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Prevalence of Bacterial Pathogens Associated to African Catfish Hatcheries in Akure, Ondo State

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Abstract

Fishes are cheap sources of protein and are commonly reared in artificial pond in Nigeria. Bacterial infested fishes have been a serious public health concern. This study therefore aimed to determine antibiotic susceptibility of isolated fish bacteria in Akure metropolis and discovered various bacterial pathogens infecting Clarias gariepinus (African catfish). Bacteria were isolated from fish body parts after aseptically collecting 100 fish samples from ten hatcheries and ten water samples. Conventional biochemical testing and visual criteria were used to identify the isolates. The Kirby-Bauer disc diffusion method was used to test antibiotic susceptibility of chosen microorganisms. Salmonella spp., Enterobacter spp., Klebsiella spp., B. subtillis S. pneumonia, B. cerceus Shigella spp., S. macesens were all tested for susceptibility to four of the most regularly used antibiotics in Akure metropolis: Ciprofloxacin, Ampicilin, Chloramphenicol, and Tetracycline.

Ciprofloxacin is resistant against Salmonella spp. and Enterobacter spp. Ciprofloxacin susceptibility is intermediate in Enterobacter spp. and Klebsiella spp., S. pneumoniae, B. cerces, Shigella spp., and S. macesens. Enterobacter spp, Klebsiella spp, and B. subtillis are vulnerable to Ampicillin, but Salmonella spp, S. pneumonia, B. cerces, Shigella spp, and S. macesens are resistant. At least five (5) of the eight antibiotics tested were effective against all isolates. Fish bacteria in Akure metropolis were susceptible to some antibiotics, while others had intermediate susceptibility, and all were resistant to tetracycline, which was the most commonly used antibiotic in all hatcheries sampled, according to the survey. Antibiotic resistance is the result of antibiotic abuse.

This found resistance is most likely indigenous to those bacteria, implying that fish microorganisms from the research area have low levels of acquired antibiotic resistance.

During one stage of production or another, all of the hatcheries sampled experienced mass mortality. The majority of them died as a result of antibiotic resistance, with up to 60% of them dying. Therefore, antibiotics should not be used in hatchery processing in order to control acute cases of bacterial infection in hatcheries without being hampered by antibiotic resistance, and to reduce the risk of spreading antibiotic-resistant germs to the human population through fish products.

Keywords: *Antibiotic susceptibility, fish, Pathogens, Clarias gariepinus (African catfish).*

Words Count: *344*

Introduction

Clarias gariepinus belong to the family Claridae, the air breathing catfish. They belong to a superorder called the Ostariophysi, which also includes the Cypriniformes, Characiformes, Gonorynchiformis andGymnotiformes, a super order characterized by the weberian apparatus (Samuel et al,2023). They are a diverse group of rayfinned fish named for their prominent barbells which resembles a cat's whiskers. Catfish range in size and behavior from the heaviest and longest Mekong giant catfish of south east Asia to the smallest parasitic fishcommonly known as Candiru. All catfishes have either smooth or armored naked bodies with bony plate. The dorsal and pectoral fins are often edged with sharp spines that are used for defense.

Among all other major protein food items such as eggs, milk, meat, and other products, fish is one of the cheapest sources of animal protein. It is a good source of high biological value protein (Cleube, 2008). Freshwater fish was also discovered to be an essential source of animal protein for human diet. Fish is crucial for livelihoods, income, and food for the rural poor, who suffer disproportionately from undernutrition, especially micronutrient deficiencies, in many low-income nations with water and fishery resources (Thompson and Subasinghe, 2011). Fish is by far the most often consumed animal source among these demographic groups, and thus contributes to the diversity of everyday meals, which are dominated by carbohydrate-rich staples. As a result, fish might be regarded an indispensable animal source, delivering critical elements with high bioavailability that are otherwise scarce in the diet. Animal protein, vital fats, minerals, and vitamins are among these nutrients.

