Field Trials For The Treatment of Bacterial Gill Disease and Skin Ulceration in Farmed Carp in Basra Governorate, Iraq

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Abstract

This study summarizes field trials for treating bacterial gill disease and skin ulceration in mud fish farms using a modified method of the Dutch-made antibiotic oxytetracycline with a concentration of 50%, compared to the standard method of administering the antibiotic with feed by adding the antibiotic to the feed at a concentration of 2 g and 3 g/kg of feed for seven to ten days. The affected farms were divided into three categories or stages of infection (mild, moderate, and severe) based on mortality rates and infection severity. The study showed that the classic or standard treatment method, which relied on providing the antibiotic with the food, had completely negative results, as it did not achieve any significant success for the infected farms in the second and third stages. The result was very weak in the farms of the first stage of infection, as only one of the three treated farms recovered (33.3%), while the other two farms did not show any signs of recovery or noticeable improvement, while the treatment completely failed to cure the fish in the second and third stages. The antibiotic was administered systematically, involving withholding food for several days, then spraying the treatment mixed with the water as a fine mist over the entire water surface for specific durations, followed by continued starvation, after which the treatment was administered with feed. The use of a modified antibiotic to treat bacterial gill disease has shown excellent results, with a 100% cure rate and cessation of mortality in mildly infected farms (stage 1 fish), exceeding 94.7% in stage 2 fish farms, and 86.66% in stage 3 fish farms. The same modified technique used to treat bacterial gill disease was also used to treat skin ulceration, yielding excellent results. The fish achieved complete recovery at all stages, meaning that the treatment trials using this method were 100% successful at all stages. Aim of this study is to adopt a new viable and effective method to treatment bacterial gill disease and ulcer disease of cultured common carp fish.

Key words: Fish diseases, Treatment, Bacterial gill diseases, Ulcer disease.

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Introduction

Carp farming in Iraq, and particularly in Basra Governorate, is a significant economic activity that provides an important source of protein for human consumption. It also serves as a vital source of income for many workers in this sector, whether those directly involved in fish farming or those involved in transporting and selling the fish. Fish farming has witnessed steady growth over the past decade in Iraq in general, and in Basra Governorate specifically, thanks to government support, the role of academic institutions in disseminating knowledge in this field, and the farmers' desire to diversify their income sources (Jassim, 2024). The common carp (*C. carpio*) is the most important species of freshwater fish farmed and is a significant source of income for rural communities in the country (Ahmed *et al.*, 2020; Ahmed, 2021). The current development in aquaculture production is accompanied by an increase in infectious diseases, significantly impacting the production, profitability, and sustainability of the global aquaculture sector (Senthamarai *et al.*, 2023). Qi (2002) indicated that the negative impact of diseases has become increasingly serious with the development of intensive aquaculture and the emergence of many hazardous environmental pollutants in recent years, and diseases of farmed fish have become the main problem in the aquaculture sector. Bacteria are the main cause of diseases in fish farms, causing significant economic losses (Al-Jubouri *et al.*, 2024). The main bacterial pathogens responsible for infectious diseases in common carp (*C. carpio*) cause negative economic impacts on aquaculture and reduce fish production (Mahmood *et al.*, 2023). Bacterial gill disease is one of the most serious diseases affecting fish and causes significant losses due to its high virulence, which leads to the death of large numbers of farmed fish due to suffocation. During a study by Jassim, In the 2024 study, which ran from January 2018 to December 2020, fish diseases were examined in fish farms in Basra Governorate, this resulted in the recording of 68 disease cases. Of these, 35 were attributed to bacterial gill disease, 15 to skin ulcers, 12 to inflammatory enteritis, four to high ammonia levels, and two to fin rot. Health problems were reported in 39 fish farms over the three-year period. Many microbial pathogens are known to cause gill diseases, and in many cases, several pathogens or agents can be involved, leading to complex gill disease (O'Halloran *et al.*, 2022). Bacterial gill disease is often accompanied by another bacterial disease, bacterial skin ulceration. Bacterial gill disease (BGD) is a common infectious disease affecting the respiratory system of farmed and wild fish and can lead to Mass mortality and significant economic losses (Bakhtiyar *et al.*, 2021). Bacterial gill disease was first reported by Davis (1926); however, the causative agent was not isolated on bacteriological media until 1978 (Kimura *et al.*, 1978). Most recent studies indicate that bacterial gill disease is the most prevalent disease in fish farms in Basra Governorate (Jassim, 2019; Jassim *et al.*, 2019; Jassim, 2024; Jassim *et al.*, 2025; AlShammari *et al.*, 2019). Although there are variations in the virulence of bacterial gill disease isolates, this disease is primarily considered a production management-related disease (Noga, 1996). Treating bacterial gill disease, in particular, and skin ulceration disease, presents a significant challenge and constitutes a point of

