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ISOLATION AND CHARACTERIZATION OF MICROBES FROM EGG SHELLS AND POULTRY DUNGS SAMPLED FROM SELECTED POULTRY FARMS IN LAGOS, SOUTH WEST, NIGERIA

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A B S T R A C T
Microorganisms associated with egg shellsand poultry dung sampledfrom selected poultry farms were studied. A total of thirty-four (34) isolates were obtained from both samples using standard microbiological methods. This consist twenty-five (25) bacteria and nine (9) fungi. The percentage occurrence of bacteria isolated from the samples indicates 64% of Gram-negative rods and 24% of Gram-positive cocci. Findings from the study revealed that these organisms were mostly of human and terrestrial origin which implies that eggs were exposed to contaminants from a wide variety of sources, the primary being faeces, manure and soil. Moreover, it was observed that enteric bacteria such as Enterobacterspp. and coliforms were more prevalent in the samples investigated. Some pathogenic bacteria that posediseases in humans and poultry such as Clostridium and Staphylococcispecies were also isolated from the samples. It is imperative to have greatunderstanding of themicrobial community of poultryproduct (egg shell) and waste(poultry dung)which is contingent to the control of animal disease that occurs as a result of contaminationof poultry product and the management of the adverse effect thatpoultry waste poses on the environment, human and animal health. Hence, the need for this research to create awareness and proffer suitable measures in the control of animal diseases that occurs as a result of contamination of its products and management of animal wastes.

INTRODUCTION

Microorganisms present both beneficial and harmful effects on humans and this depends on the way we handle them. Eggs are important and well-accepted part of the human diet all over the world. Freshly laid eggs, under normal conditions are sterile and only get contaminated thereafter.

Poultry products(eggs)contamination by microbial activitydepends on the type and concentration of the organisms involved and the natural bactericidal properties of the eggs, its immediate environment and time (Chukwuka et al., 2011).

Obviously, one of the reasons for egg shell cracks (including gross cracks, hairline crack and star crack) is mechanical damage (Juliet, 2004). Egg shell strength ultimately affects the soundness of the shell, with weaker shelled eggs more prone to cracks and breakages and subsequently microbial contamination. The effect of ageing on egg shell quality can be reversed to some degree by the process of induced molten. Shell strength can be affected by a wide range of factors including nutrition, bird age, egg size and mycotoxicosis (Mabe*et al.*, 2003; Chukwuka *et al*., 2011). In addition, the effect of nutrition and water quality on egg shell depends on the amount of calcium in a particular egg shell. Therefore the diet of hens must be rich in calcium as well as water which contain a high level of electrolyte which has long term negative effect on egg shell quality (Juliet, 2004). The water supplied to the bird must not a contaminated one, so poultry farmers should ensure that disease is not transmitted by water.

However**,** lysozyme, also known as muramidase or N- acetyl- muramideglyhydrolase,are glycoside hydrolases, enzymes (EC3.2.1.17) that damage bacterial cell walls by catalyzing the hydrolysis of 1,4-beta-linkages between N-acetylmuramic acid and N-acetyl-D-glucosamine residues in a peptidoglycanand between N-acetyl-D-glucosamine residues in chitodextrins. Lysozyme is abundant in a number of secretions, such as tears, saliva, human milk, and mucus. It is also present in cytoplasmic granules of the polymorphonuclear neutrophils (PMN). Large amounts of lysozyme can be found in egg white. C-type lysozymes are closely related to alpha-lactalbumin in sequence and structure, making them part of the same family (Peters *et al*., 1989). In humans, the lysozyme enzyme is encoded by the *LYZ* gene (Yoshimura *et al.*, 1988).Lysozyme is part of the innate immune system. Reduced lysozyme levels have been associated with bronchopulmonary dysplasia in new-borns (Revenis and Kaliner, 1992*)*. Children fed infant formula lacking lysozyme in their diet have three times the rate of diarrheal disease (Lönnerdal, 2003). Since lysozyme is a natural form of protection from Gram-positive pathogens like *Bacillus* and *Streptococcus* (Nester *et al.*, 2009); therefore a deficiency due to infant formula feeding can lead to increased incidence of disease. Whereas the skin is a protective barrier due to its dryness and acidity, the conjunctiva (membrane covering the eye) is, instead, protected by secreted enzymes, mainly lysozyme and defensin; when these protective barriers fail, conjunctivitis results. Historically, Laschtschenkoreport showed the antibacterial property of hen egg white, due to the lysozyme (Laschtschenko, 1909). Although this was not known until 1922 that the name 'lysozyme' was coined, by Alexander Fleming (1881–1955), the discoverer of penicillin (Blake *et al.*,1965).Fleming first observed the antibacterial action of lysozyme when he treated bacterial cultures with nasal mucus from a patient suffering from a head cold (Fleming, 1922). The three-dimensional structure of hen egg-white lysozyme was described by David Chilton Phillips (1924–1999) in 1965 when he obtained the first 2-Ångström (200pm) resolution model via X-ray crystallography. The structure was publicly presented at a Royal Institution lecture in 1965 (Canfield 1963; Jonhson, 2000).