In many parts of the world, aquaculture has evolved as a significant industrial force for environmental, economic, and social transformation (Inese, 2010). Aquaculture has grown at a faster rate than all other animal food-producing sectors, according to FAO (2007), with an average global annual growth rate of 8.8% every year since 1970, compared to only 1.2 percent for catch fisheries. Advances in hatchery technology and pond husbandry aided the subsector's growth, which began in 1975. (Ataguba et. al., 2009).

The tale of aquaculture in Nigeria is fundamentally the story of catfish culture, and the future of Nigeria's fish supply is dependent on its growth and culture. Recent global patterns show a decrease in landings from capture fisheries, indicating that fish stocks have reached or even exceeded their maximum sustainable yield.

Fish is the most important animal-source food in the diets of over one billion people, according to Tacon & Metian (2009). Humans rely heavily on fisheries resources for both macro- and micronutrients. Fish contributes for around 17% of animal protein consumption worldwide. In many countries, however, this percentage reaches 50%. Despite the low total African per capita consumption indicated above, the amount of dietary protein derived from fish is relatively high in West African coastal countries: The contribution is also significant in Asia and some tiny island states: 70% in the Maldives, 60% in Cambodia, 57 percent in Bangladesh, 54% in Indonesia, and 55% in Sri Lanka.

As a result, aquaculture remains the sole viable option for growing fish output in order to meet people's protein needs. The Claridae family of catfishes is the most widely grown fish in Nigeria. The constant rise in catfish culture in Nigeria is helping to drive the growth of aquaculture in the country. Inadequate seed supply for stocking and feeding used to be a serious issue. Despite the hurdles, tremendous progress is currently being achieved. Disease is the leading cause of economic loss in aquaculture, with bacterial infections accounting for the majority of cases.

Bacteria are a diverse group of prokaryotic microorganisms. Bacteria come in a variety of shapes, ranging from spheres to rods and spirals, and are typically a few micrometres long. Bacteria were among the first life forms on Earth, and they can be found in almost every habitat. Bacteria can be found in soil, water, acidic hot springs, radioactive waste, and the deepest parts of the Earth's crust (Fredrickson et al., 2004). Bacteria also coexist with plants and animals in symbiotic and parasitic interactions. Only around half of bacterial phyla have species that can be cultured in the lab (Rappé et al., 2003).

A gram of soil normally has 40 million bacterial cells, while a millilitre of fresh water contains a million. On Earth, there are around 51030 bacteria (Whitman et al., 1998), generating a biomass that dwarfs that of all plants and animals. Bacteria play an important role in several stages of the nutrient cycle, such as the fixation of nitrogen from the atmosphere. The decomposition of dead bodies is part of the nutrition cycle, and microorganisms are responsible for the putrefaction stage.

Bacteria are found in abundance in all natural systems, including water, soil, and air.

From the freezing and thawing of Arctic permafrost (Rivkina et al., 2000) to the near-boiling waters and high acidity levels of hot springs, many species face harsh environmental conditions (Roeselers et al., 2007). Bacteria occur inside most species and are typically advantageous to nitrogen fixation in plants and digestive function in mammals (Franche et al., 2009). (Cummings & MacFarlane 1997). A species of Carnobacterium, for example, is a common intestinal microbe in Atlantic Salmon (Salmo salar) and has been shown to reduce pathogen growth in fish, making it suitable for use as a probiotic in some aquaculture operations (Robertson et al., 2000). Some bacteria, on the other hand, can produce diseases that are damaging or fatal to the creatures they infect.

Enteric septicemia and columnaris, caused by *Edwardsiella ictaluri* and Flavobacterium column, respectively, are the most frequent diseases in Channel Catfish (Ictalurus punctatus), accounting for the biggest economic losses in aquaculture (Schrader 2008). Aeromonas salmonicida, a common bacteria, produces ulcers in salmonid and non-salmonid fish species.

