms were expressed as colony forming units per gram of sample. Antibiotic sensitivity was done on the isolates. Of the total samples, 209 bacterial isolates were recorded from nine bacteria genera. The bacteria isolates were *Staphylococcus aureus* (22.0%), *Escherichia coli* (18.2%), *Klebsiella pneumoniae* (15.3%), *Salmonella typhi* (11.5 %), *Pseudomonas aeruginosa* (9.6%), *Bacillus cereus* (7.2%), *Citrobacter freundii* (7.0%), *Proteus mirabilis* (5.3%) and *Enterobacter aerogenes* (4.3%). The bacteria load ranged from 1.17×10^3-3.19×10^6 cfu/g of food. Moimoi appeared generally safe, fried Rice range between tolerable and unacceptable limits while Cole-slaw was generally unacceptable for human consumption. The microorganisms demonstrated gross resistance to tested antibiotics except ofloxacin and ciprofloxacin. Management of food-borne infections caused by the microorganisms may pose clinical challenges. Health education to improve the knowledge of food vendors and consumers on food safety and hygienic practices is hereby advocated. Regulation and effective monitoring for enforcement of standards among vendors of ready-to-eat foods are therefore recommended.

Keywords: Ready-to-eat; Restaurants; Contamination; Microbial load; Resistance

1. Introduction

Ready-to-eat (RTE) foods are food sold in a restaurant or stores. They are kept in cold condition and preheated with some ingredients and sold to customers for immediate consumption or packaged for customers to take away. Great attention is given to speed of service. World Health Organization [1] asserts that unsafe food causes approximately 1.5 billion annual cases of diarrhea in children, resulting in an estimated 2.1 million deaths from diarrhea worldwide. An estimated 24 and 81 million case of food borne diarrhea disease is said to occur each year of which 128,000 are hospitalized and 3,000 die each year from food poisoning in USA [2]. In Nigeria, the prevalence of food-borne disease is estimated to be over 1.5 million cases annually of which over 200,000 people die from the illness annually [3].

Sources of food contamination include equipments, sewage, employees [4], air and water, insects and rodents [5]. Most organisms may die in the process of heat treatment but employees having poor hygiene constitute major source of food contamination. Microorganisms on employee's bodies are transmitted to food during processing, packaging, and service through the process of touching, talking, coughing, or sneezing [4]. Bacterial contamination of food is of public health concern because they are the major biological sources of many food poisoning cases. Poor food preparation and indecent cooking practices, such as in cross-contamination of food, inadequate food processing, poor hygiene and the re-use of leftovers, are said to be responsible for causing 14% of these diseases [1].

Despite the unhygienic condition under which RTE foods are prepared and the uncertainty of the microbial quality of the food, there is high rate of consumption of the food [6]. People patronize restaurants for RTE foods to satisfy hunger, eat for pleasure or to safe precious time without due consideration of safety after food consumption.

Ready-to-eat foods have gradually become an important dietary option especially in Ado-Ekiti (The Capital city of Ekiti State) possibly because of workers who finds it easier to quickly get into restaurants and get a fast food or order the food while at work. Although some investigations have been done on the microbial quality of RTE foods, there is paucity of information on the antimicrobial resistance and the potential risks connected with the consumption of food contaminated with antibiotic-resistant bacteria particularly in the present study area- Ado-Ekiti. Therefore, it is needful to carry out the investigation in order to point out the health implications of consuming such RTE foods, and proffer necessary interventions that could be used by the relevant bodies to improve the hygiene of RTE foods sold for consumption in Ado-Ekiti, Ekiti State.

This study therefore aimed at determining bacterial load and antibiotic sensitivity pattern of bacteria isolated from ready-to-eat foods sold in Ado-Ekiti, Ekiti State, Nigeria. The specific objectives were to isolate and identify bacteria contaminants from the ready-to-eat vended fried Rice, steamed beans pudding (Moimoi) and Cole-slaw, to determine total aerobic bacteria load of contaminated RTE food samples using Colony Forming Unit (CFU) count, to compare the microbial count in food sampled with the recommended standard for microbial count on ready-to-eat foods and to determine antibiotic susceptibility pattern of the different bacteria isolated.