In addition, Jonson (2000) revealed DavidChiltonPhillips**,** BaronPhillipsofEllesmere, who livebetween March 1924 – 23 February 1999; as the pioneering structural biologist who worked on lysozyme. Lysozyme was the second protein structure and the first enzyme structure to be solved via X-ray diffraction methods, and the first enzyme to be fully sequenced that contains all twenty common amino acids. As a result of Phillips' explanation on the structure of lysozyme, it was also

the first enzyme to have a detailed, specific mechanism suggested for its method of catalytic action (Johnson, 2000; Vocadlo *et al.*, 2001). Meanwhile, the risk of getting a foodborne illness from eggs is very low if proper hygiene is maintained by poultry farmers, egg sellers and the consumers. The nutrients that make eggs a high-quality food for humans are also a good growth medium for bacteria becausebacteria need moisture, a favourable temperature and time in order to multiply and increase the risk of illness. When eggs are handled with care, they pose no greater food-safety risk than any other perishable food. Most human cases of *Salmonella* have been linked to the consumption of eggs and poultry products (Jong and Ekdahl, 2006; Rabsch and Taschape, 2001). It has been observed that lysozyme also have antifungal characteristics.

Meanwhile, Sawasdipuksa *et al*., (2011) isolated lysozyme from *Pithecellobium dulce* seeds by using chromatographytechniques and tandem mass spectrometry with Mascot database searching. The plant lysozyme 0.1kDa higher than that of chicken because the plant lysozyme has a molecular mass of 14.4 kDa while chicken egg white lysozyme is 14.3 kDa. According to Sawasdipuksa and others the lysozyme also plants lysozyme shows theantifungal ability against *Macrophomina phaseolina* with arather high thermal stability at up to 80 °C for 15 min (at pH=8.0) (Sawasdipuksa *et al*., 2011).

More so, previous studies opined that pea seeds contain protease inhibitor which is capable of antifungal activities (Vernekar *et al.*, 1999; Sawasdipuksa *et al*., 2011). As with any other food of animal origin, eggs may be contaminated with microorganisms which are potentially pathogenic for humans. These organisms include *Campylobacter jejuni, Listeria monocytogenes, Macrophomina phaseolina,Yersinia enterocolitica* and the *Salmonellas* with *Salmonella enteritidis* being of great concern (Humphrey, 1994; Sawasdipuksa *et al*., 2011; Huang, 2016).

Contamination of the external part of egg shell can occur with the chicken faeces or other matter from the environment. More so, the content of shell content may be affected by contaminants of such an environment whenever the shell cracks (CDC, 1996; Ching-Lee *et al.*, 1991; Humphrey, *et al.*, 1994; Mishu *et al.*, 1991). Nonetheless, the egg itself may not be contaminated from the farm but become contaminated from improper handling by the sellers and consumers throughthe use unclean hands, playing with pets and using the same unwashed hand to touch the eggs; other foods and kitchen equipment, too can be a fomite to contaminate eggs. According to Centers for Disease Control and Prevention, if bacteria are present at an egg, they are most likely to be in the albumen (the white part) and will not be to grow due to lack of nutrients for growth in the medium. But, as the egg gets older, the white thins and the yolk membrane weaken and thereby making it possible for bacteria to reach the nutrient in the yolk and then growth takes place under warm or favourable temperatures. But, internal contamination of clean is not common (Höll *et al.*2016; CDC, 2010).

Notwithstanding, an egg has natural in-built barriers to help in prevention of bacterial growth but the porous shell itself is not a full-proof bacterial barrier. Therefore, government regulations on safe food will require that eggs should be carefully washed with special detergent and sanitized. Other protective barriers include the shell and yolk membranes and layers of the white which fight bacteria in several ways. The structure of the shell membranes helps in prevention of the passage of microorganisms. Hence, the shell membranes contain *lysozyme* which is a substance that preventsmicrobial growth in egg (Hunton, 2005). Apart from lysozyme, the layers of the white portion do not allow growth of bacteria because they are alkaline so the thick white layer in egg

inhibits growth of microorganisms. So, last layer of white portion of egg has little of the water that microbes need (low water acidity) but a high concentration of the white's protective materials which holds the yolk at the centred in the egg where it receives the maximum protection (Stepien-Pysniak, 2010).

The importance of poultry dung is like that of the eggs; because it is often used in the production of nutrient (manure) for plant growth. Hence, many preservative methods have been put in place to ensure regular and free flow of manure by arable farmers. These include refrigeration, freezing, acidification, and freeze-drying. These storage methods are used in order to keep poultry manure for later chemical analyses or future use. However, the characteristics of poultry manure are affected by feed, different species of birds, age of the birds, bedding material type, and water intake (Awosanya *et al*., 1998).Stored or treated poultry manure contains about fifty to ninety percent of the total nitrogen in the form of ammonia. According to Muhammadand others, a reliable method of poultry manure storage, in which the sample collected and analysed is similar in composition to the fresh sample, is necessary and critical for proper interpretation of data composted organic material such as plant debris and animal manure add nutrient to the soil thereby increasing the soil fertility improves plant growth and makes the plant not prone attack by pathogenic microorganisms (Muhammad *et al*., 2001; Ngodigha and Owen, 2009). Therefore, effectofpoultrydungincomposting is so useful in agriculture because organic materials such as plant debris and animal manure increase soil fertility which improves plants growth. Moreover, many researchers observed that composted agricultural wastes do suppress soil-borne plant diseases (Ferket, 2004; Stepien-Pysniak, 2010).In addition, manures supply other essential plant nutrient and serve as a soil amendment by adding organic matter. Organic matter persistent will vary with temperature, drainage, rainfall and other environmental factors. Organic matter in soil improves moisture and nutrient retention. The utilization of manure is an integral part of sustainable agriculture (Ferket, 2004; Mohammed, 2005; Ngodigha and Owen, 2009).This study unveiled microbiota of egg shells and poultry dung.

