Isolation, Characterization and Antibiogram of Bacteria from African Catfish Skin Ulcer in Abia State, Nigeria.

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Submitted: 7th May, 2022; Accepted: 24th June, 2022; Published online: 30th June, 2022
DOI: *https://doi.org10.54117/jcbr.v2i3.21*

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Abstract

Bacteria associated with African catfish skin ulcers cultured in Abia state, Nigeria have not been documented. This study was conducted to determine the antibiogram of bacteria isolates associated with skin ulcers of African catfish cultured in selected localities of Abia State. Twenty (20) African catfish with skin ulcers were purposively sampled from the selected farms. Scrapings from skin ulcers were collected from samples from Aba north and Osisioma, processed for bacteria isolation and identification. Susceptibility of bacteria isolates to antimicrobial agents was determined using the disc diffusion method. Sixty percent of the samples from Abia north in combination with 50% and Osisioma, showed positive culture for *Aeromonas hydrophila* (40%), *Escherichia coli* (30%), *Proteus spp* (10%) and *Staphylococcus aureus* (20%); and *Klebsiella sp* (10%) and *Aeromonas hydrophila* (40%). The frequency of isolation of 30 identified bacteria isolates was *Aeromonas hydrophila* (23.33%), *Escherichia coli* (36.37%), *Staphylococcus aureus* (16.67%) and *Proteus sp* (10%) and *Klebsiella spp.* (13.3%). *Aeromonas hydrophila*, *Escherichia coli, Proteus spp and Klebsiella spp* exhibited highest resistance to Vancomycin (100%). Similarly, *Staphylococcus aureus*, *Proteus spp and Klebsiella spp* exhibited highest resistance to Nalidixic acid (100%), whereas *Staphylococcus aureus* and *Proteus spp* also showed highest resistance to Tetracycline (100%). All isolates from this study exhibited multi-drug resistance to antimicrobials. These organisms isolated were pathogenic and transferable to the final consumers. Hence, there is the need to ensure that African catfish with skin ulcers are thoroughly screened and appropriate medication given for prevention and control.

Keywords: Abia State, African catfish, Antibiotics, Bacteria, Skin ulcer, antibiotic growth promoter

Introduction

Fish is one of the affordable sources of quality protein that is available worldwide for human consumption (Olugbojo and Ayola, 2015). Fish is consumed for its high biological values in terms of high protein retention in the body, low level of cholesterol and presence of essential amino acids. Fish is also an important source of income for fishermen and fish farmers; and its cultivation is a source of employment in developing countries (Felix *et al.*, 2018). The fisheries and aquaculture sector significantly expanded in the past decades, and total production, trade and consumption reached an all-time record of 179 million tons in 2018 (FAO, 2020). Over the past 35 years, aquaculture production in Nigeria has grown by 12 percent annually, from a little over 6000 metric tons in 1980 to nearly 307,000 metric tons in 2016 (Worldfish, 2018).

Nigeria is the largest fish producer in sub-Saharan Africa, accounting for 52 percent of the total farmed fish production in the region (Ogbukagu *et al*., 2020)

Clarias gariepinus (African catfish) is an omnivorous fish cultivated in ponds, cages, and pens. They are teleost with their entire body surfaces, fins and barbells covered with skin made up of living non-keratinized stratified squamous epithelial cells (Zhao *et al.,* 2008 & Esteban, 2012). The skin is the organ of interaction with the environment and it plays important homeostatic roles which include protection, sensory perception, communication, excretion, locomotion, osmoregulation, respiration, thermoregulation and antimicrobial activity (Esteban, 2012; Bordas *et al.,* 1996). Skin serves as the first site of attachment for a great number of microorganisms in the aquatic environment (Esteban, 2012 & Bordas *et al.,* 1996). Attachment of microorganisms to fish skin often induces skin lesions which irrespective of the size, results in colonization by many opportunistic pathogens, life-threatening osmotic stress, increased energy cost from locomotion due to impairment of mucus production, swimming imbalance, increased predation due to color change and deficiency in oxygen intake (Noga, 2000, Law, 2001 & Ibrahem and Mesalhy, 2010). These skin lesions adversely affect performance and productivity of the affected fish.

