BACTERIOLOGICAL ASSESSMENT OF AIR QUALITY AROUND SELECTED MARKETS IN PORT HARCOURT METROPOLIS

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Abstract

Air quality is one of the most significant factors affecting the health and wellbeing of people Bacteriological assessment of selected markets (Choba, Rumuokoro, Mile 1) was carried out within Port Harcourt metropolis. Bacteriological air quality was performed in various locations in the market area. Sedimentation technique involving exposure of Petri dishes containing Nutrient Agar to the air, and was suspended above ground level for 10 minutes, Bacteria isolates were identified using standard microbiological techniques involving cultural, morphological, microscopic and biochemical test. A total of 20 bacterial were isolated. The Total heterotrophic bacteria count ranged from 2.45×10^5 (Cfu/g) to 7.34×10^6 (Cfu/g) with Rumuokoro market having the highest count and the least count observed in Choba market. Percentage of occurrence of bacterial isolates shows that *Staphylococcus* sp 30% had the highest percentage occurrence while *Bacillus* Sp 15%, *Micrococcus* sp 15%, *Klebsiella* sp 15% *Proteus* sp 15% and *pseudomonas* sp 10%. As revealed in this study, major markets pose high risk of air contamination to occupants and market merchant especially those of compromised immunity. In conclusion, markets environments should be fumigated as part of routine either weekly or monthly to eliminate accumulated suspended microorganism in the air.

KEY WORDS: Bacteriological assessment, isolates, microbiological techniques, immunity, air quality.

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INTRODUCTION

Air quality is one of the most significant factors affecting the health and wellbeing of people. It has been reported that a single or an average person inhale an approximately 7 or 8 liters of air per minute. That totals about 11,000 liters of air per day. The air contains 15% Oxygen, which means a healthy adult human has a respiratory rate of 12-18 breaths per minute. However, the air inhaled by people is abundantly loaded with microorganisms which form part of the bioaerosol. Bioaerosols are living microorganisms suspended in the air. The study of these

living Microorganisms suspended in the air is known as Aeromicrobiology. Bioaerosols once suspended in the air, has the ability to move in large, distances with the help of the wind and precipitation, increasing the likelihood of wide spread disease. These bioaerosols are significant for the environment since they have been related to a variety of health problems, sickness in human, diseases in animals and plants.

In Nigeria and across the world, the emergence of transmissible air borne disease/virus likes the past recent Covid-19 virus and tuberculosis, has enlightened on the need for the study of aeromicrobiology. Other diseases like whooping cough, diphtheria, and Lassa fever has also caused epidemiological issues demystifying the belief that microbes cannot survive in air, since not enough nutrients exists for their proliferation. Overtime, through study the air environment has recorded drastic change in the ambient air levels due to anthropogenic disruption and natural interaction leading to the complication of air environment and consequently causing air pollution. Human activities such as sewage treatment, plant and animal rendering, fermentation processes and agricultural activities emit microorganisms into the air (Makut et al., 2014). Breathing in air by human has since been faced with hazards from aspiration of gases, smoke, dust and other substances like particulate matter and bioaerosols. Due to uncontrolled and unplanned urbanization, vehicular movements, and quest for energy in developing countries, the air environment of their surroundings are largely dense and polluted resulting in poor air quality.

Market place: A market, or marketplace, is a location where people regularly gather for the purchase and sale of provisions, livestock, and other goods. A market can be defined as an actual or normal place where forces of demand and supply operate, and where buyers and sellers interact (directly or through intermediaries) to trade goods, services or contracts or instruments for money. In different parts of the world, a market place may be described as a souk (from the Arabic), bazaar (from the Persian), a fixed mercado (Spanish), or itinerant tianguis (Mexico), or

palengke (Philippines).In Nigeria, the Igbo speaking people of South-East call market “Ahia”, Yoruba speaking people of South-West call market “Oja” and while Hausa speaking people of the North “Kasuwar”. Some markets operate daily and are said to be permanent markets while others are held once a week or on less frequent specified days such as festival days and are said to be periodic markets. (Makut et al., 2014).