MATERIALS AND METHOD

Study Area

The eggs and poultry dung were collected from selected farms in Ipaja and Oshodi Lagos, South West, Nigeria.

Collection of Samples

Chicken eggs and dung were collected from Oshodi Poultry Farm at Oshodi and Ipaja Poultry Farm at Iyana-Ipaja area of Lagos State, Nigeria. The two poultry farms were selected for the study. Both farms were being run on the deep litter system.Oshodi Poultry was mainly for home consumption while Ipaja Poultry Farm was being managed for commercial purpose. Six (6) eggs consisting of three freshly laid eggs and three old eggs were selected and used for the analysis. Also, for poultry dung, two samples were collected from each farm. Poultry dung was collected with a sterile soil auger and placed into a sterile container.The egg samples were collected with the aid of a sterile hand glove worn and placed into a sterile container. Aseptic measures were taken during the process of sample collection. Samples were transferred to the laboratory immediately for subsequent analysis. The samples were properly labeled with all necessary information such as date of collection, sample name and the site of collection.

Morphological Identification of Isolates

The colonies on Nutrient Agar (NA) and Malt Extract Agar (MEA) plates were observed directly. For bacteria, the shape, elevation, edge, surface and colour of the colonies were observed and adequately documented. The shape could be circular, irregular, rhizoid and filamentous or the edge could be entire, undulate, lobate or rhizoid. The surface could either be rough, smooth, dull or glistering. The colour of the colonies on the agar was also recorded.For fungi, changes in the colour of the colonies of sub-cultured plates were recorded.

Identification of Bacterial Isolates

The different parameters that were used to identify the bacterial isolates include Gram staining reaction, biochemical tests such as:catalase test, coagulase test, motility test, indole test, sugar fermentation test and starch hydrolysis were carried out.

Identification of Fungal Isolates

Fungi were isolated using potatoes dextrose agar and stained with lactophenol cotton blue for identification. A drop of lactophenol cotton blue was placed in the centre of a clean grease-free slide. A sterile inoculating needle was used to pick a small mycelium of a young fungi culture and then transferred into the drop of the stain on the slide. The inoculating needle was carefully used to bring out the hyphae and the preparation was covered with a coverslip. The slide was viewed under the microscope using an x40 objective lens.

RESULTS AND DISCUSSION

A total of thirty-four isolates were cultured from the four samples collected. These were made up of twenty-five bacteria and nine fungi. Bacterial isolates were identified based on their cultural, morphological and biochemical characteristics.Gram stain of fresh bacterial isolates revealed that sixteen (64%) isolates were Gram-negative rods, three (12%) of the isolates were Gram-positive rods while six (24%) isolates were Gram-positive cocci. The biochemical reactions of the bacterial isolates encountered in this study were also observed and recorded. Results of sugar fermentation showed that seventeen (68%) isolates ferment glucose, nineteen (78%) isolates ferment sucrose, fifteen (60%) isolates ferment maltose, sixteen (64%) isolates ferment lactose and twenty (80%) isolates ferment fructose. All the bacterial isolates tested were catalase positive. Eight (32%) isolates were coagulase-positive while seventeen (68%) isolates were coagulase-negative.

Based on the characteristics comparable to those enumerated in Bergey's Manual of Determinative Bacteriology and Manual of Identification of Medical Bacteria,two (8%) isolates were identified as *Staphylococcus species*, three (12%) were identified as *Citrobacter*, two (8%) isolates were identified as *Escherichia coli*, four (16%) isolates were identified as *Micrococcus species*, three (12%) isolates were identified as *Bacillus* species, two (8%) isolates were identified as *Pseudomonas* species, two (8%) isolates were identified as *Salmonella species*, two (8%) isolates were identified as *Enterobacter* species and one (4%) isolates were identified as*Aerobacter* species.

Furthermore, it was observed that moremicrobes were isolated from washing egg shell than the shell grindings. *Escherichia coli* had the highest incidence from shell washings as depicted in figure 1.*Micrococcus* spp, *Escherichia coli* and *Enterobacter* species had the highest incidence in both shell items of washingand shell grindings (Figure 1 and 2). Also, *Escherichia coli*had the highest prevalence in shell grinding (Figure2) while *Citrobacter*speciesand *Staphylococcus* species had the highest frequency of occurrence in poultry dung (Figure 4),*Micrococcus* spp. in shell washings, shell grindings and poultry dung as shown in figures 1, 2 and 4.