The increasing human population need a greater food supply, prompting an expansion in aquaculture (Goldburg & Naylor 2005). The aquaculture business must be intensified in order to feed the world's growing human population. With this escalation come the drawbacks, such as a higher risk of disease outbreak. Antimicrobials have been used by the aquaculture industry to address this. Antimicrobials are used to treat catfish at a rate of up to 114000 kg per year, with an industry-wide estimate of 200,000 kg per year (Benbrook 2002).

Bacterial pathogens have wreaked havoc on the Catfish hatchery, and it's critical to identify the most common ones so that infections may be controlled. Despite the fact that several catfish hatcheries profess to adopt biosecurity, disease outbreaks continue to be worrying, indicating that either the precautions are inadequate, inappropriate, or ineffective against the prevalent pathogen. Because there is a lack of information on the common biosecurity measures used by catfish hatcheries in south-western Nigeria, as well as their appropriateness and efficiency against widespread infections, this study is critical.

The main objective

The main objective of the study is to determine the prevalence of bacterial pathogens associated to African catfish hatcheries in Akure, Ondo State

Specific Objectives

The objectives of this study are:

(1) To identify bacteria associated with catfish hatcheries and evaluate their prevalence
(2) To evaluate antibiotic sensitivity profile of identified bacteria
(3) To investigate biosecurity measures employed in catfish hatcheries in Akure

MATERIALS AND METHOD

Study Area

This study was carried out in Akure. Akure, the capital of Ondo State, a survey of harmful bacteria associated with African Catfish hatcheries was carried out. Akure is a major commercial city in Nigeria, with a land area of approximately 3, 026.6km2 and a population of 43,191 people (NPC, 2006). It is located at latitude 70 151 N and longitude 50 151 E. Because of its tropical rain forest environment, Akure is ideal for catfish cultivation.

With African Catfish hatcheries in Akure metropolis, harmful bacteria were isolated and identified. The research areas were chosen using a stratified random sampling procedure. The city of Akure is divided into two (2) Local Government Areas (LGAS). Samples were taken from African catfish hatcheries that were actively producing fish seed in the designated Local Government Areas (LGAs) in Akure metropolitan, as shown in Figure 3.1 of the selected African catfish hatcheries for this investigation.

Method of data collection

A questionnaire was distributed to ten hatcheries in the Akure metropolitan region of Ondo State in order to obtain information about the farm, its activities, and biosecurity measures in place.

In the Postgraduate Laboratory of the Department of Microbiology, Federal University of Technology, Akure, bacteriology and water quality tests were performed

RESULTS

4.1 Hatchery facilities and biosecurity measures

The ten hatcheries used for this study are spread across Akure's two local governments: Akure North and Akure South. The land area of the hatcheries sampled varies greatly, ranging from 100m2 to three acres (30,000m2). Sixty percent of the hatcheries studied operate on less than one acre, while the other forty percent operate on one to three acres. Table 4.1 shows the results.

Recirculating aquaculture systems, timber vats, and/or fiber glass tanks are not used in any of the hatcheries studied. As stated in table 4.2, 16.7% utilize an earthen pond for seed production, whereas the majority (83.3%) use a concrete tank.

In the generation of catfish seed, the source of water is critical. Borehole and well water are the only sources of water used in the catfish hatcheries sampled, as indicated in figure 4.1. Borehole is used by the majority of hatcheries (83 percent), whereas well is used by the remaining 17%. None of them rely on rain, streams, reservoirs, or other sources of water.

Table 4.1: Land size of sampled hatcheries

Farm Size	Frequency	Percentage
Less than 1 acre	6	60.0
Between 1 and 3 acres	4	40.0
Greater than 3 acres	0	0.0
Total	10	100.0

4.2 Hatchery management practices

In terms of the source of broodstock and the quarantine of their broodstock, the management procedures of the sampled hatcheries are shown in figure 4.2 and table 4.3, respectively. None of the hatcheries obtain their parent stock from outside Nigeria; instead, 38 percent utilize farm-raised parent stock, 33 percent get it from other farms in the state, and 29 percent get it from outside Nigeria but within the state. All of the hacheries sampled, even those that employ farm-raised parent stocks, claimed to quarantine their parent stock prior to use.