2. Materials and Methods

Study area

The study was conducted using fast food restaurants in Ado-Ekiti, Ekiti State. Ado-Ekiti is the capital city of Ekiti State and is in Southwest Nigeria and lies between latitude 7° 35 and 7° 38 north of the equator and Longitude 5° 10 and 5° 15 east of the Greenwich Meridian [7]. It has a population of 424,340 [8].

Sample size and collection

A total of 90 food specimens comprising of five each of ready-to-eat food - fried Rice, Moimoi and Cole-slaw - were purchased randomly from six (6) different restaurants in Ado-Ekiti. The restaurants were designated restaurants "R i", "R ii", "R iii", "R iv", "R v" and "R vi". The packaged

samples were immediately transferred in cooled packs, under aseptic condition to the Medical Microbiology Laboratory of Medical Laboratory Science Department, Afe Babalola University, for microbiological analysis within one hour of collection.

Sample analysis

Sample preparation: Ten grams (10.0 g) of each RTE food was mashed aseptically in a sterile stomacher bag. Each mashed sample was suspended in 90 ml of sterile distilled water [9]. The homogenized sample was then aseptically transferred into a sterile beaker. One ml (1 ml) of the homogenized food sample was aseptically transferred using a sterile graduated pipette into a sterile test tube containing nine ml (9 ml) sterile distilled water. Tenfold serial dilutions of the resultant homogenates were made to obtain dilutions of 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5} and 10^{-6} respectively in sterile distilled water [9].

One (1.0) ml of each diluted sample was plated onto Nutrient Agar (Himedia) for aerobic plate count and MacConkey Agar (Himedia) for the isolation of bacteria organisms respectively. Xylose-Lysin Dextrose Agar (Himedia) agar was inoculated after 24 hrs culture in Selenite-F broth for the isolation of enteric organisms. Nutrient agar plates were incubated at 32℃ for 24-48 hrs while MacConkey agar and XLD agar plates were incubated at 37℃ for 24-48 hrs [10]. All colonies growing on the Nutrient agar plates were counted and expressed as colony forming unit per gram (cfu/g) of the sample [11,9].

Identification of isolates

The bacterial isolates were identified based on cultural, morphological and biochemical characteristics of the isolates using standard microbiological methods [12,13,14].

Antibiotics sensitivity testing

Disc diffusion method of antibiotic susceptibility testing [15] was used to test the bacteria isolates against orthodox antibiotics. The inoculum was prepared from an 18 hours broth culture of about 2-3 colonies of each bacterial isolate incubated at 37℃ and its turbidity compared with 0.5M McFarland's standard [13,15]. Inoculums size of 0.1 ml were spread evenly on Mueller-Hinton agar and allowed to stay for 5 minutes before incorporation of antibiotics. The antibiotic discs were placed at equidistance from each other on the plate. The antibiotics used were ceftazidime (30 μg), ciprofloxacin (5 μg), cefuroxime (30 μg), ofloxacin (5 μg), cefixime (5 μg), gentamicin, (10 μg), augmentin (30 g) and nitrofurantoin (300 μg) (Abtek Biological Ltd, UK). The zones of inhibition were measured and interpreted according to Clinical and Laboratory Standards Institute to determine their resistance patterns [5].

Statistical analysis

The data obtained was analyzed using the Statistical Package for the Social Sciences (SPSS Inc. Chicago, Illinois, USA) software, version 23.0. The information was presented on tables.

3. Results

Two hundred and nine (209) bacterial isolates belonging to nine (9) genera were recorded from 90 RTE food samples in this study. Of the 209 isolates, *Staphylococcus aureus* recorded the highest occurrence of 22.0% followed by *Escherichia coli* (18.2%), *Klebsiella pnuemoniae* (15.3%), *Salmonella typhi* (11.5%), *Pseudomonas aeruginosa* (9.6%), *Bacillus cereus* (7.2%), *Citrobacter freundii* (6.7%), *Proteus mirabilis* (5.3%) and *Enterobacter species* (4.3%). The frequency of occurrence of the different bacterial isolates in the various food samples is shown on Table 1. of the 90 RTE foods, *Staphylococcus aureus* had the highest frequency occurring 46 times followed by *Escherichia coli* 38 times, *Klebsiella pnuemoniae* 32 times, *Salmonella typhi* 24 times, *Pseudomonas aeruginosa* 20 times, *Bacillus cereus* 15 times, *Citrobacter freundii* 14 times, *Proteus mirabilis* 11 times and *Enterobacter species* 9 times.