The fungi encountered in this study were identified based on their cultural, morphological and

microscopy. Result of lactophenol staining revealed that nine isolates were encountered of which two were encountered as *Saccharomyces*species, two isolates were identified as *Aspergillusniger*, one isolate was identified as *Sporothrix*species, two isolates were identified as *Aspergillusflavus*, one isolate of *Rhizopus* species while one isolate was identified as *Candida albican.*

Table 1:Microbial Counts

Sample code	Microbial Counts (X 10^3)CFu/ml
EI_1	530
EI_2	290
EI_3	8
EI_4	210
EI_5	11
EI_6	420
EI_7	29
EI_8	470
EI_9	25
EI_{10}	TN
EI_{11}	330
EO_1	84
EO_2	160
EO_3	34
EO_4	47
EO_5	6
EI_6	510
EO_7	98
EO_8	1
PI_1	390
PI_2	TN
PI_3	76
PO_1	4
PO_2	44
PO_3	189

EI= Egg samples from Ipaja Poultry Farm EO = Egg samples from Oshodi Poultry Farm

PI = Poultry dung from IyanaIpajaPO = Poultry dung from OshodiTN = Too numerous

Table 2: Morphological Characteristics of Bacterial Isolates

Isolates	Form	Edge	Elevation	Surface	Colour	Opacity
EI_1	Irregular	Rhizoid	Flat	Dull	Pink	Opaque
EI_2	Irregular	Undulate	Raised	Rough	Cream	Opaque
EI_3	Punctiform	Lobate	Convex	Smooth	Cream	Opaque
EI_4	Irregular	Undulate	Raised	Smooth	Green	Translucent
EI_5	Irregular	Undulate	Raised	Rough	Cream	Opaque
EI_6	Irregular	Entire	Raised	Smooth	Cream	Translucent

EI_7	Irregular	Lobate	Raised	Rough	Cream	Opaque
EI_8	Irregular	Undulate	Raised	Dull	Pink	Translucent
EI_9	Irregular	Lobate	Raised	Rough	Bluish	Opaque
EI_{10}	Circular	Entire	Convex	Smooth	Green	Opaque
EI_{11}	Irregular	Undulate	Raised	Smooth	Cream	Opaque
EO_1	Circular	Entire	Flat	Smooth	Cream	Translucent
EO_2	Irregular	Undulate	Raised	Rough	Pink	Opaque
EO_3	Circular	Entire	Flat	Smooth	Cream	Translucent
EO_4	Circular	Entire	Flat	Smooth	Cream	Opaque
EO_5	Irregular	Undulate	Raised	Smooth	Cream	Translucent
EI_6	Irregular	Lobate	Raised	Rough	Cream	Opaque
EO_7	Irregular	Lobate	Flat	Dull	Cream	Opaque
EO_8	Irregular	Lobate	Raised	Rough	Cream	Opaque
PI_1	Irregular	Entire	Raised	Smooth	Green	Translucent
PI_2	Irregular	Undulate	Raised	Rough	Cream	Opaque
PI_3	Punctiform	Erose	Raised	Rough	Blue	Translucent
PO_1	Rhizoid	Lobate	Convex	Rough	Green	Opaque
PO_2	Circular	Entire	Convex	Smooth	Cream	Opaque
PO_3	Circular	Irregular	Raised	Smooth	Cream	Opaque

EI = Egg samples from IyanaIpaja EO = Egg samples from Oshodi

PI = Poultry dung from IyanaIpajaPO = Poultry dung from Oshodi

Table 3: Morphological Characteristics and Microscopy of Fungiisolates.

Isolates	Cultural Characteristics		Spore and conidia arrangement under a microscope	Tentative identity
	Colour	Hyphae		
1	Cream to tarnish the cream	Bud	Blastoconidia (cell buds) were observed. They are unicellular globose and eclipsed to elongate in shape hyphae are absent.	*Saccharomycessp p*
2	Cream to tarnish the cream	Bud	Blastoconidia (cell buds) were observed. They are unicellular globose and eclipsed to elongate in shape hyphae are absent.	*Saccharomyces spp*
3	Black(powdery) colony	In-septate	Conidia heads are black in colourand the conidiophores arevery long.	*Aspergillusniger*
4	Black (powdery) colony	In-septate	Conidia heads are black in colourand the conidiophores arevery long.	*Aspergillus niger*
5	Cream to dark brown	Septate	A small white waxy colony which was later wrinkled. Pear-shaped conidia attached to denticles on hyphae were seen microscopically	*Sporothrix spp*
6	Yellowish green	In-septate	Conidia head radiate surface containing many phialides and chains of conidia collumella is absent.	*Aspergillus flavus*
7	White	In-septate	Columella is flattened with hyaline aerial hyphae and irregular sporangiophore. Sporangia have many spores.	*Rhizopus spp*
8	Yellowish green	In-septate	Conidia head radiate surface containing many phialidesand chains of conidia co~~l~~lumella is absent.	*Aspergillus flavus*
9	Soft cream coloured colony	Non-septate	Oval budding yeast cells produced on mycelium epically. Pseudohyphae are formed.	*Candida albican*

