Contaminated Condition of Commercial Blenders and their Contact Surface in the Local Market in Port Harcourt, Rivers State Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Grinding or milling is a size reduction exercise in which pre-prepared food condiments are completely reduced to flour or powder (dry grinding) or paste (wet grinding). Different models of grinding machines are found scattered all over Port Harcourt metropolis. This study investigated the sanitary quality of manual and mechanical blenders. Standard microbiological procedures were adopted. The Mean Heterotrophic counts ranged from Log_{10} $CFU/5cm^2$ 4.2 - 5.1, for manuel blender and its contact surfaces while the mechanical blenders and its contact surfaces had counts ranging from: Log_{10} $CFU/5cm^2$. 4.2 - 4.8. The predominant bacterial species were Staphylococcus sp. *Salmonella* sp., *Escherichia coli*, *Bacillus* sp, *Aeromonas* sp, *Micrococcus* sp., *Enterobacter* sp., *Shigella* sp., *Protues* sp. *Klebsiella* sp. *Citrobacter* sp and *Serratia* sp., while the fungal species isolated were *Aspergillus niger*, *Fusarium* sp. *Penicillium* sp. and *Sacharomyces* sp. Gram positive and negative bacteria showed variable degrees of resistance and susceptibility to the various

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antibiotics used. Cleaning of commercial blenders before and after use should be encouraged and the importance of health education and awareness on personal hygiene should be encouraged in our local communities, so as to minimize the spread of possible food borne pathogens.

1. INTRODUCTION

Blenders are a tool used to reduce huge food particles to a size that may be consumed. They are industrial power tools that cut or remove material using an abrasive wheel. A revolving abrasive wheel is used to cut metal from the surface of the work item during the process. The many dry foods that are ground or blended in these machines include grains, rice, soybeans, sugar, chile, spices, black pepper, herbs, peanuts, etc. The high mortality rate being popular in underdeveloped nations like Nigeria is made worse by insufficient food monitoring and poor health care delivery, which leads to a high intake of unhealthy food [1].

When consumed by humans, high levels of microbial contamination and trace metals in food have the potential to be a source of disease. Because these contaminants can cause a variety of diseases, it is essential to continuously analyze foods for microbial and trace metal contamination. In Nigerian marketplaces, it is common practice to grind food in an unhygienic manner using old, worn-out grinders, and the operators are unaware of the health concerns associated with such practices [2].

These blenders are made available in markets to satisfy consumer demand because most culinary components and spices must be adequately ground before use. Blenders, which are used to break down food ingredients into tiny pieces, are crucial and have grown in popularity throughout time because most households in our society no longer grind food on stones or pound it in mortars. The majority of food items, including egusi, ogbono, pepper, crayfish, etc., are grinded by blenders that are sold in stores. These food ingredients, which cannot be utilized without grinding, are added to food to enhance flavor or impart a desired flavor. The majority of these food ingredients provide nutrients that could support the growth and proliferation of a variety of pathogenic and non-pathogenic microorganisms, including Staphylococcus aureus, Bacillus sp., and others, making the presence of microorganisms in the ones that have been used and re-used before being cleaned (if at all it is cleaned) of importance to public health. However, the sanitary quality of these blenders is largely undermined by the occurrence of microorganism such as *Xanthomonas sp., Escherichia coli, Pediococcus sp., Pseudomonas sp., Klebsiella sp., Lactobacillus sp. and Micrococcus sp* [3].

These microbial contaminants are deposited in the blenders and are mostly associated with blended food as well as airborne contaminants. In the market, people who blend food end up reusing blenders without properly cleaning them, regardless of where the food comes from. This is probably due to the large number of people who come to blend food. Sometimes, the food is already or almost ready to spoil, as with some fresh tomatoes and peppers brought in for blending. As a result, some food spoilage microorganisms end up in the blender. These organisms may occasionally replicate and transfer to the new food brought for blending if they are not properly cleaned. In the typical Nigerian market, food ingredients must be blended before being used, and blenders are available at prominent locations to blend these ingredients.