Of the 30 pieces each of the RTE foods, *Proteus mirabilis* food contamination was highest in Cole-slaw (6) followed by fried Rice (3) and then Moimoi (2). *Citrobacter freundii* recorded highest food contamination in Cole-slaw (7), followed by fried Rice (5) and then Moimoi (2). *Enterobacter species* recorded more food contamination in fried Rice (4), Cole-slaw (3) and then Moimoi (2). *E. coli* food contamination was highest in fried Rice (15), followed by Cole-slaw (12) and then Moimoi (11). *Klebsiella pneumoniae* food contamination was highest in fried Rice (13) followed by Cole-slaw (11)

and then Moimoi (8). *Pseudomonas aeruginosa* food contamination was highest in Cole-slaw (10) followed by Moimoi (6) and the fried Rice (4). *Salmonella typhi* food contamination was highest in Coleslaw (13) followed by fried Rice (7) and then Moimoi (4). *Bacillus cereus* food contamination was highest in fried Rice (10), followed by Cole-slaw (4) and then Moimoi (1). Finally, of the three foods, *Staphylococcus aureus* contamination was highest in fried Rice (18), followed by Cole-slaw (16) and then Moimoi (12).

Table 2 show the mean total aerobic plate count of microorganisms obtained from the various food samples. The microorganism counts on fried Rice range from 1.17 x 10^3-3.19 x 10^6 cfu/g of food. The mean aerobic plate counts on fried Rice range from 1.54 x 10^4-2.12 x 10^6 cfu/g of food. The mean aerobic plate count of microorganisms on Moimoi range from 1.17 x 10^3-3.11 x 10^4 cfu/g of food while that of Cole-slaw range from 1.98 x 10^5-3.19 x 10^6 cfu/g of food. The lowest aerobic plate count of microorganisms (1.17 x 10^3 cfu/g of food) was recorded in Moimoi against Restaurant "R v" while the highest count (3.19 x 10^6 cfu/g of food) was recorded in Cole-slaw against Restaurant "R iv".

Table 3 presents the mean zone of inhibition of the *Proteus mirabilis*, *Citrobacter freundii*, and *Enterobacter species*. *Proteus mirabilis* was resistant to cefuroxime, gentamicin, cefixime, augmentin, and nitrofurantoin. It is only sensitive to ofloxacin and ciprofloxacin but showed intermediate sensitivity to ceftazidime. *Citrobacter freundii* was resistant to gentamicin and augmentin, sensitive to ceftaxidime, ofloxacin, nitrofurantoin, and, ciprofloxacin, and intermediate sensitivity to cefuroxime and cefixime. *Enterobacter species* recorded resistance to ceftaxidime, cefuroxime, augmentin, and nitrofurantoin, sensitive to only ofloxacin and ciprofloxacin. The bacteria were moderately sensitive to gentamicin and cefixime.

In table 4, *Escherichia coli* were resistant to all the antibiotics except ceftazidime, ofloxacin and ciprofloxacin. *Klebsiella pneumoniae* was resistant to all the antibiotics except only ciproflozacin. It showed moderate sensitivity to ofloxacin. *Pseudomonas aeruginosa* recorded resistance to all the antibiotics except ofloxacin. It recorded intermediate sensitivity to ciprofloxacin.

In table 5, *Salmonella typhi* recorded resistance to all the antibiotics except ofloxacin and ciprofloxacin. *Bacillus cereus* recorded resistance to all the antibiotics except ciprofloxacin. It recorded intermediate sensitivity to ofloxacin. *Staphylococcus aureus* was resistance to all the antibiotics except gentamicin, ofloxacin and ciprofloxacin.