Figure 1 A typical market in Port Harcourt metropolis

Types of market in Port Harcourt state and description

Local market: Local market can be defined as a localized business usually in small stalls erected used to sell goods and render services to mainly individuals living within and are limited to some goods they do not sell all the products and services. Local market in Port Harcourt comprises of fimie market, creek road etc sells goods which are mainly from peasant farm. They contain small stalls which they sell goods which include food stuffs and other locally made materials.

International market: Some international markets include; Ubani International Market and Aria-aria international market respectively. A lot of good ranging from food stuffs, house use equipment’s, chemicals, medicine and livestock, clothes etc is sold in big quantities in the

market. The activities in the markets listed above attract lots of people from all works of life who buys goods from the market. As they troop in their thousands, sands and dust in the market environments are disturbed which contaminate the air present in environments. The air which are released from the mouth of buyer and sellers and as they sneeze, it contaminate the air in the environment. The dust which comes out from the engine which grind cereal products mix with the dust in the surroundings which along contaminates the air. Markets have existed for as long as humans have engaged in trade. Informal markets gradually made way for a system of formal, chartered markets across Europe during the medieval period. Regulation of market place practices gave consumer's confidence in the quality of market goods and the fairness of prices. In many countries, shopping at a local market is a standard feature of daily life. International market operates daily and people buy goods and services rendered to them in a modernized method.

Air: Air is a mixture of gases which does not constitute an adequate environment for microorganisms as it fails to provide nutrients and good physicochemical conditions. Failing to provide nutrients and good physicochemical conditions, the air, a mixture of gases, does not constitute an adequate environment for microorganisms. However, microorganisms suspended in the air in the form of bioaerosol significantly affect air quality (Dacarro et al., 2003). Bioaerosol is a collection of biological particles dispersed in the air or the gas phase. It consists of single spores, pollen, bacterial cells and viruses, aggregates of spores, cells, and other biological material, products or fragments of mycelium, fungal spores and bacterial cells (endotoxins and mytotoxins), biological material lifted from the ground on its own accord or carried by bigger non-biological particles (Chmiel et al*.,* 2015).

Air quality: Air quality is one of the most significant factor affecting the health and well – being of people. It has been reported that a single person inhale's an average of approximately $10m^3$ of air every-day (Dacarro et al., 2003). However, the air inhaled by people is abundantly loaded with microorganisms which form part of the bioaerosol. Bioaerosol is a colloidal suspension, formed by droplets and particles of solid matter in the air, whose components can contain or have attached to them viruses, fungal spores and conidia, bacterial endospores, plant pollen and fragments of plant tissues (Karwowska 2005). Biological contamination of air is mostly caused by bacteria, moulds and yeasts. They can be dangerous as pathogenic living cells but they also secrete some substances harmful to human health (Daisey et al., 2003).

Airborne microorganisms: Airborne microorganisms are usually derived from various natural sources such as soil, animals, and humans (Fang et al., 2007). Human activities such as sewage treatment, plants and animals rendering, fermentation processes and agricultural activities do emit microorganisms into the air (Gillum and Leventin, 2008). Several studies have identify human activities like talking, sneezing and coughing, while other activities such as vehicular transportation and human movements, washing in homes and business centers, flushing of toilets and sewages, sweeping of floors and roadsides can generate bioaerosols indirectly. Biological particles get into the atmosphere in many ways: removed from the surface of soil and plants, carried by the wind or lifted by means of thermal convection, released (either spontaneously or by rainfall) from natural bodies of water (Kulkarni et al., 2011). Qualitative and quantitative composition of bioaerosol depends on time and location. Constituting 70% of the microbial population, filamentous fungi (*Cladosporium, Alternaria, Penicillium, Aspergillus, Mucor, Rhizopus*) are typically the main component of bioaerosols. Saprophytic bacteria belonging to the genera *Micrococcus* and *Bacillus* constitute another group. In contrast, actinomycetes and yeast (belonging to the genera *Torulopsis, Rhodotorula, Candida, Saccharomyces*) represent