Since the majority of food ingredients are highly nutritious and can provide a favorable environment for microbial growth when residues are left behind in these blenders without being properly cleaned, the gap could paves the way for microbial proliferation and subsequent contamination of the ingredients that are being ground with the grinders because the majority of operators of these blenders do not pay hygienic attention to the use of these blenders. According to Tsado et al., [4] physiological harm and contamination with spoilage microorganisms are the most significant concerns. The majority of the microorganisms that are associated with blenders are primarily associated with the foods that are blended in them. Since foods ar high in oil, essential nutrients, and protein, [5]. They provide adequate environment for microbial growth. During grinding, particles of these foods are left in the blender and microorganisms associated with the blended food is left in the blender. These microorganisms may include *Baccillus* sp., *Micrococcus* sp., *Staphylococcus* sp., *Proteus* sp., *Enterobacter* sp. and

Enterococcus sp. while fungal species like *Saccharomyces* sp., *Aspergillus niger, Camndida* sp *., Penicillium* sp., and *Rhizopus* sp. are predominant. Presence of some pathogenic species such as Escherichia coli, Pseudomaonas sp., and Klebsiella have also been documented [6]. This study aims to determine the sanitary quality of blenders used in grinding some food ingredients in the market.

2. MATERIALS AND METHODS

2.1 Study Area

Choba market was used as the study area . It is located in Port Harcourt metropolis, Rivers State, Nigeria. it is a popular market where students and indigenes of Choba community visit for their daily wants. Due to its proximity to the University, it witnesses much influx of people on daily basis and blenders are used on a regular basis.

2.2 Sample Collection

A total of 60 swab samples (30 Mechanical blenders and 30 hand blenders) comprising of table stand, handle, bowl, wooden stick and grinder swabs were collected from the Choba market. The sterilized cotton stick was dipped in 10 mL of peptone water (Merck, Germany), prior to swabbing and an area of $5cm^2$ on the inside of the blender was swabbed at each blending point sampled.

2.3 Isolation of Microorganisms

After the swabbing process, the swabbed cotton sticks were returned to the universal bottles containing the 10 mL peptone water. The samples were immediately labelled and transported to the laboratory for further analysis. One millilitre (1 ml) of stock solution was diluted

in 9ml of peptone water and continued ten-fold serial dilution was done up to 10^{-5}.

One ml of each dilution was plated on freshly prepared agar plates Plate Count Agar, Mannitol Salt Agar and MacConkey Agar in duplicates. These were incubated in a well-regulated incubator for 24 hours at 37^0C for the isolation of bacteria pathogens. Pure cultures were obtained by sub-culturing distinct colonies on freshly prepared culture plates. Plate Count Agar, Mannitol Salt Agar and MacConkey Agar were used for bacteria growth and potato dextrose agar for fungi isolation.

2.4 Identification and Characterization of Isolates

2.4.1 Examination of bacteria

Isolates were identified based on their cultural morphology on growth media which included colony size, colour, opacity, consistency, colony pigmentation, elevation, odour and swarming) and biochemical characteristics, identification materials, reagents and protocols according to [7].

2.4.2 Examination of fungi

Identifying the cultural morphology of each fungi isolate was based on its colour and shape, for the cell morphology was done based on mycelia, hyphae, septate, and spore formation using lacto phenol blue. A piece of the mycelium from the Petri plates was mounted on a cleaning grease free slide using a sterile wire loop and covered with a cover slip, after taking a drop of lactophenol blue cotton was added and examined with the microscope.

Pic. 1. Hand Blender in the Market   **Pic. 2. Mechanical Blender in the Markets**

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2.5 Antibiotics Susceptibility Testing

Antibiotic sensitivity patterns of all the confirmed Gram's positive and negative isolates were performed according to standard disk diffusion method of Kirby-Bauer on Mueller-Hinton agar (Titan, Biotech Ltd, Indian) following the procedures recommended by CLSI [8,9]. Eleven antibiotics were commonly used as (µg/disc) viz. amoxicillin-clavulanate or Augmentin, Gentamycin, Nitrofurantoin, Erythromycin, Ofloxacin, Cotrimoxazole, Streptomycin, Tetracycline, Chloramphenicol, Nalidixic acid, Amoxicillin Abtek, (UK) were tested. From an overnight culture of the organisms, (0.5 MacFarland turbidity standards), bacterial culture was prepared in sterile saline, from which 0.1mL was aseptically placed on the surface of the agar. The plates were incubated at 37°C for 24h. Zone of inhibition was measured in millimeter.