Table 1: The frequency of various bacteria isolated from the different ready-to-eat foods in Ado-Ekiti

ORGANISMS	READY-TO-EAT FOODS			
	Fried Rice n = 30 (%)	Moimoi n = 30 (%)	Cole-Slaw n =30 (%)	Total n=90 (%)
Proteus mirabilis	3 (10.0)	2 (6.7)	6 (20.0)	11 (12.2)
Citrobacter freundii	5 (16.7)	2 (6.7)	7 (23.3)	14 (15.6)
Enterobacter species	4 (13.3)	2 (6.7)	3 (10.0)	9 (10.0)
Escherichia coli	15 (50.0)	11 (36.7)	12 (40.0)	38 (42.2)
Klebsiella pneumoniae	13 (43.3)	8 (26.7)	11(36.7)	32 (35.6)
Pseudomonas aeruginosa	4 (13.3)	6 (20.0)	10 (33.3)	20 (22.2)
Salmonella typhi	7 (23.3)	4 (13.3)	13 (43.3)	24 (26.7)
Bacillus cereus	10 (33.3)	1 (3.3)	4 (13.3)	15 (16.7)
Staphylococcus aureus	18 (60.0)	12 (40.0)	16 (53.3)	46 (51.1)
Total	79	48	82	209

Key: n = total number of food sample obtained.

Table 2: Mean aerobic bacteria counts in (cfu/g) obtained from various food samples against the various restaurants in Ado-Ekiti

Restaurants	Fried Rice	Moimoi	Cole-slaw
	Mean(cfu/g)	Mean (cfu/g)	Mean (cfu/g)
R i	2.12×10^6	3.11×10^4	3.17×10^6
R ii	3.15×10^5	1.63×10^4	2.96×10^5
R iii	1.43×10^6	2.54×10^4	2.43×10^6
R iv	2.27×10^5	1.36×10^4	3.19×10^6
R v	1.52×10^4	1.17×10^3	1.98×10^5
R vi	3.61×10^6	2.41×10^4	2.35×10^6

Table 3: The mean inhibition diameter (mm) and sensitivity status of *Proteus mirabilis, Citrobacter freundii*, and *Enterobacter species* against commercially prepared antibiotics

Antibiotics	*Proteus mirabilis*		*Citrobacter freundii*		*Enterobacter species*	
	Mean±SD	Sensitivity	Mean±SD	Sensitivity	Mean±SD	Sensitivity
CAZ (30µg)	17.0±1.2	I	20.6±1.8	S	12.0±0.4	R
CPR (5µg)	23.5±0.9	S	22.3±0.2	S	23.0±1.4	S
CRX(30µg)	11.7±0.4	R	17.4±0.6	I	10.0±1.0	R
OFL (5µg)	20.1±1.6	S	28.1±0.5	S	21.0±0.6	S
CXM (5µg)	10.5±1.1	R	16.2±1.3	I	11.3±1.3	I
GEN (10µg)	10.1±0.7	R	13.5±0.4	R	17.5±0.2	I
AUG (30µg)	7.5±0.7	R	10.3±0.7	R	4.0±0.1	R
NIT (300µg)	11.5±0.2	R	20.2±1.4	S	11.0±1.1	R

KEY: CAZ = Ceftazidime, CRX = Cefuroxime, GEN = Gentamicin, CXM = Cefixime, OFL = Ofloxacin, AUG = Augmentin, NIT = Nitrofurantoin, CPR = Ciprofloxacin, R = Resistant, S = Sensitive, I = Intermediate sensitivity.

Table 4: The mean inhibition diameter (mm) and sensitivity status *of Escherichia coli, Klebsiella pnuemoniae* and *Pseudomonas aeruginosa* against commercially prepared antibiotics

Antibiotics	*Escherichia coli*		*Klebsiella pneumoniae*		*Pseudomonas aeruginosa*	
	Mean±SD	Sensitivity	Mean±SD	Sensitivity	Mean±SD	Sensitivity
CAZ (30µg)	19.0±1.4	S	8.7±0.9	R	6.8±1.0	R
CPR (5µg)	23.5±1.5	S	19.2±1.4	S	15.6±0.8	I
CRX (30µg)	3.8±0.1	R	2.8±0.0	R	3.4±0.1	R
OFL (5µg)	21.0±1.3	S	15.3±1.2	I	19.7±1.2	S
CXM (5µg)	6.4±0.2	R	4.5±0.3	R	0.0±0.0	R
GEN(10µg)	9.5±0.7	R	9.9±0.6	R	4.4±0.2	R
AUG (30µg)	1.9±0.0	R	1.8±0.1	R	0.0±0.0	R
NIT (300µg)	12.4±0.8	R	3.7±0.1	R	0.0±0.0	R