Table 5 shows that 20% of respondents had less than a year of experience. Only 10% of the respondents have more than 10 years of experience, with 50% having 1-5 years of experience, 20% having 6-10 years of experience, and only 10% having more than 10 years of experience.

This suggests that 70% of respondents have no more than 5 years of experience managing catfish hatcheries.

As shown in Table 6, 90 percent of respondents said they have an average annual capacity of 0-50,000 seeds, while the remaining 10% said they have an average annual capacity of 51,000-100,000. Despite the huge capacity of numerous hatcheries, none of the responders produce more than 100,000 seeds each year. All of the hatcheries that were tested employed Artemia as a beginning feed. None of them employ live zooplankton, compounded fry feed, fishmeal, or other similar ingredients.

Table 4.2: Culture system use in sampled hatcheries and their percentage

Culture System Type	Frequency	Percentage
Earthen Pond	2	16.7
Concrete	10	83.3
Fibre Glass Tank	0	0.0
Wooden Vat	0	0.0
Recirculating Aquaculture System	0	0.0
Total	10	100.0

4.3 Incidence of mass mortality of fry

100% of respondents have experienced mass mortality at one time or the other in their course of production (table 4.10). This usually happen after siphoning, sorting, water change etc. 12.5% of respondents claim they don’t see any physical sign on the fry before the mass mortality, 12.5% report pale look, 12.55 report sluggishness while majority (62.5%) report slughishness as the sign that precede the mass mortality as shown in table 4.6. Majority of the hatcheries, 71.4% experience mass mortality within the first two weeks of the fry life while only 28.3% experience it after two weeks. 20% of the respondents revealed that they experience between 0%-20%

mortality, 30% of them experience between 21%-40% mortality, while exactly half (50%) of them experience between 41%-60% mortality rate figure 4.2)

Table 4.3: Percentage of hatcheries that quarantine parent stock before use

Response Category	**Frequency**	**Percentage**
Yes	10	10.0
No	0	0.0
Total	10	100.0

4.4 Water quality parameters

The highest and lowest dissolved oxygen levels found in the samples were 5.4 mg/l and 4.2 mg/l, respectively, and came from farms 7 and 1. Farm 9 had the greatest mean alkalinity of 121 mg/l, whereas farm 1 had the lowest alkalinity of 75 mg/l. The pH ranged from 6.96 to 7.92, with farms 4 and 8 recording the highest and lowest values. Farms 3, 4, 6, 9, and 10 have ammonia levels that above the acceptable range of 0.04 mg/l for freshwater fish aquaculture.

In the event of a disease epidemic, 59 percent of respondents utilize antibiotics, 17 percent use chemicals such as formalin, potassium permanganate, hydrogen peroxide, and others, 12 percent employ botanicals, and another 12 percent improve management procedures (figure 4.3)

Table 4.4: Years of experience of sampled hatchery managers

Number of Years	Frequency	Percentage
Less than 1 year	2	20.0
Between 1 and 5 years	5	50.0
Between 6 and 10 years	2	20.0
Greater than 10 years	1	10.0
Total	10	100.0

4.5 Antibiotic and chemical use in sampled hatchery

Table 15 shows that formalin is used by four of the respondents. Potassium permanganate is used in four of them. They don't utilize lime in any of them. Eight of them use ordinary salt. Malachite green is used by one respondent, whereas neither phosphide nor other compounds are used by the others.