only 5% of the microorganisms isolated from the air (Marta et al., 2007). Epidemiological studies show that high concentration of microorganisms in the air can be allergenic. Sometimes, however, even very low concentrations of particular microorganisms can cause serious diseases. Fungal allergens may trigger symptoms of respiratory disorders and skin diseases in susceptible patients. Exposure to molds may have multiple health effects: it can cause allergies in people with poor resistance can result in severe opportunistic infections. Fungal conidia present in the air contain extremely high amounts of mycotoxins. They cause skin infections and toxemias characterized by headaches, diarrhea, changes to immunological mechanisms and damage to the liver, kidneys and central nervous system, and they can also be carcinogenic. Presence of microorganisms in the air is ubiquitous but their proportion varies according to the environmental conditions and locations. Markets are characterized as a human activity enriched site and also a highly trafficked site. People in these areas are actively engaged in various activities, responsible for generation of higher quantity of bioaerosols. **(**Karwowska, 2005).

Bioaerosols : Bioaerosols are airborne particles that are living (bacteria, viruses and fungi) or originated from living organisms. Spore-forming bacteria and fungi are able to survive in bioaerosols and stay viable for a long time in the air but the situation becomes worse when they are able to multiply in these aerosols. It is generally known that bioaerosols present in the air can affect human health, causing mainly respiratory and related diseases transmitted via respiratory route, allergic and toxic reactions. In addition, long-term contact of people with bioaerosols can be a source of serious illnesses; can influence a person's mental power and learning ability. Some previous study has also reported high level of potential hazardous bioaerosols in the similar environments (Pathak & Verma, 2009). Exposure to these bioaerosols can impose adverse effect on local inhabitants as well as tourists. For the above reasons, it is important to monitor air quality in places of increased risk of biological contamination in storage premises

where food items are stored, in places where people spend time every day, like dwelling places, public utility buildings and atmospheric air in the streets of towns with heavy traffic.

Microorganisms found in market places: According to Kavita & Jyoti, (2014), in their work "Distribution Pattern of Airborne Bacteria and Fungi at Market Area", Gram negative bacilli which comprised *Enterobacter aerogenes, Escherichia coli, Pseudomonas* sp. and *Serratia marcescens* were observed as dominant among all bacteria. The second most commonly isolated bacteria belonged to Gram positive cocci and identified as *Staphylococcus aureus*, *Micrococcus luteus* and *Micrococcus kristinae.* Endospore forming Gram positive bacilli (*Bacillus* sp.) represented the third bacterial group and constituted total bacterial count. It included: *Bacillus subtilis*, *Bacillus megaterium, and Bacillus lentus.* Kavita & Jyoti, (2014) observed that among the fungi isolated; *Aspergillus* sp. prevailed as the highest occurring fungi. Other fungi includes: *Aspergillus niger, Aspergillus fumigatus and Aspergillums flavus*. Other fungal isolates, constituted 51.55% of total fungal count were identified as *Penicillium* sp., *Rhizopus* sp., *Alternaria alternata, Cladosporium cladosporioides, Fusarium solani* and *Fusarium oxysporum.*

MATERIALS AND METHODS

Description of sampling Area

The sampling area was Port Harcourt Rivers State, Nigeria area, it is located in the coastal (Southern) region of Niger Delta and it records rainfall in almost all months of the year. The samples selected market are (Choba, Rumuokoro, and Mile 1) Market respectively. This was done to enable us have a comprehensive research and to enable us have a comparative analytical bacteria isolates in market environments which can help in identifying bacteria pollutants (aerosols and microorganism) that is present in our environments.