contention. A critical threat to the success of fish farming projects arises when an infection develops into an epidemic, potentially wiping out more than 90% of farmed fish. Oxytetracycline is one of the most widely used and recommended antibiotics for treating fish diseases. It is administered either by injection, through feed, or via water bath (Herwig, 1970). The same researcher indicated that this antibiotic treats both Gram-positive and Gram-negative bacteria. Oxytetracycline is used to treat numerous bacterial diseases affecting fish, such as cold-water disease caused by Cytophaga psychrophila, bacterial hemorrhagic septicemia, columnaris disease (*Chondrococcus columnaris*), invasive putrefactive catfish (*Edwardsiella tarda*), furunculosis, infections caused by Pseudomonas bacteria, red mouth disease in trout, and ulcerative lesions. Oxytetracycline is effective against Haemophilus piscium and Vibriosis, as well as Saprolegnia, and acts as a fungicide against some protozoa, such as the parasite Ichthyophthirius.

This study aims to present field trials for treating these two diseases, conducted over nine consecutive years, with an excellent success rate. These trials can be used to treat two of the most significant diseases facing the fish farming sector in Iraq, thus preventing farmers from incurring substantial losses due to the damage caused by these diseases, particularly bacterial gill disease.

Materials And Methods

A field trial was conducted to treat bacterial gill disease and skin ulceration in mud fish farms using a modified 50% concentration of the Dutch-made antibiotic oxytetracycline. This was compared to the standard method of administering the antibiotic with feed. Disease cases in the fish farms were divided into three stages: mild infection (present but without mortality), moderate infection (present but with daily mortality reaching up to 50 fish), and severe infection (daily mortality exceeding 50 fish and potentially reaching 250 fish). Because absolute mortality counts are not comparable between farms of different size and stock, these thresholds were also expressed relative to the estimated standing stock of each farm (pond area × stocking density, i.e. approximately 9,600–28,000 fish per farm): a daily mortality of 50 fish corresponds to approximately 0.18–0.52% of the stock per day, and 250 fish to approximately 0.89–2.60% of the stock per day. Daily mortality rate was therefore calculated for each farm as (number of dead fish per day ÷ estimated number of fish stocked) × 100. Diagnosis was made in the field on the basis of clinical signs and gross lesions of the gills and skin. list the signs recorded, e.g. respiratory distress, crowding at the water inlet and surface, swollen gills with excess mucus, pale or necrotic gill filaments, and skin ulcers, together with the previous isolation and molecular identification of the bacterial gill disease pathogen from cultured common carp in earthen ponds in the same governorate (Jassim *et al.*, 2025). The number of farms in the first, second, and third stages was 20, 19, and 15 respectively, with areas ranging from 8 to 20 dunams per farm. Fish stocking densities were similar, ranging from 1200 to 1400 fish per dunam, with a weight of 150 to 250 grams. The standard method for treating bacterial gill disease was used in three farms from the first stage, four farms from the second stage,

and three farms from the third stage. This involved adding the antibiotic to the feed at a concentration of 2 g and 3 g/kg of feed for seven to ten days, and the results were recorded. A modified method included withholding the feed for three days with a partial water change to reduce the bacterial load in the water and treat superficial infections of the gill tissues. Another treatment method used the same antibiotic in two stages: first, the antibiotic was sprayed onto the surface of the ponds by mixing it with the water and using a manual or electric sprayer to create a fine mist at a concentration of half a kilogram per dunam/day for three days in the first stage of infection, five days in the second stage, and seven days in the third stage. Water removal was to be stopped for at least twelve hours between each treatment period. After the spraying process is complete, feeding is withheld for three days. Then, feed is provided along with treatment according to the standard method for three days in the first stage, five days in the second stage, and seven days in the third stage of infection. The fish are then left without food for three days, after which feed is provided at 25% of the fish's nutritional requirements, gradually increasing to the required 5% of their total body weight. Pre-prepared floating feeds containing the antibiotic were used. These feeds were thoroughly ground and kneaded, with a small amount of flour added to improve consistency. The feed was then spread on a clean surface, and the antibiotic was added at a concentration of 2 mg/kg. The feed was kneaded again and then spread out to be mixed with a small amount of oil to prevent the antibiotic from leaching into the water. The results of treatment using both methods were recorded and compared, and the effectiveness of each method was studied based on the mortality rate achieved after treatment. Replace the antibiotic in the spraying stage only with Tetramethylammonium chloride and complete the treatment with food using the antibiotic to determine the effectiveness of this treatment compared to the antibiotic in reducing the bacterial load in the water and to prevent the production of resistant strains when antibiotics are used repeatedly.