Table 4.5: Starter feed used in sampled hatcheries

Starter Feed Type	**Frequency**	**Percentage**
Artemia	10	100.0
Ready made compounded fry feed	0	0.0
Fish meal	0	0.0
Freshwater zooplankton	0	0.0
Egg yolk	0	0.0
Other	0	0.0
Total	10	100.0

4.6 Antibacterial susceptibility test

Susceptibility testing was performed on all of the bacteria isolated, including salmonella spp., Enterobacter spp., Klebsiella spp., B. *subtillis* S. *pneumonia*, B. cerceus Shigella spp., and S.

macesens, using four of the most commonly used antibiotics in Akure, namely Ciprofloxacin, Ampicilin, Chloramphenicol, and Tetracycline, and the zone (Table 4.11). Salmonella spp. and Enterobacter spp. are resistant to Ciprofloxacin, according to the CLSI interpretive chart. Ciprofloxacin susceptibility is intermediate in Enterobacter spp. and Klebsiella spp., S. pneumoniae, B. cerces, Shigella spp., and S. macesens. Enterobacter spp, Klebsiella spp, and B. subtillis are vulnerable to Ampicillin, but Salmonella spp, S. pneumonia, B. cerces, Shigella spp, and S. macesens are resistant. Chloramphenicol susceptibility was found in all of the isolated bacteria, but tetracycline resistance was found in all of them. The bacteria isolated were susceptible to formalin, potassium permanganate, and malachite green in the same way that one or more of the above-mentioned medications were. Tetracycline resistance was expected because tetracycline was the most often used antibiotic in all of the studied hatcheries.

All the fish samples collected had high microbial load and there was coliform bacteria in all. The highest bacterial load was observed in hatchery 10 while the lowest was observed in hatchery 5. However despite having the highest bacteria load in hatchery 10, percentage coliform was the lowest. The opposite trend was observed in hatchery 5 where despite having the lowest bacteria load the percentage coliform bacteria was observed. According to table 4.10, all the hatcheries (100%) have experience mass mortality. Although none of the hatcheries experience mass mortality always, 60% of the sampled hatcheries experienced mass mortality very often while the remaining 40% experienced it less often.

Table 4.6: Annual production capacity of sampled hatcheries

Average Annual Capacity	Frequency	Percentage
0-50,000 seeds	9	90.0
51,000 – 100,000	1	10.0
101,000 – 200,000	0	0
200,000 and Above	0	0
Total	10	100.0

4.7 Microbial load on fish body

The bacterial flora of the catfish obtained from the ten farms was somewhat similar. The gram–negative rod shaped bacteria dominated all populations. In total, 8 bacteria genera were identified from pond water, skin, gill and intestine. The bacteria isolates were Streptococcus sp., Escherichia coli, Salmonella sp., Staphylococcus sp., Pseudomonas sp., Serratia sp., Klebsiella sp., Shigella sp. , Enterococcus sp., Proteus sp. The bacteria isolates obtained from pond water and are almost similar to parts of the fish. The highest frequency and most prevalent of bacteria count was recorded in Farm 6 while the least frequency of bacteria count was recorded in Farm 5 (Table 4.15).

Table 4.7: Table showing various times mass mortality occur in sampled hatcheries

Day	**Frequency**	**Percentage**
5-8	1	14.3
9-12	4	57.1
13-16	2	28.6
Total	7	100.0

Table 4.8: Signs noticed by hatcheries managers prior to mass mortality

Sign Noticed	Frequency	Percentage
Loss of Appetite	5	62.5
Sluggishness	1	12.5
Pale look	1	12.5
No physical sign	1	12.5
Total	8	100.0

Table 4.9: Water quality parameters results of culture fish water of the farms

Farms	DO	Temperature	Alkalinity	Nitrate
Farm 1	4.2^{f}	28^{a}	75^{f}	0.04^{bc}
Farm 2	5.3^{ab}	26^{bc}	73^{g}	0.03^{c}
Farm 3	4.9^{cd}	25^{c}	85^{d}	0.035^{bc}
Farm 4	5.0^{c}	27^{ab}	92^{c}	0.05^{ab}
Farm 5	4.6^{e}	26^{bc}	108^{b}	0.04^{bc}
Farm 6	4.8^{d}	26^{bc}	93^{c}	0.03^{c}
Farm 7	5.4^{a}	25^{c}	84^{d}	0.04^{bc}
Farm 8	5.2^{b}	28^{ab}	79^{e}	0.05^{ab}
Farm 9	5.0^{c}	$26b^{c}$	121^{a}	0.06^{a}
Farm 10	$4.9c^{d}$	$26b^{c}$	121^{a}	0.04^{bc}

Superscript with same letter in the same column does not significantly differ.