Sampling method: Samples were collected three times in a week in triplicates at stipulated times of the day (morning, afternoon and evening) in October 2024 using sedimentation methods, which is based on particles microorganism settling onto surface of agar plates through gravity. The plates containing sterile prepared solid nutrient agar, was expose to the atmosphere at different strategies points in the various market and were transfer to the laboratory for further monitoring, after growth the colonies seen were sub cultured into the following agar: mannitol salt Agar, Maconkey salmolella shigella and Eosin Methylene Blue (EMB) for the isolation of various isolate of bacteria respectively. The use of streptomycin was used to inhibit the growth of fungi. The bacteria cultures plates were incubated 37^0C for 24-48hours. After incubation the total number of colony forming unit (CFU) for bacteria were enumerated and recorded

Autoclave, measuring scale (weighing balance), Bunser burner, petri dishes, refrigerators, wire loop, clean slides, normal saline, crystal violet stain, test bubes, bijou bottles, peptone water, simmont's citrate, microscope, lactic acid, water, alcohol, lugo's lodine methyl red, agar, kovac reagents, oxidase reagent; filters paper, triple sugar, iron sugar.

Media used: Nutrient agar, Mannitol salt Agar, Macconkey agar, Salmonella shigella Agar, and Eosin methylene Blue Agar. They were all prepared according to the manufacture's instruction.

Sterilization of materials: All ass and mud a used for the study were sterilized at 121^0C for 15 minutes using the autoclave. Wire loop and inoculating needles were sterilized by flaming he instrument until red hot.

Enumeration of Isolates

After 24 hours of inoculation, the bacteria colonies on all the media used (Agar plates) were counted to determine the bacteria (CFU) colony forming unit

Isolation and purification of culture: District colonies that develop on the agar plates after inoculation were sub cultured into freshly prepared Agar (The Agar used above). The plates were incubated for 37^{0C} for 24 – 48^{0}C for the isolation of bacteria.

Preparation of stock cultures: Pure cultures were sub cultured into all the agar plates used for the inoculation and incubated at 37^{0}C for 24-48 hours. These served as stock cultures for further use in bijou bottles and were stored at 5-20^{0}C.

Gram staining: A thin smear of bacterial culture was placed on clean grease-free slid, air dried and heated fixed by passing the underside of the slide over Bunsen burner flame for about three times. Primary stain (crystal violet) was added for 60 seconds and was washed off with clean distilled water. Lugols iodine was also added for one minute after which it was washed off with clean distilled water and decolorized with acetone for 30s and was washed with clean distilled water, safranin was finally added for 30 seconds to counter the stain and was washed off with clean distilled water. It was allowed to blot-dry and then viewed microscopically by a drop of oil immersion.

Biochemical Test: The identities of the isolates were confirmed using biochemical test. Test c arried out include indole, catalase, methyl red production, vogues proskauer reaction, oxidase, citrate, triple sugar icon test, and urease for all isolates. Gram staining test was also carried out.

Frequency of occurrence: This was done to determine the frequency of occurrence of bacteria in air samples. The frequency of occurrence was calculated as

$$\% \text{ of occurrence} = \frac{\text{no of positive isolate}}{\text{Total number of isolates}} \times \frac{100}{1}$$

Statistical analysis: The samples data were statistically analyzed using SPSS (Statistical Package for the Social Sciences) Version 16 for PC Windows

RESULTS

Cultural morphological: Cultural morphological and microscopic characteristics of bacterial isolated from air concentration (morning, afternoon and evening) of 3 different markets studied in Port Harcourt metropolis. It reveals that 20 bacteria were isolated. They were characterized base on their colony, features, including their colour, size, opacity, elevation margin, as well as their shape is shown in table 1 below