3. RESULTS

3.1 Total Heterotrophic Bacterial Count of Manual and Mechanical Blenders Studied

The total heterotrophic bacterial counts obtained from the manual and mechanical blenders studied showed varying counts for the various samples. Mean total heterotrophic bacteria count of the different manual blender and their contact surfaces were obtained: Bowl Log_{10} CFU/5cm^2 4.2 Grinder 4.9 CFU/5cm^2, Handle 5.1 CFU/5cm^2, Stick 5.1 CFU/5cm^2 and Table 4.9

CFU/5cm^2 while the mechanical blenders and their contact surfaces had counts were : Bowl 4.7 CFU/5cm^2, Grinder, 4.8 CFU/5cm^2, Handle 4.69 CFU/5cm^2, Stick 4.2 CFU/5cm^2 and table 4.8 CFU/5cm^2.

3.2 Total Fungal Count of Manual and Mechanical Blenders Studied

The fungal counts obtained from the manual and mechanical blenders studied showed varying counts for the various samples. Mean fungal counts of the different manual blender studied were Bowl 3.7 CFU/5cm^2, wooden stick 3.3 CFU/5cm^2, Handle 3.4 CFU/5cm^2, grinder 4.1 CFU/5cm^2.Table 4 CFU/5cm^2 However, the Bowl, Grinder, handle, wooden stick and table had counts of 3.84, 3.5, 3.39. 4.6, 3.5 CFU/5cm^2 respectively for mechanical blenders Fig. 2.

3.3 Staphylococcus Counts of Manual and Mechanical Blenders Studied

The Staphylococcus counts obtained from the manual and mechanical blenders studied showed varying counts for the various samples. Staphylococcus counts of the different manual blender studied obtained Log_{10} 5.2, 5,4.2,4.2, 4.1 CFU/5 cm^2 for Bowl, Grinder, handle ,wooden stick and table respectively. Staphylococcus counts of the different Mechanical blenders were Log10 cfu/g 6.2, 6.5, 6.2, 6.6, 5 CFU/5cm^2 for Bowl, Grinder, handle, wooden stick and table respectively.
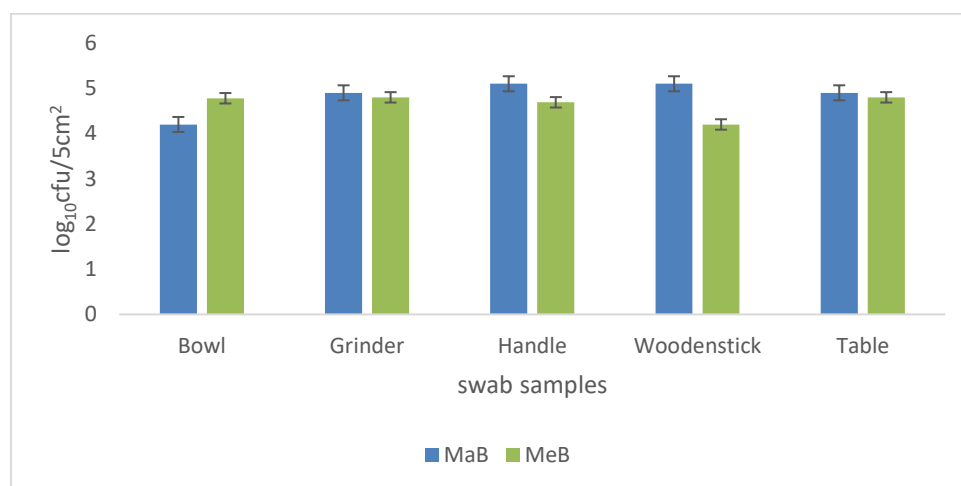