Severe skin ulcers may lead to exposure of underlying musculature, resulting in systemic infection or sepsis. Infection of large populations of the fish can lead to damages and economic losses. Skin lesions in farmed fish are an important challenge to the fish farmer.

In aquaculture and production, the economic losses acquired as a result of diseases are now an important problem all over the world: it's a major setback to the sustainability of the aquaculture industry as a whole (Rahman *et al.,* 2017).

Farmers and veterinarians usually attempt to treat bacterial infections using different antimicrobial agents. There have been reports of treatment failure often attributed to development of resistance by the implicated organisms (Olatoye & Basiru, 2013). Knowledge about antibiotic susceptibility of bacteria is vital for the proper management of the diseases they cause. Worldwide, the use of antibiotics as growth promoters in aquaculture and the potential transmission of resistant gene bacteria among the bacterial organisms between terrestrial and aquatic environments have been reported as the major causes of multidrug resistance in animals and humans (Cabello, 2006). This usage has been blamed for increased development of multidrug resistance because the antibiotics are used at subtherapeutic doses, and this breeds resistance.

Bacterial pathogens are a great threat to fish production worldwide due to the high economic importance of diseases they cause (Bondad-Reantaso *et al.,* 2005). A few studies focusing on bacteria were limited to identification of the pathogens at genus level (Walakira *et al.,* 2014).

However, little or no studies on the isolation, identification of bacteria and antibiotic susceptibility test of the bacteria isolates from African catfish skin ulcers in Abia State are available. *Clarias gariepinus* with skin ulcers from the study areas were examined for the presence of bacteria and antimicrobial susceptibility profile of bacteria isolates.

Materials and methods

The study was carried out in two (2) local government areas of Abia State-Aba north and Osisioma from April 2021 – August, 2021. Abia State, Nigeria, is located in a tropical rainforest between latitude 5.4527^{o}N and longitude 7.5248^{o}E. The average annual

temperature and rainfall are 26.9ºC and 2193 mm, respectively (Kattek et al., 2006).

Samples and Sampling

Twenty African catfish with skin ulcers were collected from five African catfish farms from April, 2021 to August, 2021, and screened for bacteria. The African catfish with skin ulcers were collected using a purposive sampling method. Samples were collected batch by batch, and African catfish farms that had no history of recent antibacterial medication were selected . The samples collected were transported to Veterinary Microbiology laboratory, College of Veterinary Medicine, Michael Okpara University of Agriculture, Umudike, Abia state, in a well-labeled transparent, non-airtight bucket containing fresh water. Culture and identification of bacteria in skin scrapings from the skin ulcers was carried out in the Department of Veterinary Microbiology Laboratory, Michael Okpara University of Agriculture, Umudike.

Media preparation

Nutrient agar (CM0003- Oxoid, U.K), MacConkey agar (CM0007- Oxoid, U.K), Salmonella-Shigella agar (CM0122- Oxoid, U.K) and Mannitol salt agar (CM 0009 – Oxoid, UK) were prepared according to manufacturer's instructions for the isolation and identification of bacteria from the skin ulcers. Mueller Hinton agar (CM00337- Oxoid, U.K) was prepared and used to determine antimicrobial susceptibility of bacteria isolates.

Bacteria isolation and Identification

The streak plate method of inoculation was used, and a wire loopful of inoculum of skin scrapings from the skin ulcers was inoculated on Nutrient agar plates, which were incubated at 37ºC for 24 hours. The inoculated plates were examined and the colonies subcultured onto MacConkey agar, Salmonella-Shigella agar, Blood agar Mannitol salt agar plates accordingly for isolation of pure cultures and also for identification. The inoculated plates were incubated at 37ºC for 24 hours.

Macroscopic identification of the bacteria isolates was carried out based on the colonial morphologies such as the growth pattern, size, shape and color of the pure colonies on media.