Table 4.10 Number of hatcheries that have experienced mass mortality

Response Category	Frequency	Percentage
Yes	10	100.0
No	0	0.0
Total	10	100.0

Table 4.11: Frequency of mass mortality

Frequency of Occurrence	Frequency	Percentage
Always	0	0
Very often	6	60.0
Less often	4	40.0
Rarely	0	0

Never	0	0
Total	10.0	100.0

Table 4.12: Various chemicals used in sampled hatcheries

Chemical	Frequency	Percentage
Formalin	4	23.5
Potassium permanganate	4	23.5
Lime	0	0.0
Common salt	8	47.1
Malachite green	1	5.9
Phosphide	0	0.0
Others	0	0.0
Total	17	100.0

Table 4.13: Common antibiotics use in sampled hatcheries

Antibiotics	**Frequency**	**Percentage**
Tetracycline	10	100.0
Oxytetracycline	0	0.0
Ciprofloxacin	0	0.0
Enrofloxacin	0	0.0
Total	10	100.0

Table 4.14: Microbial load of fish body part

Farms	Total viable Bacteria Count (Cfu/ml)	Total Coliform (Count cfu/ml)
1	36.00 ± 2.00^{ab}	15.00 ± 3.00^{ab}
2	60.50 ± 6.50^{c}	15.00 ± 2.00^{ab}
3	41.50 ± 1.50^{b}	14.00 ± 4.00^{a}
4	40.50 ± 1.50^{b}	14.00 ± 4.00^{a}
5	30.00 ± 2.00^{a}	26.00 ± 6.00^{b}
6	130.00 ± 0.00^{f}	59.00 ± 1.00^{d}
7	110.00 ± 1.00^{e}	39.50 ± 1.50^{c}
8	58.00 ± 4.00^{c}	19.50 ± 1.50^{ab}
9	81.00 ± 3.00^{d}	14.50 ± 4.50^{a}
10	133.50 ± 1.50^{f}	16.50 ± 1.50^{ab}

Values were presented as mean±standard error, values in the same column carrying same superscript are not significant different according to new Duncan’s Multiple Range test at $p<0.05$

Table 4.15: Biochemical characterization of bacterial isolated from fish

Biochemical and cultural characterization of bacterial isolates

Gram stain	**Shape**	**Spore**	**Indole**	**Nitrate**	**H_2S production**	**Citrate**	**Methyl-red**	**Voges-Proskauer**	**Oxidase**	**Glucose**	**Manitol**	**Maltose**	**Sucrose**	**lactose**	**Motility**	**Pigment colouron NA**	**Presumptive identification**
-	Rod	-	-	+	+	+			-	+	+	+	-	-	+	Gray white	*Salmonella* spp.
-	Rod	-	-	-	-	+	-	-	-	+	+	+	+	+	+	creamy	*Enterobacter* spp.
-	Rod	-	-	+	-	-	+	-	-	+	-	+	-	+	+	Slimy white	*Klebsiella* Spp.
+	Long rod	+	-	+	-	+	-	-	-	+	+	+	+	-	+	White spreading	*Bacillus subtilis*
+	chain Cocci	-	-	+	-	-	-	-	-	+	+	+	+	+	-	Grey beaded	*Streptococcus pneumonia*
+	Long rod	+	-	+	-	+	-	-	-	+	-	+	-+	-	+	White to yellow	Bacillus cereus
-	Short rod	-	-	+	-	-	+	-	-	+	±		+	-		Gray to brown	*Shigella* spp.
-	Short rod	-	-	+	-	+	±	±	-	+	+		-	-	+	White then red	*Serratiamacescens*