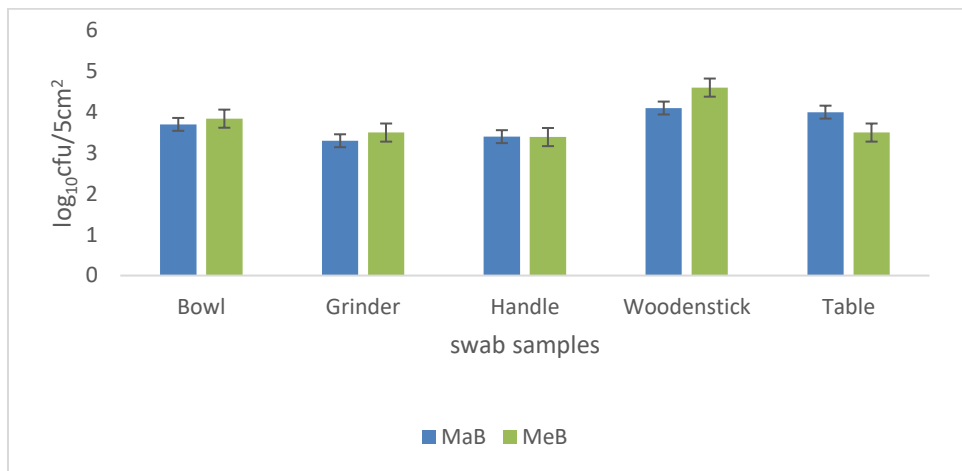**Fig .1. Mean total heterotrophic bacterial count manual and mechanical blenders**

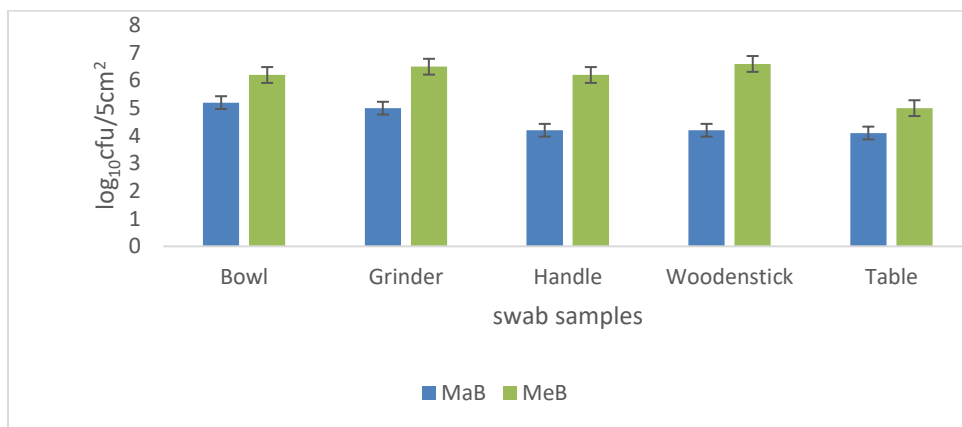**Fig. 2. Mean total fungal count of manual and mechanical blenders**

Fig. 3. Mean staphylococcus counts of manual and mechanical blenders studied

3.4 Coliform Count of Manual and Mechanical Blenders Studied

The coliform counts obtained from the manual and mechanical blenders studied showed varying counts for the various samples. Mean coliform counts of the different manual blenders studied were Log_{10} 2.4, 3.5, 2.9, 2.2, 3.1 CFU/$5cm^2$ for Bowl, Grinder, handle, wooden stick and table respectively. Mean coliform counts of the different mechanical blender studied were Log_{10} 1.5, 1.5, 2.4, 1.2, 1.1 CFU/$5cm^2$ for Bowl, Grinder, handle, wooden stick and table respectively. Much lower ranges were observed for mechanical blenders (Fig. 4).

3.5 Salmonella Count of Manual and Mechanical Blenders Studied

The Salmonella counts obtained from the manual and mechanical blenders studied showed varying counts for the various samples. Log_{10} 1.4, 3.5, 1.2, 1.8 CFU/$5cm^2$ for Bowl, Grinder, wooden stick and table respectively. None of the mechanical samples had Salmonella counts (Fig. 5).