The microscopic examination of the bacteria isolates was carried out using Gram staining technique.

The bacterial isolates were characterized by the following biochemical tests: motility, catalase, oxidase, coagulase, citrate, urease, sugar fermentation, hemolytic activity, indole and methyl red tests according to Bergey's manual of systemic bacteriology (Krieg and Holt, 1994).

Antibiotic sensitivity test

The Disk diffusion method (Bauer et.al., 2000) was used to determine the antibiotic susceptibility pattern of the bacteria isolates. A single colony of pure culture was picked and grown on Tryptic Soy broth (TSB). The inoculated broth was incubated at 37ºC for 16 hours and the concentration adjusted using sterile Tryptic Soy broth until 0.5 Macfarland turbidity was attained. One hundred milliliter (100µl) of the broth culture was swabbed unto Mueller Hinton agar using a sterile cotton swab. Ten antibiotic impregnated disks, purchased from Oxoid Limited, Basingstoke, Uk, were used. The antibiotics were Nalidixic acid, NA (30 µg), Vancomycin, VA (30 µg), Streptomycin, S (10 µg), Tetracycline, TE (30 µg), Amoxicillin, AML (10 µg), Clarithromycin, CLR (15 µg), Chloramphenicol, C (30 µg), Gentamicin, N (10 µg), Nitrofurantoin, F (300 µg) and Ciprofloxacin, CIP, (5 µg). These disks were placed on the surface of the Mueller Hinton agar plates at a distance to

avoid overlapping of inhibition zones. The plates were incubated at 37^{o}C for 16 to 18 hours, and the results interpreted as susceptible (S), Intermediate (I) and Resistant ® according to the Clinical Laboratory Standard Institute (2008).

Determination of the prevalence of bacteria from Clarias gariepinus skin ulcers

The prevalence of bacteria in the skin scrapings was calculated as follows:

$$\text{Prevalence (\%)} = \frac{Number\ of\ positive\ samples}{Total\ number\ of\ samples\ collected} \text{ x } 100$$

The frequency of isolation of bacteria from the samples was calculated as follows:

$$\text{Frequency (\%)} = \frac{Number\ of\ isolates\ of\ a\ genus}{Total\ number\ of\ isolates} \text{ x } 100$$

Data analysis

Data generated were calculated and presented using descriptive statistics in percentages.

Results

All the *Clarias gariepinu*s samples collected had apparent skin ulcers on their body surfaces (Figure I).



Figure 1: African catfish sample from farms in Abia state showing skin ulcers (arrows).

Out of the 20 African catfish examined, 6 samples (60%) from Aba north and five samples (50%) from Osisioma showed positive culture for bacteria. Thirty (30) bacterial isolates were recovered from the positive cultures and they belonged to 5 genera, namely, *Aeromonas*, *Escherichia*, *Staphylococcus*, *Proteu*s and *Klebsiella* (Table 1).

Table 1: Bacterial organisms isolated from African catfish skin ulcers in Abia state.

Location	Bacteria genera
Aba north	*Aeromonas hydrophila*
	Escherichis coli
	Staphylococcus aureus
	Proteus sp
Osisioma	*Aeromonas hydrophila*
	Klebsiella sp.

On the basis of occurrence of the genera, *Aeromonas hydrophila*, *Escherichia coli*, *Staphylococcus aureus*, *Proteus spp and Klebsiella sp* showed prevalence of 40%, 30%, 20%, 10% and 10%, respectively (Table 2). *Aeromonas hydrophila* had the highest prevalence, followed by *Escherichia coli* and the least was *Proteus spp and Klebsiella spp.* The frequency of isolation of the various genera was *Aeromonas hydrophila* (23.33%), *Escherichia coli* (36.37%), *Staphylococcus aureus* (16.7%), *Proteus spp* (10%) and *Klebsiella spp* (13.35) (Table 2). *Escherichia coli* had the highest number of isolates (11) and the least was *Proteus spp* (3).