Table 1 Morphological characteristic of bacterial isolates

Isolate Code	Colour	Size	Elevation	Shape	Opacity	Margin	Surface	Probable isolate
C1	Cream	0.3cm	Raised	Circular	Opaque	Entire	SD	*Staphylococcus* sp
C 2	Yellow	0.3cm	Flat	Circular	Opaque	Serrated	SD	*Bacillus* sp.
C3	Cream	0.4cm	Flat	Circular	Opaque	Serrated	SS	*Micrococcus* sp
C4	Orange	O.4cm	Flat	Circular	Opaque	Entire	RD	*pseudomonas* sp.
C5	Cream	2cm	Raised	Circular	Opaque	Entire	SS	*Proteus* sp
C 6	Yellow	0.1cm	Flat	Circular	Opaque	Entire	SS	*Klebsiella* sp
C 7	Orange	0.1cm	Flat	Circular	Opaque	Entire	SS	*Bacillus* sp
C8	Cream	0.3	Flat	Round	Opaque	Entire	Ss	*Micrococcus* sp
C9	Yellow	0.3cm	Raised	Circular	Opaque	Entire	SD	*Staphylococcus* sp
C 10	Cream	0.3cm	Flat	Irregular	Opaque	Serrated	SD	*Micrococcus* sp
C11	Yellow	0.4cm	Raised	Circular	Opaque	Serrated	SS	*Staphylococcus* sp
C12	Orange	O.4cm	Flat	Circular	Opaque	Entire	RD	*Bacillus* sp.
C13	Cream	2cm	Flat	Circular	Opaque	Entire	SS	*Staphylococcus* sp
C14	Orange	O.4cm	Raised	Irregular	Opaque	Entire	RD	*pseudomonas* sp
C15	White	2cm	Raised	Circular	Opaque	Entire	SS	*Proteus* sp
C 16	Yellow	0.1cm	Raised	Circular	Opaque	Entire	SS	*Klebsiella* sp
C 17	Orange	0.1cm	Raised	Circular	Opaque	Entire	SS	*Proteus* sp
C18	White	0.3	Raised	Irregular	Opaque	Entire	Ss	*Staphylococcus* sp
C19	Yellow	0.3cm	Flat	Circular	Opaque	Entire	SD	*Klebsiella* sp
C 20	Cream	0.3cm	Flat	Irregular	Opaque	Serrated	SD	*Staphylococcus* sp

Keys: SS=shinny and smooth, SD= shinny and dull, RD =rough and dull

Biochemical test

The isolate identified from biochemical test analysis showed that the following species were present; they include: *Staphylococcus* sp, *Micrococcus* sp*, Klebsiella* sp*, Bacillus* sp*, Proteus* sp and *Pseudomonas* sp respectively as shown in table 2 below.

Table 2 Biochemical characteristics of isolates

Code	Catalase	Oxidase	Glucose	Lactose	Mannitol	Sucrose	Indole	Mr	VP	TSI	H_2S	Gram stain	Motility	Citrate	Possible genera
C1	+	-	+	-	-	-	-	-	+	AB	-	+cocci	-	+	*Staphylococcus* sp
C 2	+	-	+	-	+	+	-	-	+	AB	-	+rod	+	+	*Bacillus* sp.
C3	+	-	+	+	+	+	-	-	-	AB	-	+cocci	-	+	*Micrococcus* sp
C4	+	-	+	+	+	+	-	-	-	AA	-	- rod	+	+	*pseudomonas* sp
C5	+	-	+	-	-	-	-	+	-	AB	+	-rod	+	+	*Proteus* sp
C 6	+	-	+	-	+	+	-	-	+	AB	-	-rod	_	+	*Klebsiella* sp
C 7	+	-	+	-	+	+	-	-	+	AB	-	+rod	+	+	*Bacillus* sp
C8	+	-	+	-	-	-	--	+	+	AB	-	+cocci	-	+	*Micrococcus* sp
C9	+	-	+	+	-	-	-	-	+	AB	-	+cocci	-	+	*Staphylococcus* sp
C10	+	-	+	+	+	+	-	+	+	AB	-	+cocci	-	+	*Micrococcus* sp
C11	+	-	+	+	+	+	-	-	+	AB	-	+cocci	-	+	*Staphylococcus* sp
C12	+	-	+	-	+	+	-	-	+	AB	-	+rod	_	+	*Bacillus* sp.
C13	+	-	+	-	-	-	-	-	+	AB	-	+cocci	-	+	*Staphylococcus* sp
C14	+	-	+	-	-	-	-	-	-	AA	-	-rod	+	+	*pseudomonas* sp
C15	+	-	+		-	-	-	+	-	AA	+	-rod	+	+	*Proteus* sp
C16	+	-	+	-	+		-	-	+	AA	-	-rod	+	+	*Klebsiella* sp
C17	+	-	+	+	+	+	-	+	-	AA	+	-rod	+	+	*Proteus* sp
C18	+	-	+	+	+	+	-	-	+	AB	-	+cocci	-	+	*Staphylococcus* sp
C19	+	-	+	+	-	-	-	-	+	AA	-	-rod	+	+	*Klebsiella* sp
C20	+	-	+	+	-	-	-	-	+	AB	-	+cocci	-	+	*Staphylococcus* sp