KEY: CAZ = Ceftazidime, CRX = Cefuroxime, GEN = Gentamicin, CXM = Cefixime, OFL = Ofloxacin, AUG = Augmentin, NIT = Nitrofurantoin, CPR = Ciprofloxacin, R = Resistant, S = Sensitive, I = Intermediate sensitivity.

Table 5: The mean inhibition diameter (mm) and sensitivity status *of Salmonella typhi, Bacillus cereus* and *Staphylococcus aureus* against commercially prepared antibiotics

	Salmonella typhi		*Bacillus cereus*		*Staphylococcus aureus*	
Antibiotics	Mean±SD	Sensitivity	Mean±SD	Sensitivity	Mean±SD	Sensitivity
CAZ (30µg)	5.5±0.1	R	9.9±0.2	R	8.8±0.3	R
CPR (5µg)	21.5±1.5	S	25.4±1.1	S	21.4±1.0	S
CRX(30µg)	4.9±0.3	R	4.5±0.5	R	6.9±0.4	R
OFL (5µg)	20.6±1.3	S	17.4±0.8	I	20.8±1.6	S
CXM (5µg)	4.7±0.4	R	8.9±0.2	R	4.7±0.5	R
GEN (10µg)	9.2±1.1	R	8.8±0.3	R	22.2±1.4	S
AUG (30µg)	1.9±0.1	R	6.4±0.2	R	1.9±0.1	R
NIT (300µg)	8.8±0.6	R	9.5±0.6	R	8.8±0.3	R

KEY: CAZ = Ceftazidime, CRX = Cefuroxime, GEN = Gentamicin, CXM = Cefixime, OFL = Ofloxacin, AUG = Augmentin, NIT = Nitrofurantoin, CPR = Ciprofloxacin, R = Resistant, S = Sensitive, I = Intermediate sensitivity.

4. Discussion

The three RTE foods (fried Rice, Moimoi and Cole-slaw) evaluated in the present study were grossly contaminated with different bacteria. Bacteria isolated from the foods: *Proteus mirabilis*, *Citrobacter freundii*, *Enterobacter species*, *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Bacillus sereus*, and *Staphylococcus aureus*, are consistent with the previous reports [16-18], who all identified *Staphylococcus aureus*, *Bacillus spp*, *Pseudomonas aeruginosa*, *Enterobacter species*, *Klebsiella pneumoniae*, and *Proteus mirabilis* from ready-to-eat food samples in Ado-Ekiti, Nigeria.

Of the total of 206 bacteria isolated, *Staphylococcus aureus* was the highest prevailing bacteria with a prevalence of 22.0 % followed by *Escherichia coli* (18.2%), *Klebsiella pneumoniae* (15.3%), *Salmonella typhi* (11.5%), P*seudomonas aeruginosa* (9.6%), *Bacillus cereus* (7.2%), *Citrobacter freundii* (6.7%), *Proteus mirabilis* (5.3%) and *Enterobacter species* (4.3%). *Staphylococcus aureus* is ubiquitous and can be found on soils and surfaces of articles and on human's body [19]. Its frequent isolation could be a pointer to an uncontrolled human handling of food [4,20], improper storage, or an unhygienic environment where food is served possibly with contaminated materials. *E. coli*, *Klebsiella pneumoniae*, *Citrobacter freundii*, *Proteus cereus* and *Enterobacter species* are environmental microorganisms generally found on soils, garden vegetables, water or sewage [21]. The presence of the microorganisms on RTE foods indicate poor hygiene in food handling processes, insufficient heating of food, or failure to adherence to standard protocols by the staff working in the eateries. *E. coli* is an enteric microorganism and its presence on RTE foods could be an indication of direct or indirect fecal contamination from the hands of food handlers [5]. *Salmonella typhi* is also an enteric microorganism. Contamination of drinking water or food by this organism is a major cause of typhoid fever. High prevalence of typhoid fever has been variously reported in Ado-Ekiti [22, 23]. These researchers' report appears supported by the finding of high contamination of RTE foods in the present study by *Salmonella typhi*, the common causative agent of typhoid fever [22, 25]. *E. coli* could pose serious challenges to food safety most particularly in cases of enterotoxigenic *E. coli* serogroup 0:157; the main causative agent of hemorrhagic colitis [26, 27]. *Bacillus cereus*, *Klebsiella pneumoniae* (formerly *Klebsiella aerogenes*) and *Pseudomonas aeruginosa* are known environmental contaminants. Their presence on RTE foods could be as a result of undue exposure of foods to air thereby allowing airborne and dust contamination of foods. *B. cereus* is a common soil saprophyte and is effortlessly being transmitted to many types of foods, especially of plant origin, but is also commonly isolated from meat, eggs and dairy products [28,29]. *Bacillus cereus* is found in uncooked Rice and as an aerobic spore former is often reported in fried Rice food poisoning [30, 31]. The vegetative cells may be destroyed by heat during processing but the heat resistant spores grow and release toxins on store processed food under favorable condition [32]. Contaminated equipment