Table 2: The prevalence and frequency of isolation of bacterial organisms identified from African catfish skin ulcers in Abia state

Bacteria genera	Prevalence (%)(n = 10)	Frequency of isolation (%)(n = 30)
Aeromonas hydrophila	4 (40%)	7 (23.3%)
Escherichia coli	3 (30%)	11 (36.4%)
Staphylococcus aureus	2 (20%)	5 (16.7%)
Proteus sp	1 (10%)	3 (10%)
Klebsiella sp.	1 (10%)	4 (13.3%)

On the basis of biochemical reactions, the 5 genera were identified phenotypically (Table 3).

Table 3: Phenotypic reactions of bacterial isolates from African catfish skin ulcer in Abia state

Characteristics	Percentage of bacterial isolates				
	A. hydrophila (n = 7)	*E. coli* (n = 11)	*S. aureus* (n = 5)	*Proteus sp* (n = 3)	*Klebsiella sp* (n = 4)
Motility	7 (100)	11 (100)	0 (0)	3 (100)	0 (0)
Gram reaction	-ve	-ve	+ve	-ve	-ve
Catalase production	7 (100)	11 (100)	5 (100)	3 (100)	0 (0)
Oxidase production	7 (100)	0 (0)	0 (0)	0 (0)	0 (0)
Citrate utilization	7 (100)	0 (0)	5 (100)	3 (100)	4 (100)
Urease production	0 (0)	0 (0)	5 (100)	3 (100)	4 (100)
Beta hemolysin	7 (100)	5 (45.5)	5 (100)	0 (0)	0 (0)
Growth on salt agar					
7.5%	0 (0)	0 (0)	5 (100)	0 (0)	0 (0)
Coagulase production	0 (0)	11 (100)	5 (100)	0 (0)	0 (0)
Indole	7 (100)	10 (90.9)	0 (0)	0 (0)	0 (0)
Methyl red	7 (100)	11 (100)	0 (0)	3 (100)	0 (0)
On TSI slant					
Gas production	0 (0)	11 (100)	0 (0)	3 (100)	4 (100)
H_2S production	0 (0)	0 (0)	0 (0)	3 (100)	0 (0)
Sugar fermentation					
Lactose	0 (0)	11 (100)	5 (100)	0 (0)	4 (100)
Glucose	7 (100)	11 (100)	5 (100)	3 (100)	4 (100)
Maltose	7 (100)	0 (0)	5 (100)	0 (0)	0 (0)
Sucrose	7 (100)	0 (0)	5 (100)	0 (0)	4 (100)
Arabinose	7 (100)	11 (100)	5 (100)	0 (0)	4 (100)
Mannitol	7 (100)	11 (100)	5 (100)	0 (0)	4 (100)
Inositol	7 (100)	0 (0)	0 (0)	0 (0)	4 (100)

The in vitro antibiotic susceptibility test on the bacteria isolates showed that 25 (83.3%) isolates out of the 30 bacteria isolates identified exhibited high resistance to Vancomycin (100%). Similarly, 12 (40%) and 8 (26.7%) isolates out of the total (30) isolates identified exhibited high resistance to Nalidixic acid (100%) and Tetracycline (100%), respectively (Table 4 & 6).

Table 4: Percentage resistance of bacterial isolates (n = 30) from African catfish skin ulcers in Abia state, Nigeria to various antimicrobial agents tested in the study