Treatments	**Bacterial isolates**							
	***Salmonella* spp.**	***Enterobacter* spp.**	***Klebsiella*Spp.**	***B. subtilis***	***S. pneumonia***	**B. cereus**	***Shigella*spp.**	***S.macescens***
Ciprofloxacin	20.00±3.00^{a}	24.00±1.00^{c}	23.00±2.00^{b}	19.00±3.00^{bc}	25.00±0.00^{c}	22.00±0.40^{b}	25.00±0.00^{a}	21.00±2.00^{b}
Oxytetracycline	18.00±2.00^{a}	20.00±2.00^{bc}	18.00±2.00^{ab}	18.00±2.00^{b}	17.50±1.50^{a}	17.75±1.75^{a}	21.00±0.00^{a}	12.00±2.00^{a}
Malachite green	21.00±2.00^{a}	18.20±0.80^{b}	19.50±1.50^{b}	24.30±0.30^{d}	21.00±2.00^{abc}	21.00±0.00^{ab}	22.00±1.00^{a}	16.00±3.00^{ab}
$KMNO_4$	20.00±0.00^{a}	10.00±0.00^{a}	23.00±2.00^{b}	18.35±0.35^{b}	17.00±0.00^{a}	20.20±0.80^{ab}	24.00±2.00^{a}	19.00±2.00^{b}
Formalin	19.00±2.00^{a}	18.00±0.00	23.00±1.00^{b}	24.00±0.00^{cd}	21.00±0.00^{abc}	22.00±2.00^{b}	20.00±2.00^{a}	21.00±0.00^{b}
Ampicillin	22.25±0.25^{a}	12.00±2.00^{a}	12.00±3.00^{a}	8.00±0.00^{a}	24.00±1.00^{c}	18.20±0.80^{ab}	20.00±1.00^{a}	18.00±1.00^{ab}
Chloramphenico	21.00±3.00^{a}	23.00±2.00^{bc}	18.00±2.00^{ab}	21.15±0.15^{bcd}	22.00±2.00^{bc}	19.00±0.00^{ab}	24.00±1.00^{a}	19.00±2.00^{b}
Tetracycline	21.35±0.35^{a}	20.00±2.00^{bc}	18.00±0.00^{ab}	24.00±2.00^{cd}	19.25±0.75^{ab}	20.00±1.00^{ab}	22.00±3.00^{a}	21.00±0.00^{b}

Values were presented as mean standard error, values in the same column carrying same superscript are not significant different according to new Duncan's Multiple Range test at p <0.05

CONCLUSION AND RECOMMENDATION

CONCLUSION

The bacteria infecting African catfish hatcheries were identified, and the antibiotic susceptibility of selected fish bacteria was established in Akure. This data is critical for fish illness management in the state and serves as a baseline for future comparison. Major fish bacterial infections are common in Akure Catfish hatcheries, which could contribute to the state's observed decrease in fish productivity. Although fish bacteria in Akure are highly susceptible to a variety of antibiotics, the increased intensification of fish farming has accelerated the emergence and spread of antimicrobial resistance, and the introduction of resistant bacteria from the terrestrial environment is a likely scenario in the near future.

RECOMMENDATION

Controlling fish bacterial infections, as well as the growth and acceleration of antibiotic resistance in fish bacteria, should be a priority in Akure. Focus on non-antibiotic alternative control techniques for bacterial infections in catfish should be encouraged. Antibiotics should not be used in hatchery processing in Akure in order to control acute cases of bacterial infection in hatcheries without being hampered by antibiotic resistance, and to reduce the risk of spreading antibiotic-resistant germs to the human population through fish products.

The isolated bacteria must be characterized, including pathogenicity studies, in order to fully comprehend their implications for fish and human health in the country. In larger research, antibiotic susceptibility for each bacterial species should be assessed. In addition, future research should focus on using more reliable bacterium identification methods, such as 16S rRNA gene sequencing, to fully understand the problem.

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