4. DISCUSSION

Food condiments are completely reduced to flour, powder, or paste through the process of grinding or milling, also known as a size reduction exercise. Dry grinding and wet grinding is used in the Port Harcourt metropolis. Various models of grinding machines can be found. These machines contrast in many regards, for example, size, power rating, limit, working and support necessities and processing execution. Due to their consistently expanding utilization and support, crushing or processing has turned into a colossal industry. They are visited by thousands of people who come to the market to grind their condiments for food. The majority of operators find it extremely challenging to thoroughly clean their blenders, let alone to

concentrate on the various components, given the high demand and frequent use. The purpose of this study was to investigate the market's sanitary blenders for grinding food ingredients. The mean microbial counts obtained from the manual and mechanical blenders studied showed varying microbial loads for the various samples.as shown in Figs. 1-5. The large number of people who come to blend food may be the cause of the high counts in these samples; those who blend end up reusing the blenders without properly cleaning them, regardless of where the food comes from. Sometimes, the food is already or almost ready to spoil, as with some fresh tomatoes and peppers brought in for blending. As a result, some food spoilage microorganisms end up in the blender. These organisms may occasionally reproduce without proper cleaning, and they may also transfer to the new food brought in for mixing. These microorganisms could have come from the food samples that were blended, or even better, from the water that was used to clean the blender before it was used, or even from the environment, like soil dust. Particulate matter carrying microorganisms may have settled on the blenders due to the busy market. Then again, in some cases water utilized in cleaning the blenders might have been put away for a significant stretch of time, and presumably a few pathogenic microorganisms might have multiplied in the water. Additionally, the bacteria from the spoilt food samples brought for blending may be deposited in the blender during the process Obioma et al., [3]. The bacterial species isolated from sampled food contact surfaces, include *Staphylococcus* sp. *Salmonella* sp., Escherichia *coli*, *Bacillus* sp., *Aeromonas* sp, *Micrococcus* sp., *Enterobacter* sp., *Shigella* sp., *Protues* sp. *Klebsiella* sp. *Citrobacter* sp and *Serratia* sp *Escherichia coli*, *Klebsiella* spp. and *Staphylococcus aureus*.
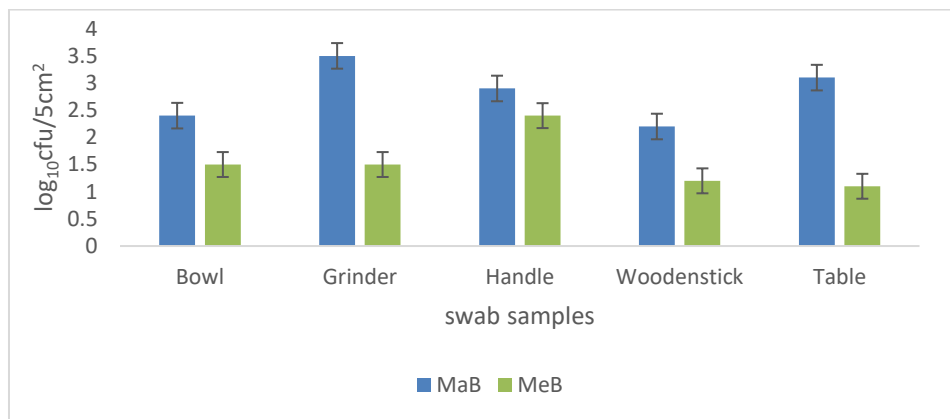