Antimicrobial agent	Antimicrobial resistance of bacterial isolates (%)				
	A. hydrophila (n = 7)	*E. coli* (n = 11)	*S. aureus* (n = 5)	*Proteus sp* (n = 3)	*Klebsiella sp* (n = 4)
Nalidixic acid (NA, 30µg)	0 (0)	0 (0)	5 (100)	3 (100)	4 (100)
Vancomycin (VA, 30µg)	7 (100)	11 (100)	0 (0)	3 (100)	4 (100)
Streptomycin (S, 10µg)	4 (57.1)	90 (90.9)	0 (0)	0 (0)	0 (0)
Tetracycline (TE, 30µg)	5 (71.4)	4 (36.4)	5 (100)	3 (100)	4 (100)
Amoxicillin (AML, 10µg)	2 (28.6)	5 (45.5)	0 (0)	2 (66.7)	3 (75)
Clarithromycin (CLR, 15µg)	3 (42.7)	4 (36.4)	3 (60)	0 (0)	3 (75)
Chloramphenicol (C, 30µg)	5 (71.4)	0 (0)	0 (0)	0 (0)	0 (0)
Gentamicin (N, 10µg)	0 (0)	9 (81.8)	3 (60)	0 (0)	0 (0)
Nitofurantoin (F, 300µg)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Ciprofloxacin (CIP, 5µg)	0 (0)	7 (63 6)	3 (60)	1 (33.3)	0 (0)

All (100%) the isolates (30) identified exhibited high sensitivity to Nitrofurantoin (100%) whereas 18 (60%) and 12 (40%) isolates out of the total isolates (30) exhibited high sensitivity to Nalidixic acid (100%) and Chloramphenicol (100%), respectively (Table 5).

Table 5: Percentage susceptibility of bacterial isolates (n = 30) from African catfish skin ulcers in Abia state, Nigeria to various antimicrobial agents tested in the study

Antimicrobial agent	Antimicrobial sensitivity of bacterial isolates (%)				
	A. hydrophila (n = 7)	*E. coli* (n = 11)	*S. aureus* (n = 5)	*Proteus sp* (n = 3)	*Klebsiella sp* (n = 4)
Nalidixic acid (NA, 30µg)	7 (100)	11 (100)	0 (0)	0 (0)	0 (0)
Vancomycin (VA, 30µg)	0 (0)	0(0)	5 (100)	0 (0)	0 (0)
Streptomycin (S, 10µg)	3 (42.9)	1 (9.1)	5 (100)	3 (100)	4 (100)
Tetracycline (TE, 30µg)	2 (28.6)	7 (63.6)	0 (0)	0 (0)	0 (0)
Amoxicillin (AML, 10µg)	5 (71.4)	6 (54.6)	5 (100)	1 (33.3)	1 (25)
Clarithromycin (CLR, 15µg)	4 (57.1)	7 (63.6)	2 (40)	3 (100)	1 (25)
Chloramphenicol (C, 30µg)	2 (28.6)	11 (100)	5 (100)	3 (100)	4 (100)
Gentamicin (N, 10µg)	7 (100)	2 (18.2)	2 (40)	3 (100)	4 (100)
Nitofurantoin (F, 300µg)	7 (100)	11 (100)	5 (100)	3 (100)	4 (100)
Ciprofloxacin (CIP, 5µg)	7 (100)	4 (36.4)	2 (40)	2 (66.7)	4 (100)

All the bacterial isolates identified exhibited multi-drugs resistance to the various classes of antimicrobial agents tested . The bacterial isolates exhibited obvious resistance to two or more of antimicrobials tested (Table 6 and 7).

Table 6: Antimicrobial resistance patterns of the bacterial isolates obtained from African catfish skin ulcers in Abia state.

Bacterial isolate	Resistance Pattern	Frequency
Aeromonas hydrophila (AH)		
AH1	VA-S-TE-CLR	1
AH2	VA-S-AML-C	1
AH3	VA-TE-C	1
AH4	VA-S-C-CLR	1
AH5	VA-TE-CLR	1
AH6	VA-S-TE-C	1
AH7	VA-TE-AML-C	1
Escherichia coli (EC)		
EC1	VA-CLR	1
EC2 & 9	VA-TE-AML-CLR	2
EC3	VA-TE	1
EC4	VA-AML-CLR	1
EC5	VA-TE-AML-	1
EC6	VA-TE-CLR	1
EC7	VA-CIP	1
EC8	VA-TE-N-CIP	1
EC10	VA-AML-CLR-CIP	1
EC11	VA-TE-AML-CLR-N-CIP	1
Staphylococcus aureus (SA)		
SA1	NA-TE-CLR	1
SA2	NA-TE-CLR-N	1
SA3	NA-TE-CIP	1
SA4	NA-TE-N-CIP	1
SA5	NA-TE-CLR-N-CIP	1
Proteus sp. (PS)		
PS1& 2	NA-VA-TE-AML	2
PS3	NA-VA-TE-CIP	1
Klebsiella sp. (KS)		
KS1 & 3	NA-VA-TE-AML-CLR	2
KS2	NA-VA-TE-AML	1
KS4	NA-VA-TE-CLR	1