Frequency distribution of organism

The bacterial isolated from the different market studied in accordance in the morning, afternoon and evening time Organisms isolated from choba market in the morning hours were *Staphylococcus* sp *Micrococcus* sp and *Bacillus* sp. In the afternoon were: *Staphyloccus* sp *Bacillus* sp *Micrococcus* sp and *Klebsiella* sp. In the evening were, *Bacillus* sp *Pseudonamas* sp *Staphyloccuccus* sp Micrococcus sp and *Klebsiella* sp

From Mile one market Organism isolated in the morning hours were, *Bacillus* sp *Micrococcus* sp and *Proteus* sp. In the afternoon hours were: *Bacillus* sp *Staphylococcus* sp and *Proteus* sp while in the evening hours were *Bacillus* sp *Staphylococcus* sp *Micrococcus* sp and *Pseuodomonas* sp respectively. From Rumuokoro Markets the organism isolated in the morning Hours were *Bacillus* sp and *Klebsiella* sp, in the afternoon where *Staphylococcus* sp *Micrococcus*

sp *Klebsiella* sp and *Proteus* sp. While in the evening were *Bacillus* Sp *pseudomonas* sp *Micrococcus* sp *and Klebsiella* sp respectively.

Table 3: Bacteria isolated from the selected markets in Port Harcourt

Markets	Morning	Afternoon	Evening
Choba	*Staphylococcus* sp *Micrococcus* sp, *Bacillus* sp	*Staphyloccus* sp *Bacillus* sp *Micrococcus* sp *Klebsiella* sp	*Bacillus* sp *Pseudonamas* sp *Staphyloccuccus* sp *Micrococcus* sp *Klebsiella* sp
Mile 1	*Bacillus* sp *Micrococcus sp* *Proteus* sp	*Bacillus* sp *Staphylococcus* sp *Proteus* sp	*Bacillus* sp *Staphylococcus* sp *Micrococcus* sp *Pseuodomonas* sp
Rumuokoro	*Bacillus* sp *Klebsiella* sp	*Staphylococcus* sp *Micrococcus* sp *Klebsiella* sp *Proteus* sp	*Bacillus* Sp *pseudomonas* sp *Micrococcus* sp *Klebsiella* sp

The Total Heterotrophic Bacterial Count

The Total Heterotrophic Bacterial Count for Choba market was 2.45×10^5, 3.51×10^5 and 5.45×10^6 for morning, afternoon and evening respectively. For Mile 1 market, the total counts were 2.57×10^5, 3.61×10^5 and 6.42×10^6 for morning, afternoon and evening respectively. For Rumuokoro market, the total bacteria count were $3.54\times10^{5,}$ 3.54×10^5 and 7.34×10^6 for morning, afternoon and evening respectively as shown in table 4 below

Table 4: Total Heterotrophic Bacterial Count (THBC) in Cfu/g

Market	Morning	Afternoon	Evening
CHOBA	2.45×10^5	3.51×10^5	5.45×10^6
MILE 1	2.57×10^5	3.61×10^5	6.42×10^6
RUMUOKORO	3.54×10^5	3.20×10^5	7.34×10^6

Percentage of occurrence of bacterial isolates : Percentage of occurrence of bacterial isolates from air concentration of three different market places in Port Harcourt Metropolis show the following**:** 30 **%** *Staphylococcus* sp, 15% *Bacillus* Sp, 15% *Micrococcus* sp, 15% *Klebsiella* sp, 15 % *Proteus* sp and 10% *pseudomonas* sp respectively

Table 5: Percentage of occurrence of bacterial isolates from air concentration of three different market places in Port Harcourt Metropolis

Isolate	No of isolates	Percentage (%)
Staphylococcus sp	6	30
Bacillus sp	3	15
Micrococcus sp	3	15
Klebsiella sp	3	15
Proteus sp	3	15
Pseudomonas sp	2	10
Total	20	100