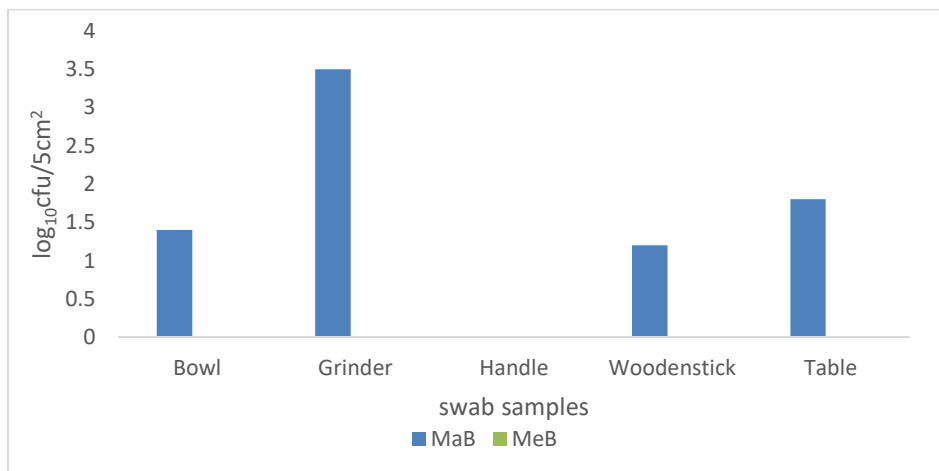**Fig. 4. Coliform count of manual and mechanical blenders studied**

Fig. 5. Mean salmonella count of manual and mechanical blenders studied

Table 1. Frequency of occurrence of bacterial isolates from manual blenders

Isolate	Table		Grinder		Stick		Bowl		Handle		Prevalence (%)
	No. Isolated	Frequency (%)	No. Isolated	Frequency (%)	No. Isolated	Frequency (%)	No. Isolated	Frequency (%)	No. Isolated	Frequency (%)	
Escherichia coli	4	15	6	27	2	8	3	12	3	13	18 (15.1)
Salmonella sp.	2	7	1	4	4	16	2	8	-	-	9 (7.16)
Shigella sp	-	-	-	-	1	4	-	-	1	4	2(1.68)
Staphylococcus sp	6	23	6	27	6	24	7	29	7	31	32(26.8)
Proteus sp	4	15	1	4	1	4	1	4	1	4	8(6.7)
Bacillus sp	5	19	5	22	6	24	5	20	5	22	26(21.8)
Enterobacter sp	-	-	1	4	-	-	1	4	2	9	4(3.36)
Klebsiella sp	4	15	2	9	2	8	4	16	3	13	15(12.6)
Citrobacter sp.	1	3	-	-	1	4	-	-	-	-	2(1.68)
Micrococcus sp.	-	-	-	-	-	-	1	4	-	-	1(0.84)
Serratia sp.	-	-	-	-	1	4	-	-	-	-	1(0.84)
Aeromonas sp.	-	-	-	-	1	4	-	-	-	-	1(0.84)
Total	26	97	22	97	25	100	24	97	22	96	119