and utensils, inappropriate processing or inadequate heating [33] -as in pre-heating of food before serving-could cause contamination of RTE foods.

The report on total aerobic count of microorganisms on fried Rice in the present study is supported by the findings of Odu and Assor [10] who reported a range of $2.45x10^5$ cfu/g - $1.78x10^6$ cfu/g on cooked rice in Port Harcourt, Nigeria. Our report on bacterial load of Moimoi (a derivative of beans) is comparable to that reported by Odu and Assor [10] on cooked beans in Port Harcourt. Moreover findings of the present study was higher than a range of 1.0 x 10^2 cfu/g to 8.7 x 10^4 cfu/g reported by Monday et al. [9] on Rice but comparable with the report on Moimoi in a higher institution of learning in Taraba State, Nigeria. Generally lower aerobic plate count of microorganisms on Moimoi might be due to its preparation and packaging as it is often wrapped and boiled in paper foil and exposure is minimal. Cole-slaw on the other hand consisting of pieces of raw cabbage, carrot, onion etc, and mixed with mayonnaise and eaten with meat or salads is more liable to microbial contamination. This might be the reason for gross contamination of the food.

The specification of International Commission for Microbiological Specification for Foods [34] states that ready-to-eat foods with plate count between 0-10^3 is acceptable, between 10^4 and $\leqslant$ 10^5 is tolerable and 10^6 and above is unacceptable. Rating the findings of the present study therefore, Moimoi appears generally tolerable, fried Rice range between tolerable and unacceptable limits while Cole-slaw is generally unacceptable.

All bacteria isolated in the present study were resistant to augmentin. Eight (8) of the bacteria were resistant to cefuroxime, gentamicin and nitrofurantoin, seven of the bacteria were resistant to cefuroxime while no resistance was recorded against ofloxacin and ciprofloxacin. This antibiotic resistant pattern is supported by Okeke et al. [35] especially against enteric pathogens. Management of food-borne infections may be complicated by the presence of these antimicrobial resistant bacteria [36]. The 100 % antibiotic sensitivity recorded against *Escherichia coli* is in agreement with previous report [37].

In conclusion, this study recorded contamination of ready-to-eat foods in Ado-Ekiti in the order of *Staphylococcus aureus* 22.0%, *Escherichia coli* 18.2%, *Klebsiella pneumoniae* 15.3%, *Salmonella typhi* 11.5%, *Pseudomonas aeruginosa* 9.6%, *Bacillus cereus* 7.2%, *Citrobacter freundii* 6.7%, *Proteus mirabilis* 5.3% and *Enterobacter species* 4.3%. The viable microbial loads on ready-to-eat foods sold in Ado-Ekiti are such that while Moimoi is generally suitable for human consumption, fried Rice and Cole-slaw are generally below standard for human consumption. Majority of the bacteria contaminating the foods recorded gross antimicrobial resistance. Management of food-borne infections caused by the microorganisms may pose clinical challenges.

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Conflict of Interest

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