NA = Nalidixic acid, VA = Vancomycin, TE = Tetracycline, AML = Amoxicillin, C = Chloramphenicol, CLR = Clarithromycin, N = Gentamicin, CIP = Ciprofloxacin

Table 7: MAR Index analysis of the 30 bacterial isolates obtained from African catfish skin ulcers in Abia state.

S/N	Isolate ID	No. of antibiotic to which the isolate was resistant	MAR Index (a/b)
1.	AH1	4	0.4
2.	AH2	4	0.4
3.	AH3	3	0.3
4.	AH4	4	0.4
5.	AH5	3	0.3
6.	AH6	4	0.4
7.	AH7	4	0.4
8.	EC1	2	0.2
9.	EC2	4	0.4
10	EC3	2	0.2
11.	EC4	3	0.3
12.	EC5	3	0.3
13.	EC6	3	0.3
14.	EC7	2	0.2
15.	EC8	4	0.4
16.	EC9	4	0.4
17.	EC10	4	0.4
18.	EC11	6	0.6
19	SA1	3	0.3
20.	SA2	4	0.4
21.	SA3	3	0.3
22.	SA4	4	0.4
23.	SA5	5	0.5
24.	PS1	4	0.4
25.	PS2	4	0.4
26.	PS3	4	0.4
27.	KS1	5	0.5
28.	KS2	4	0.4
29.	KS3	5	0.5
30.	KS4	4	0.4

MAR = Multiple antibiotic resistance = a/b: a = total number of antibiotics to which the test isolate was resistant; b = total number of antibiotics to which the test isolate has been evaluated for sensitivity.

Discussion

The clinical examination of African catfish samples (20) revealed apparent skin ulcers on the body and fins. These lesions may be attributed to the toxins secreted by the associated bacteria, causing severe pathological changes that appeared on the fish in the form of ulcers.

Good knowledge about prevalence, isolation frequency of the causative agents and treatment options is essential for proper management and control of disease in a susceptible population.