Water quality: Water temperature (22-25°C), dissolved oxygen (5-7mg/L), pH (7-8.1) during study.

Statistical analysis: The farm was the experimental unit. The outcome was complete recovery, defined as cessation of mortality and disappearance of clinical signs by the end of treatment. Recovery proportions were calculated for each method and infection stage, with 95% confidence intervals (95% CI) by the Wilson score method. Recovery with the modified and standard methods was compared within each stage and for all stages combined using Fisher's exact test, and differences among the three stages within the modified method were tested using the Fisher–Freeman–Halton exact test. Differences were considered significant at $P < 0.05$. Analyses were performed in Python (SciPy and statsmodels).

Results and Discussion

The study showed that the classical or standard treatment method, which relied on administering antibiotics with feed, yielded entirely negative results. It achieved no significant success in infected farms in the second and third stages of infection, and the results were very poor in farms in the first stage of infection, where only one of the three treated farms recovered (33.3%; 95% CI 6.1–79.2%), while the remaining two farms (66.7%) showed no signs of recovery or noticeable improvement, while the treatment completely failed to cure the fish in the second and third stages. The use of the antibiotic in the modified form showed excellent results, with a 100% recovery rate and cessation of mortality in farms with mild infection (first-stage fish), exceeding 94.7% in the second-stage fish farms and 86.66% in the third-stage fish farms (Figure 1; Table 1). Recovery with the modified method was significantly higher than with the standard method in the first stage (20/20 vs. 1/3 farms; Fisher's exact test, P = 0.012), the second stage (18/19 vs. 0/4; P < 0.001) and the third stage (13/15 vs. 0/3; P = 0.012), and for all stages combined (51/54, 94.4%, 95% CI 84.9–98.1% vs. 1/10, 10.0%, 95% CI 1.8–40.4%; P < 0.001). Within the modified method, the decrease in recovery from the first to the third stage was not statistically significant (Fisher–Freeman–Halton exact test, P = 0.18). The small number of farms treated with the standard method results in wide confidence intervals. The results mentioned above are based on the number of farms where complete recovery and cessation of mortality were achieved. This required 12 days in farms in the first stage, 16 days in farms in the second stage, and 20 days in farms in the third stage of infection. Results of the standard method and 95% confidence intervals are given in Table 1.

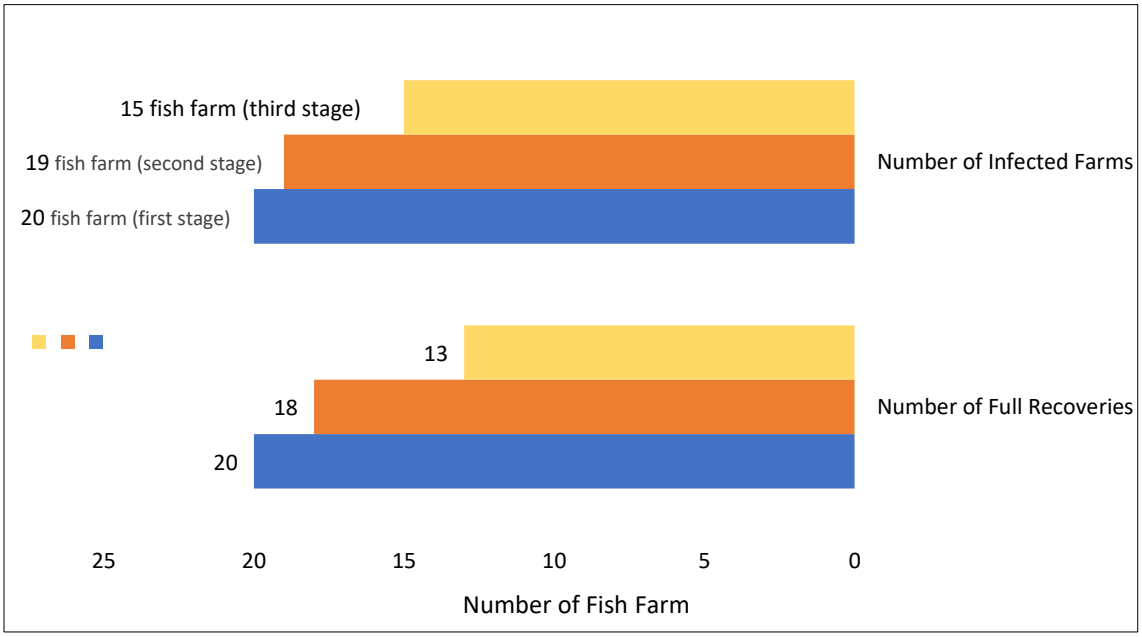


Figure 1: Number of infected farms and farms that recovered after treatment with the modified method, by infection stage (first stage n = 20, second stage n = 19, third stage n = 15).