Table 2. Frequency of occurrence of bacterial isolates from mechanical blenders

| Isolate	Table		Grinder		Stick		Bowl		Handle		Prevalence (%)
	No. Isolated	Frequency (%)	No. Isolated	Frequency (%)	No. Isolated	Frequency (%)	No. Isolated	Frequency (%)	No. Isolated	Frequency (%)	
Escherichia coli	6	33	4	22	3	20	3	15	3	17	19(21.5)
Salmonella sp.	-	-	-	-	-	-	-	-	-	-	-
Shigella sp	-	-	-	-	-	-	-	-	-	-	-
Staphylococcus sp	5	27	8	28	5	33	6	31	5	29	26(29.5)
Proteus sp	3	16	1	5	2	13	1	5	2	11	9(10.2)
Bacillus sp	4	22	6	33	3	20	4	21	5	25	22(25)
Enterobacter sp	-	-	-	-	-	-	1	5	-	-	1(1.1)
Klebsiella sp	-	-	2	11	5	13	4	21	3	17	11(12.5)
Citrobacter sp.	-	-	-	-	-	-	-	-	-	-	-
Micrococcus sp.	-	-	-	-	-	-	-	-	-	-	-
Serratia sp.	-	-	-	-	-	-	-	-	-	-	-
Aaromonas sp.	-	-	-	-	-	-	-	-	-	-	-
Total	18	98	21	98	15	99	19	98	17	101	92
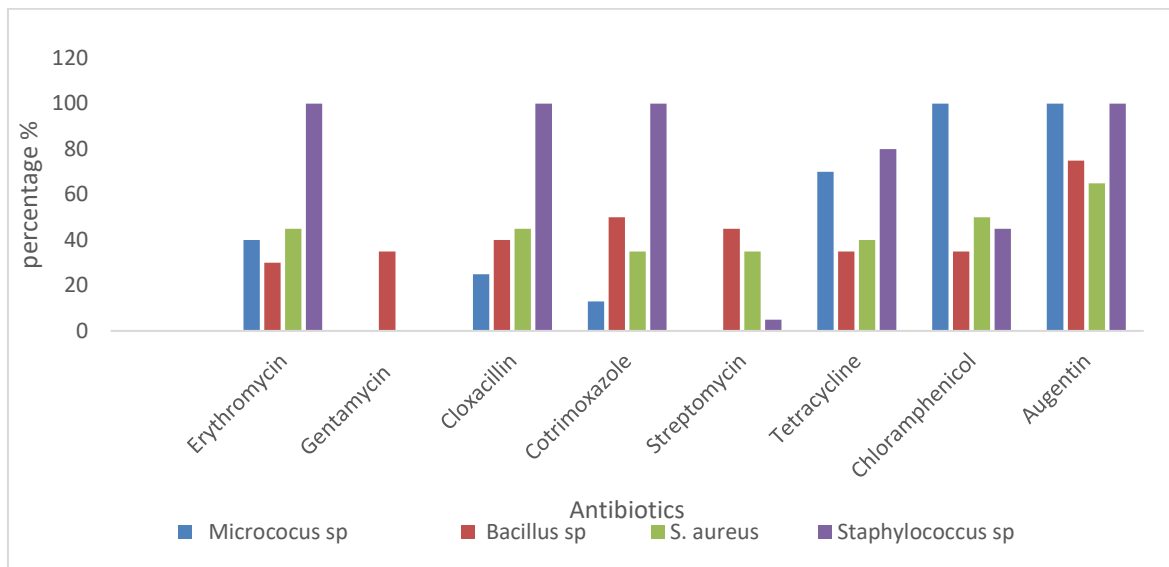
Fig. 6. Antibiotic resistance of the isolated of gram positive bacteria from Mechanical and Manual Blenders (n=211)
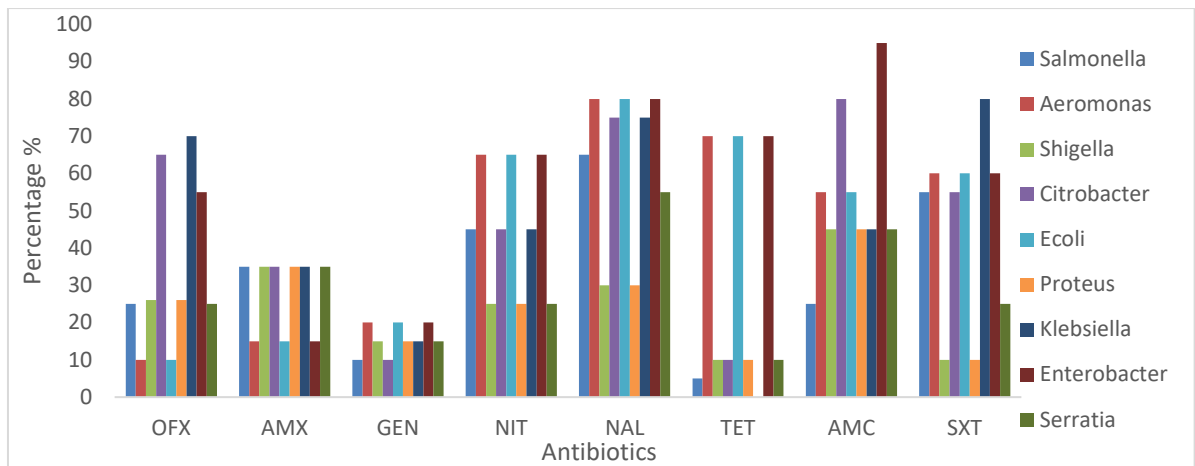
Ofloxacin	OFX
Amoxicillin	AMX
Gentamycin	GEN
Nitofuratoin	NITT
Nalidixic acid	NAL
Tetracyline	TET
Augmentin	AMC
Cotrimoazole	SXT