Out of the 5 bacterial genera identified, Aeromonas hydrophila and Staphylococcus aureus are known to be pathogenic to fishes (Shayoet et.al., 2012; Anshary et.al., 2014). Isolation of bacterial organisms from the skin ulcers of African catfish suggests that these bacteria are associated with skin ulcers of African catfish in Abia state. Similar finding was reported by Anyanwu et al., (2014), associating Aeromonas species (bacteria) with skin lesions of African catfish in Southeastern Nigeria. However, five bacterial genera were identified in our study whereas only a genus, Aeromonas was identified in their study. Other genera identified comprise Escherichia, Staphylococcus Klebsiella and Proteus, showing that Aeromonas is not the only potential pathogen causing skin lesions in African catfish. Similarly, five genera of bacteria, comprising Escherichia coli, Staphylococcus, Pseudomonas, Salmonella and Enterobacter, were identified among the 129 isolates from Clarias geriepinus skin and gill cultured in Kumbotso, Kano state (Danba et al., 2014). Also, a study conducted on fish bacteria isolated from Oreochromis niloticus and Clarias gariepinus in Uganda, showed that bacterial pathogens of fish identified include Aeromonas sp, Edwardsiella tarda, and Streptococcus sp. from diseased fish (Wamala et al., 2018). Pathogenic bacteria associated with fish have been classified by Kvenberg (1991) and Rodricks (1991) into indigenous and non-indigenous bacteria. The non-indigenous bacteria which include Escherichia coli, Clostridium botulinum, Shigella dysenteriae, Staphylococcus aureus, Listeria monocytogene, and Salmonella sp contaminate the fish or their habitat; while the indigenous bacteria pathogens are found living naturally in the fish's habitat, for example, Vibrio species and Aeromonas species, which are not harmful to fish but may be harmful to man on consumption (Salihu et al.,2012). The occurrence of Escherichia coli and Staphylococcus aureus observed in this study is an indication of contamination of Clarias gariepinus by man during fish harvesting and handling process. The isolation of enteric organisms such as Escherichia coli is particularly useful as an indicator of feacal contamination (Carla and Mawa, 2016). The results of the antibiogram showed high susceptibility of all the isolates to Nitrofuratoin.Similar findings was reported by Rahman and coworkers (Rahman et al., 2017). All the bacterial isolates exhibited highest resistance to Vancomycin, Nalidixic acid and Tetracycline). Contrary to our findings, a 100% sensitivity of Aeromonas hydrophila, Staphylococcus aureus and Proteus sp. to Vancomycin was reported in Anambra state (Chioma et al., 2021). Furthermore, the antibiotic sensitivity tests conducted revealed drug resistance to two or more antibiotics among the 30 strains of bacteria, belonging to the genera *Aeromonas, Escherichia, Staphylococcus, Klebsiella* and *Proteus.* These findings agree with reports from several studies carried out in Nigeria that bacterial isolates from diverse environmental samples, such as *E. coli, Staphylococcus aureus, Proteus vulgaris, Streptococcus pyogenes, Bacillus cereus, Klebsiella sp, Micrococcus sp, Pseudomonas aeruginosa, Enterobacter sp, Streptococcus*

equi and *Bacillus subtilis*, exhibited high levels of multiple-drug resistance (Lateef, 2004; Adewoye and Lateef, 2004; Lateef et al., 2005; Lateef et al., 2006). This multidrug resistance exhibited by these bacterial isolates could have resulted from acquisition of multidrug resistance genes from microbes in the environment since the aquaculture is often loaded with microbes (Su et al., 2011). The relatively high level of resistance to antimicrobial agents as observed in this study suggests a high level of abuse of these antimicrobial agents in the environment. The prolonged practice of using low doses of antibiotics for a long period of time for growth promotion and arbitrary use of antibiotics in animal husbandry is a strong contributor to the development of the antibiotic resistant bacteria in the environment. Olatoye and Basiru (2013) reported that 100% of catfish farmers in Ibadan Southwest, Nigeria routinely administers several antimicrobial agents to their fish for disease prevention, treatment and productivity performance. This indiscriminate practice may not be different among catfish farmers in Abia state, Southeast, Nigeria. The inherent danger associated with indiscriminate use of antibiotic growth promoters is manifold as this practice encourages the development of multi-drug resistant strains of bacteria that are easily transferred to susceptible consumers such as humans, other animals and the environment. The establishment of multi-drugs resistance strains in humans, animals and the environment would pose a great threat to one health and the economy.

Conclusion

. Five genera of pathogenic bacteria were associated with skin ulcers namely, *Aeromonas hydrophila, Escherichia coli, Staphylococcus aureus, Proteus spp* and *Klebsiella spp*. These isolates have acquired multidrug resistance to antibiotics possibly due to abuse of antimicrobial agents in animal husbandry and aquaculture. The sanitary conditions under which fishes are reared or cultured in ponds should be improved by following standard or good practices, such as use of good quality water, use of feeds with high microbial quality, regular draining of pond water after specific period of time and closure of pond to the public. The long-age practice of using antibiotics as growth promoters in aquaculture should be discouraged. Isolation and identification of causative agents and determination of the antimicrobial profile of bacterial organisms associated with African catfish skin ulcers is essential for effective antibiotic treatment.

Acknowledgements

The authors acknowledge the Head and the laboratory Technologists, Department of Veterinary Microbiology, College of Veterinary Medicine, MOUAU, for their technical assistance and expert advice.

Conflict of Interest

The authors declare no conflicts of interest regarding the publication of this work.

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