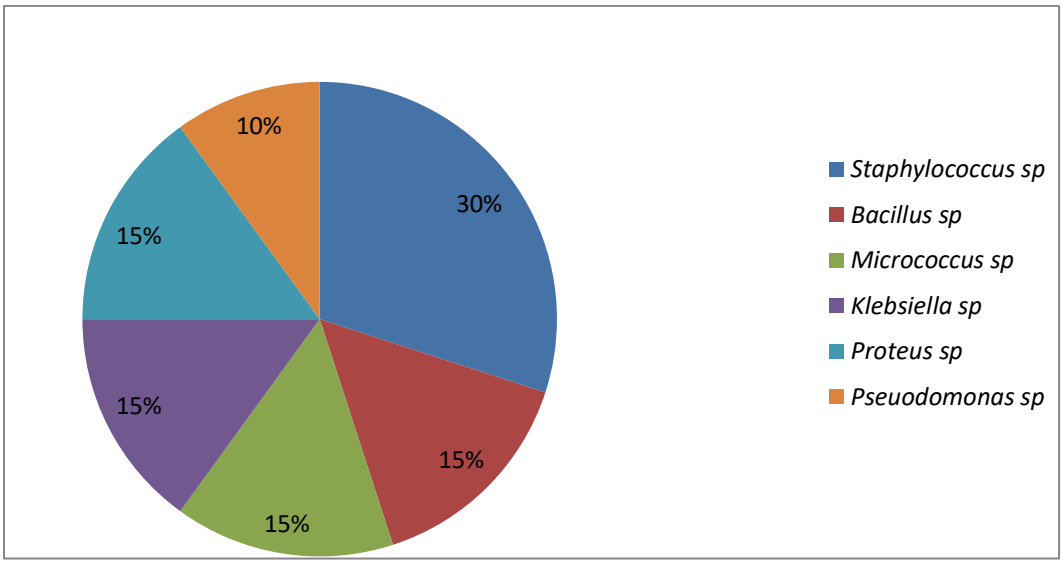

Figure 2: Frequency of Occurrence of the bacteria Isolated from the different market sampling location.

Discussion

From the result of the bacteria isolated, it was observed that *Staphylococcus* sp is the highest bacteria isolated. This indicates that *Staphylococcus* sp is present mostly in all Markets, and high exposure to microorganism can cause bacteria, endocarditis, Pneumonia and septicemia in

immmuno compromised patients. Although *Micrococcus* sp which can also cause meningitis, and septic arthritis which is a normal flora in the eyes and skin of humans. *Bacillus* sp a spore forming microbe produce toxins that can impact and settle on food surfaces thereby causing food poisoning affecting gastrointestinal tracts and this is a public health concern in a market, where food produce is sold, because it was isolated there. *Micrococcus* species are generally opportunistic in nature, staphylococcus sp are normal flora of skin and mucosal membrane, but can lead to skin injections, Skin infections, inflammations and sometimes pneumonia.

Data from the table 3 indicates that Choba market has the least number of microorganisms in the morning, but the number increased in the evening. The total heterotrophic bacterial count ranged from 2.45×10^5 (Cfu/g) to 7.34×10^6 (Cfu/g) with Rumuokoro market having the highest count and the least count observed in Choba market. The Concentration of CFU (colony forming unit) each locations exceeded the recommended limits as suggested by the National Institute of Occupational Safety and Health (NOSH) which is (1,910-1000).

The study also revealed a higher bacteria count in the densely populated market in Rumuokoro Market compared to this is because this is as a result of high populated places than choba market So microorganism can increase or decrease based on the factors that affects them. In Choba market where the population is not largely dense, microbial source from both animals and humans is reduced, plus there is little accumulation since the markets are run on stipulated market day basis.