Table 1: Recovery of farms with bacterial gill disease treated with the modified and standard methods, by infection stage (farm = experimental unit).

Infection stage	Method	Farms treated (n)	Farms recovered (n)	Recovery % (95% CI)	P (Fisher's exact)
First (mild)	Modified	20	20	100 (83.9–100)	0.012
	Standard	3	1	33.3 (6.1–79.2)	
Second (moderate)	Modified	19	18	94.7 (75.4–99.1)	<0.001
	Standard	4	0	0 (0–49.0)	
Third (severe)	Modified	15	13	86.7 (62.1–96.3)	0.012
	Standard	3	0	0 (0–56.1)	
All stages	Modified	54	51	94.4 (84.9–98.1)	<0.001
	Standard	10	1	10.0 (1.8–40.4)	

*95% CI: Wilson score confidence interval. P values compare the modified and standard methods within each stage and for all stages combined. Difference among stages within the modified method: Fisher–Freeman–Halton exact test, P = 0.18.

The results of using ammonium tetrachloride as a spray alternative to antibiotics were identical to those of using antibiotic sprays. This indicates that this treatment is highly effective in reducing the bacterial load in the water and can be used alternately with antibiotics when infection recurs after recovery to prevent the development of resistant bacterial strains.

The same modified technique used to treat bacterial gill disease was also applied to treat skin ulceration, yielding excellent results. The fish achieved complete recovery at all stages, meaning that this treatment method was 100% successful in all phases.

The modified treatment method was designed according to three principles or stages: first, cutting off nutrient sources through starvation or feeding cessation; second, reducing the bacterial content in the water by spraying the antibiotic onto the water surface as a fine mist, ensuring uniform distribution of the treatment throughout the water column, thus treating superficial tissue inflammation; and third, treating systemic infections by administering the antibiotic along with the feed. Withholding feed for a reasonable period was designed primarily for two main purposes: first, it effectively prevents the availability of nutrients to bacteria, which are known to multiply exponentially; and second, infected fish already have a reduced appetite or refuse to feed in severe cases. Experimentally, it was also observed that mortality rates increase with feeding. Using either the antibiotic or

ammonium tetrachloride as a spray applied to the entire water surface of infected tanks proved highly effective when used in this manner. Numerous experiments were conducted to add the above treatments in different ways, such as adding them to the tank supply pumps or directly into the tanks, but these yielded entirely negative results. Spraying the surface of the pond water ensures the treatment reaches the entire water mass. This method is experimentally considered the best for reducing the bacterial content in the water, thus providing both a preventative measure to stop the spread of infection to healthy fish and a curative one, as the treated water will pass over the gills and skin of the fish. The modified treatment method, implemented in two phases (withholding food before and after spraying, and spraying the treatment), has, based on the results obtained, contributed to reducing infection, weakening the bacterial content, and superficially disinfecting infected tissues. This allows for systemic treatment through feeding, which is readily available and effective. Hungry fish consume all the treated feed, meaning the highest or even the full concentration of the feed reaches them. Therefore, the treatment absorbed in the intestines is more efficient.

When comparing the modified treatment method with the traditional method involving feeding the medication with food, the results show a very significant difference in efficiency and a clear advantage for the field-tested modified method. Feeding fish with feed treated with oxytetracycline at a laboratory rate of 2 g/kg twice daily resulted in a gradual decrease in bacterial load in the pond water, gills, intestines, and skin of the fish, suggesting that oxytetracycline may be an effective antibiotic for reducing bacterial load in fish (Haque, 2014).

Oxytetracycline is a broad-spectrum antibiotic widely used in aquaculture to treat bacterial infections in fish, including bacterial gill disease. Treatment via medicated feed has demonstrated its ability to reduce mortality rates and decrease bacterial load in infected fish populations (Herwig, 1979; Plumb, 1999). (Noga, 2010) However, the most important field-based features of these differences are that the recovery rate is absolutely higher and the mortality rate stops completely after treatment, unlike the traditional method where mortality rates continue to increase. In addition, treatment with the modified method ensured the prevention of recurrence in the short term. The excellent treatment results in farms with minor infections (first-stage fish), where the recovery rate and cessation of mortality were 100%, and exceeding 94.7% in second-stage fish farms and 86.66% in third-stage fish farms, explain the role played by continuous monitoring of fish health, as early diagnosis of diseases provides a greater chance of successful treatment and avoiding losses. The lower treatment success rate in the third stage compared to the first and second stages is due to the fact that the infection caused irreparable damage to the gill tissues, leading to death by suffocation. The sharp increase in infection and mortality rates coincides with the appearance of the following gill lesions: extensive bacterial colonization of the gill surfaces, watery degeneration and necrosis of the gill epithelium, and gill edema. In contrast, lesions were observed Other changes in the gills, such as lamellar fusion, epithelial hyperplasia, and various metastatic responses,