Fig. 7. Antibiotic resistance of the isolated of gram negative bacteria from mechanical and manual blenders (n=211)

On the skin of humans, plants, soil, water, sewage, the intestines of animals and humans, and some dairy products, *Enterobacter* can be found. Segregating this from food or contact surface demonstrates waste defilement or possibly affirms unfortunate cleanliness practice. Microccocus is some relatively harmless bacteria that can cause food poisoning through its enterotoxins and can be found in meat products, water, and soil. *Staphylococcus*, on the other hand, can be found everywhere. It is widespread on the skin and can also be found in the throat, nose, and other parts of the body. Enterotoxins produced by virulent strains can cause staphylococcal food poisoning, which is typically spread through food contaminated with toxins. It

has a short latency period and symptoms go away within 24 to 48 hours. The incubation time is one to four hours. According to the CDC [10], clinical symptoms include diarrhea, abdominal discomfort, and nausea. Food poisoning and its symptoms are typically brought on by foods with high levels of coliforms [11]. Therefore, poor hygiene practices can be established in the sampled food contact by the mere presence of coliforms in high concentrations without the associated presence of well-known entero pathogens. Even though *E. coli* was found, the presence of *Enterobacter* could also mean that food, water, or food handlers may have been contaminated by feces or that poor processing practices were used [12,13].

Since S. aureus is a typical component of the skin and nasal flora, its presence is mostly due to human interaction, which raises concerns about the operators' cleanliness procedures. Foods must, to the greatest extent feasible, be free of pollutants. Given that these organisms are pathogenic and have been linked to foodborne illnesses, their presence indicates a possible health concern [14,15,16]. By using excellent hygiene techniques like excellent Manufacturing Practices (GMP) and Hazard Analysis Critical Control Point (HACCP), foodborne disease may be avoided. Food contamination may have been caused by improper handling, insufficient heating, or secondary contamination through contact with contaminated tools and utensils Gopal et al. [17]. Microorganisms can also be introduced to food contact surfaces as raw food products Humphrey et al., [18]. High humidity of raw foods and prolonged contact times can also increase the likelihood of contact surface contamination [19]. The presence of similar pathogens on food contact surfaces further indicates their previous contamination from raw food. The presence of pathogens on contact surfaces can also be due to poor hygiene practices. Microorganisms can attach to food contact surfaces and find favorable conditions for their growth [20]. Therefore, it is necessary to ensure that the surfaces are cleaned properly. Gram-positive and gram-negative bacteria show varying degrees of resistance and sensitivity to the different antibiotics used. Resistance patterns of bacteria associated with contact surfaces have been reported [21-24]. The high resistance rate observed among the Gram negative organism support earlier assertion that majority of multidrug resistant isolates in clinical and environmental samples. Bakkali et al., [25], Odigie et al., [26] Wang et al., [27] Gram

negative bacteria possessed outer membrane in addition to cell wall. This membrane prevents many substances from entering into the cell. Brooks et al., [28], Kapoor et al., [29] Multi-drugs resistant strains pose serious health effects with attendant treatment failure, prolong hospital stay and increase cost of treatment Odigie et al., [26].

5. CONCLUSION

This present study contributed to the scarcity of information on the hygienic condition of blender contact surfaces in the market. Isolation of pathogenic organisms from these surfaces suggests that they may be a source of disease transmission. Therefore, it is necessary to apply adequate hygiene measures that can help prevent contamination and interrupt the spread of disease through these surfaces. These commercial blenders should be cleaned daily and contact surfaces cleaned after each grinding. Proper and hygienic cleaning after each use of blenders in market place and daily cleaning and drying to avoid overnight microbial growth in blenders.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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