A total numbers of six bacteria isolates were identified from this research work. They include: *Staphylococcus* sp, *Bacillus* Sp, *Micrococcus* sp*, Klebsiella* sp, *Proteus* sp and *pseudomonas* sp. The findings from this work correlates with research carried out by Makut et al., (2014) who also

isolated *Staphylococcus aureus, Streptococcus pyogenes, Bacillus* sp *Klebsiella* sp, *pseudomonas* sp as shown in table 2

From the result of this research, the total heterotrophic bacterial count (THBC) exceeded the recommended limit which is 10^3cfu/g suggested by National Institute of Occupational Safety and Health (NIOSH). Also American Conference of Governmental Industrial Hygienist (ACGIH) had suggested 500cfu/g for cultural bacteria (Kalogerakis et al., 2005). This research falls above the standard of 500cfu/m^3 as recommended by American Conference of Governmental Industrial Hygienist (ACGIH). Considering all available threshold limits for bacterial concentrations in the air environments, it is clear that the market places are heavily loaded with bacteria. The bacterium which was isolated from this work has shown to be amongst most prevalent resident bacteria in the air (Burge and Hoyer, 1990). From this work *Staphylococcus* sp was the most prevalent bacteria. *Staphylococcus* sp is said to be carried in the naso-pharynx, throat, skin cuts, boils, nails and such can easily contribute to the microflora in the market places which is always busy with activities involving in most cases human and vehicular movement as carried out in this my research. *Bacillus* sp was among the specie of bacteria isolated from this study and it's a spore forming soil bacteria and persistence in the atmosphere (Newson et al., 2000),

Occurrence of bacteria isolates showed that *Staphylococcus* sp 30% had the highest percentage occurrence while *Bacillus* sp 15%, *Micrococcus* sp 15%, *Klebsiella* sp 15%, *Proteus* sp 15% and *pseudomonas* sp 10% had the lowest occurrence as shown in table 5. Epidemiological studies have shown that a large number of people around the world are exposed to biological agents (Daisey et al., 2003). The lack of qualitative health-based guideline values or threshholds for the acceptable levels of microbial contamination in the air may be due to a lack of dose-response relationship for most of the air microbiological agents (Golofit-Szymezak & Gorny, 2010).

Several investigators in this area had highlighted that source data on concentrations of biological agents in the air environments are still insufficient (Golofit-Szymezak and Gorny, 2010). This notwithstanding, the qualitative and quantitative information on the composition and concentrations of microorganisms in the air environments of human habitations at any point in time would help in alerting the public of possible health risk that may be encountered by vulnerable individuals. Several researchers in this area had earlier reported that exposure to high concentrations of microorganism in the air frequently lead to allergies, asthma (Newson et al., 2000), pneumonia and other health side-effects. In addition to public health advantage, routine monitoring of air quality can serve as a means of military surveillance for the detection of any possible biological threat of bioterriorism (Douwes et al., 2003).

CONCLUSION

The importance of evaluating the quality of human environments, the air we breathe especially in market places where there is increase activities of human, especially in areas where there is high traffic congestion, increase vehicular movements, market merchants and various activities cannot be over emphasized. The number and type of airborne microorganisms can also be used to determine the degree of cleanliness as a means of determining the source of human discomfort and certain airborne microbial infections. As revealed by this study, major markets pose high risk of air contamination to occupants and market merchant especially those of compromised immunity.

Increase humidity supports the activities of micro organism in the air. In areas where there are increase human activities such as slaughter houses, factories, waste treatment plants, Microorganisms in the air may be increased in the mornings where there is increased humidity. Also for areas with high vehicular movement, and traffic congestion, the air may stay dense

throughout the day. This can cause bioaerosols to be suspended in the air, thereby leading to spread of diseases. The amount of microbial population can be influenced by the period of the day as the evening and afternoon sampling period accorded more microbial population, compared to the morning as revealed in this study. From this study, it will be recommended that the clean air environment of markets in Port Harcourt Metropolis should be encouraged both the merchants and the government

Finally, the importance of evaluating the quality of the air humans breath whether indoor or outdoor, especially in the market places where there is high human activities cannot be over emphasized. The number and type of airborne microorganism can also be used to determine the degree of cleanliness as a means of determining the source of human discomfort and certain airborne microbial.

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