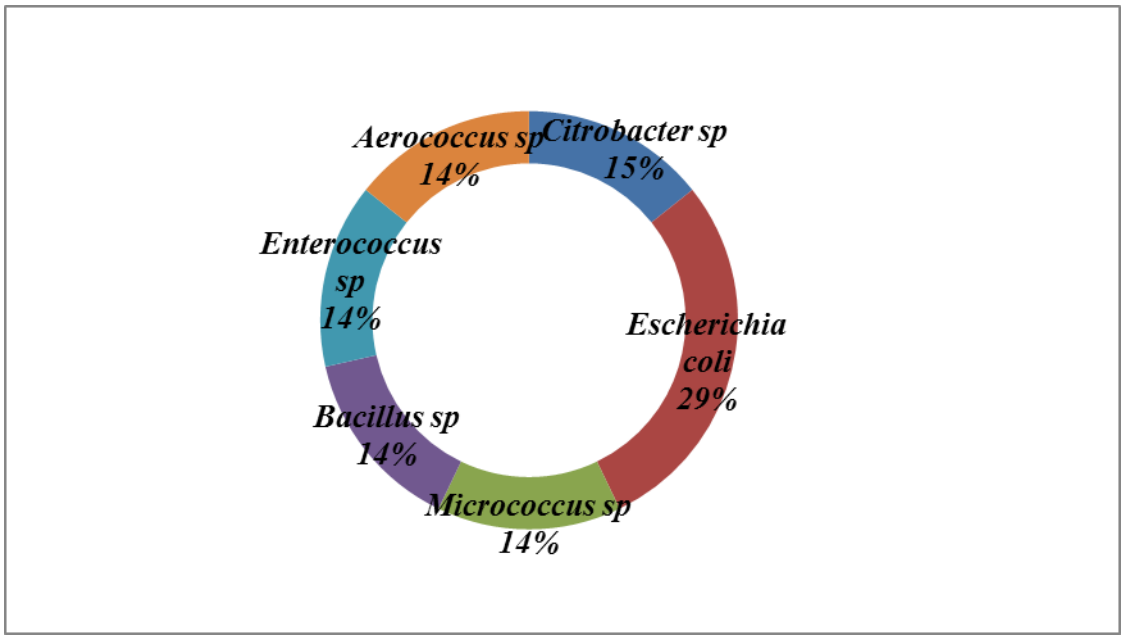

Figure 1: Isolates from Shell Washings

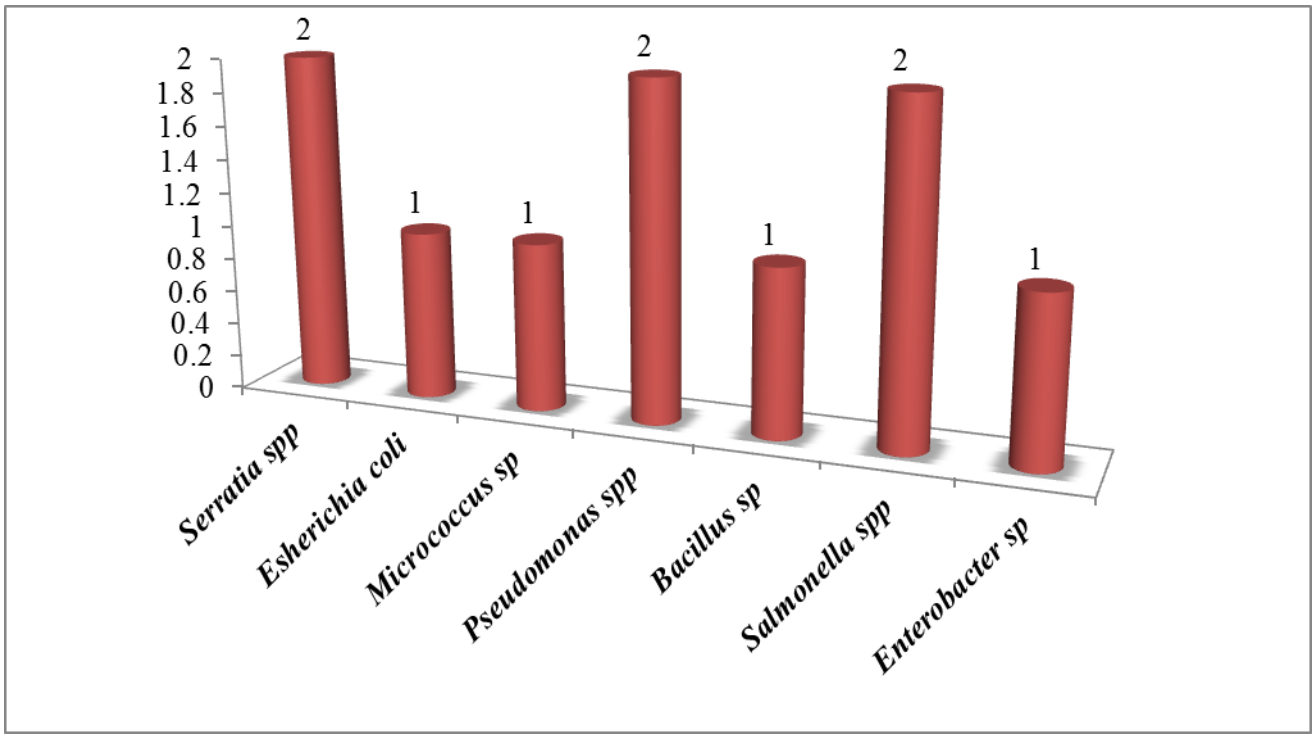

Figure 2: Bacterial isolates from shell grindings

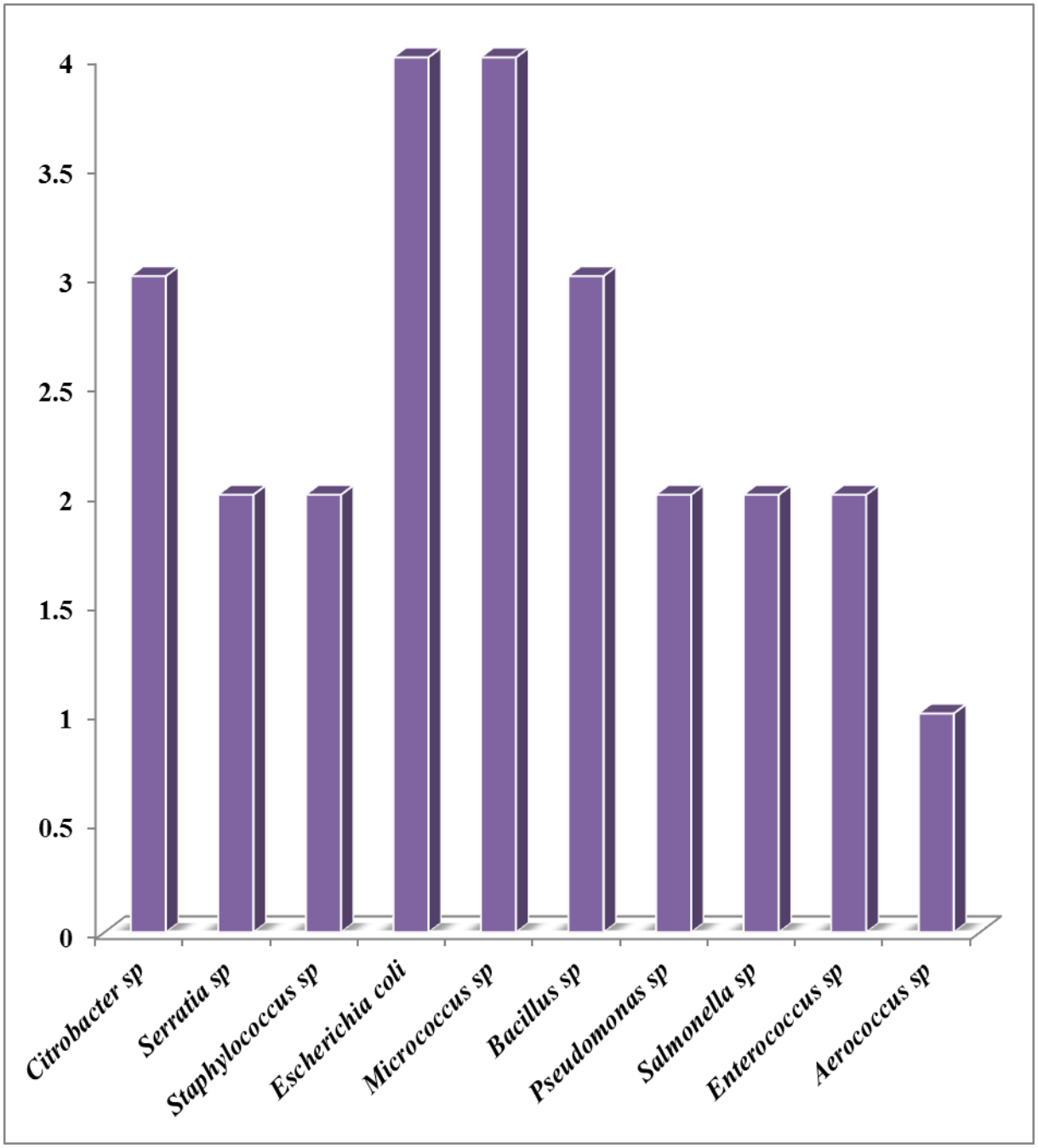

Figure 3: Bacterial isolates from poultry dung and egg shells

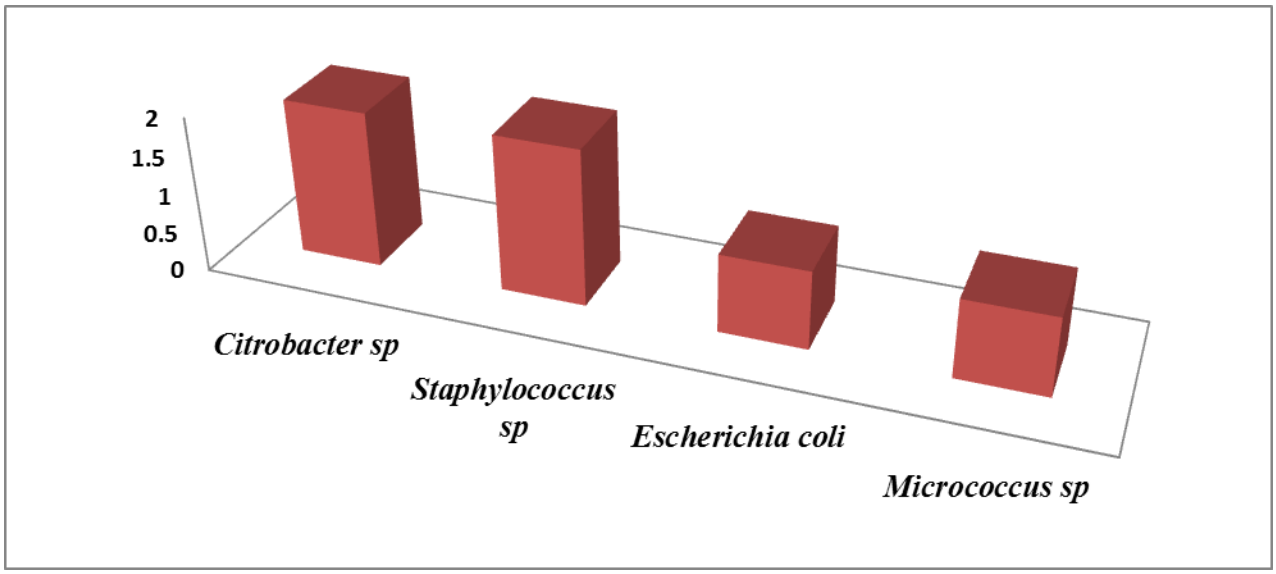

Figure 4: Bacterial isolates from poultry dung

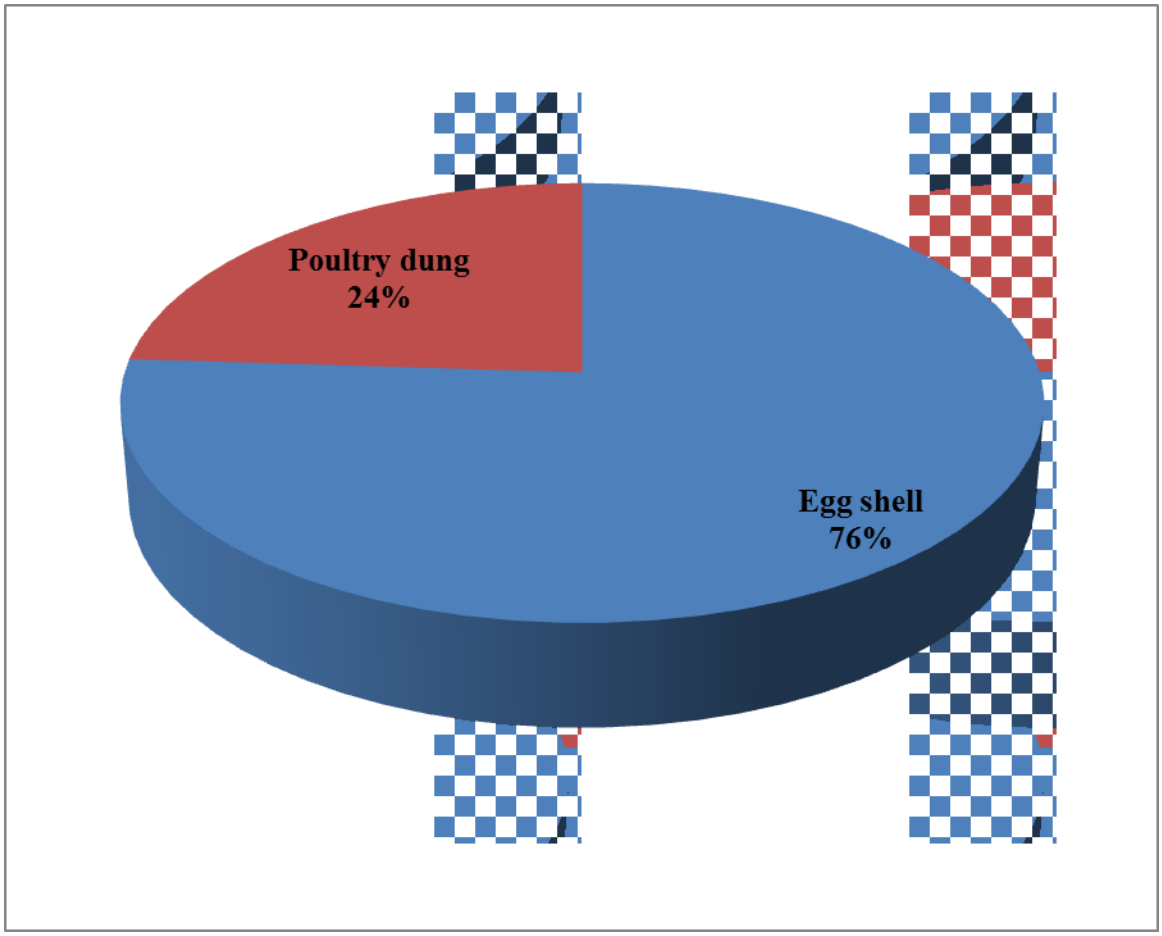

Figure 5: Distribution of bacterial isolates in relation to sources

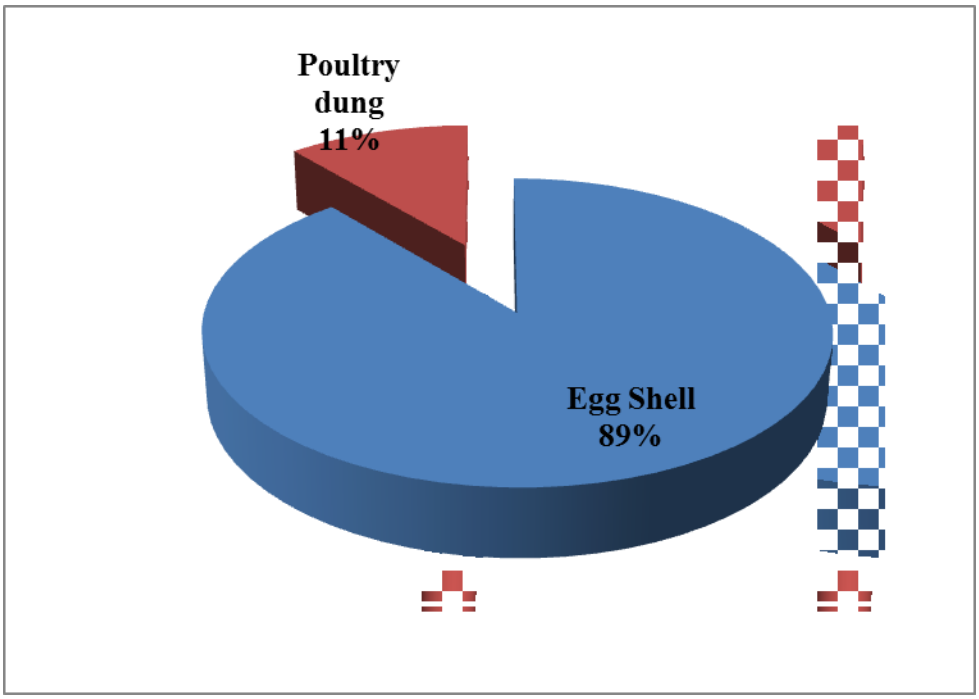

Figure 6: Distribution of fungi in relation to sources

A wide variety of microorganisms were isolated from the poultry dung and eggs shell examined. These included a range of coliforms of intestinal origin, bacteria and fungi of terrestrial origin. This result affirms the previous findings by Folorunsho and Charles (2013) who posits that freshly laid eggs are generally devoid of organisms but following exposure to environmental conditions such as soil, dust and dirty nesting materials, eggs become contaminated with different types of microorganisms. A review by Ngodigha and Owen (2009) agrees with this result;Ngodigha and Owenopined that this range of organisms have been obtained from poultry untreated litter.Sawasdipuksa *et al.*(2011) discovered that lysozyme inhibits microbes such as *Salmonella*, *Escherichia coli* and otherpotential contaminants that are found in poultry environment, which confirm these bacteria genera in egg samples from Oshodi Poultry Farm in Oshodi and Ipaja PoultryFarm at Iyana-Ipaja, Lagos Nigeria. The enteric bacteria involved in the study shows consistency to the research by Garcia-Graells *et al*. (2000) where *Escherichia coli* were isolated from a dairy product. The incidence of *Enterobacter*species, *Pseudomonas* species, *Citrobacter* species and *Esherichia coli*encountered more frequently from the egg shells examined shows the possibility of internal contamination of poultry eggs in the study area. These organisms may present an endemic disease in the area, because the rate of penetration and possible contamination of poultry products(eggs) is quite low. Hence, other organisms isolated may not be considered pathogenic on man because they are mostly found as normal flora of the gastrointestinal tract and their presence only indicate the possibility of egg shell contamination if the suspended organisms were to occur. However, egg spoilage occurs due to both physical and chemical changes (Waleed *et al.*, 2018). So, the white portion (albumen) of eggs becomes less viscous and more watery thereby allowing water of the albumen (egg white portion) moves into the yolk and eventually allow spoilage of the egg by making it

thinner. The evaporation of the water through the shell and escape of carbon (IV) oxide increase the pH of the contact eggs. In addition, poor treatment of freshly laid eggs results in the movement of bacteria into the shell leading to the nettling of eggs when the bacteria are insufficient numbers. This is the commonest form of bacterial spoilage of eggs. This also corroborates the previous studies bythe researchers who investigated foodborne pathogen contamination of table eggs sold in Jordanian marketsby the isolation of *Staphylococcus*, *Pseudomonas* spp., *Proteus* spp., *Klebsiella* spp., *Escherichia coli*, *Bacillus* spp., *Listeria monocytogenes* and *Salmonella* spp.from eggshell surfaces: (Oviasogi èt al, 2016; Waleed *et al.*, 2018).It is noteworthy from this study that the number of bacteria isolated predominates the number of fungi species in the samples. This may be due to the fact that bacteria are the most diverse groups of compost microorganisms and they use a wide range of enzymes to chemically degrade many organic materials. The present investigation reveals that the contamination of the environment by faecesharboring pathogens especially poultry dung can pose serioushealth hazards to human and animal.

CONCLUSION

The microbiological study of poultry product and poultry waste cannot be overemphasized because an egg is one of the poultry products consumed across the globe. Also, poultry dung is a waste which is often used as manure by arable farmers. Therefore, this research reveals that poultry dung and egg shells are favourable habitats for microbial growth. Hence, proper poultry management should be embarked upon by stakeholder who operates poultry business to ameliorate occurrence of poultry diseases which can easily spread from these two sources (egg and poultry dung) if either or both are contaminated.More so, an individual can be predisposed to *Salmonella* infection bythe consumption of raw eggs already contaminated with the pathogenic bacteria. Thus, musical Artists fond of ingesting raw eggs to improve the voice quality should put an end to this habit. The egg should be cooked before consumption to avoid incidence of infection. Furthermore, spoilage of eggs can be taken care of through short period storage of egg at room temperature. Moreover, eggs should be thoroughly washed perhaps with detergents and clean water before cooking because it can also be contaminated by the pathogens embedded in the poultry dung. However, poultry dung should be removed on regular basis, the poultry flood should be disinfected before sawdust is added to the floor. In as much poultry dung does not pile up for quite along time in the cage, pathogenic microbes as can be easily evacuated fromthe environment. Also, it is pertinent to sensitize all poultry farmers to avoid the applications of manure to crops especially vegetables that are due for harvesting as it may be implicated in the spread of pathogenic bacteria which could result to a serious public health problem. Additionally, hygienic hand wash practices before handling eggs should be a regular habit exhibited by all poultry farmers, eggs sellers and consumers which will in no doubt helps to mitigateand if possibleeradicate the risk of foodborne illnessthat could occur from the consumption of contaminated eggs and plausible infections that could occur as a result of contact of contaminated poultry dung with food products and the immediate environment.

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