subsequently appear either as subacute (3-5 days) or chronic (7-14 days) changes (Spare *et al.*, 2006). On the other hand, treatment of gill ulcer disease was successful at all stages due to the fact that the infection is external and not as severe as bacterial gill disease, which affects vital parts of the fish, causing partial or total dysfunction. It was observed that the most important causes of bacterial gill disease and gill ulcer disease are poor management leading to high nutrient levels in the aquatic environment and consequently high bacterial load in the water, in addition to stress caused by incorrect management practices. The importance of antimicrobial agents in protecting animal health has been widely established, but the negative effects of using these agents in animals raised for food have been and remain a concern (Karunasagar, 2012). The continuous use of antibiotics in aquaculture has led to the development of resistance to them over time (Ying Feng *et al.*, 2022). The use of antibiotics in treating bacterial fish diseases cannot be eliminated without implementing health management programs that prevent the introduction of pathogens by raising disease-free fish from a reliable and certified source and following health monitoring and control programs. Oxytetracycline (OTC) is a commonly used antibiotic in aquaculture for treating bacterial diseases due to its broad spectrum of activity and cost-effectiveness. However, its use for longer than the usual treatment period or at high doses leads to negative changes in immune system indicators and can produce resistant strains, making fish more susceptible to other pathogens (Kurtboğan *et al.*, 2025). Therefore, in this study, ammonium tetrachloride was used as an alternative to the antibiotic when fish farms were infected a second time in successive seasons to reduce the likelihood of producing resistant strains. Herwig (1970) indicated that the dose used for the antibiotic as a daily water bath is 12.5 mg/L and 10-20 mg/L as a long-term bath. In this study, a concentration of 0.13 mg/L daily was used, based on a dosage of half a kilogram per dunam (approximately 0.25 acres) at a depth of 1.5 meters. This represents a significant difference in the amount of antibiotic used and a lesser impact on the development of resistant strains. Furthermore, the elimination period, or reduction of antibiotic effects on consumers, will be shorter at the time of fish harvesting. The same researcher indicated that its use should be discontinued 21 days before slaughtering fish for human consumption. This method is the culmination of numerous practical experiments in treating fish diseases, including bacterial gill disease and bacterial ulceration. It has proven beyond doubt to be the most effective method available, is easily applicable, and has saved many fish farming projects from significant losses that could have led to their failure.Conclusion:

The method used in field trials for treating bacterial gill disease and bacterial skin ulceration has proven highly effective over years of use, saving many fish farms from losses and project failures. Therefore, we recommend its use, but in a controlled manner to avoid the development of resistant bacterial strains. Based on the study results, the above mentioned method is effective, provided that, upon recurrence of infection, the spraying with oxytetracycline is replaced with ammonium tetrachloride as a precautionary

measure. This reduces the chances of developing resistant strains and has the same effect as the spraying treatment.

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Declaration of Competing Interest

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المستخلص

تمثل الدراسة خلاصة تجارب ميدانية لعلاج مرض الغلاصم البكتيري ومرض تقرح الجلد في مزارع الاسماك الطينية باستخدام المضاد الحيوي Oxytetracycline هولندي المنشأ بتركيز 50% لكن بطريقة محورة ومقارنتها مع الطريقة القياسية المعروفة التي تتضمن تقديم المضاد الحيوي مع الغذاء من خلال اضافة المضاد الحيوي مع العليقة بتركيز 2 غم و 3 غم / كغم علف لمدة سبعة–عشرة ايام. قسمت المزارع المصابة الى ثلاث فئات او مراحل من الاصابة (بسيطة ومتوسطة وشديدة) حسب نسبة النفوق وشدة الاصابة. بينت الدراسة ان الطريقة الكلاسيكية او القياسية للعلاج والتي اعتمدت على تقديم المضاد الحيوي مع الغذاء كانت نتائجها سلبية تماما اذ لم تحقق اي نجاح يذكر للمزارع المصابة في المرحلتين الثانية والثالثة وكانت النتيجة ضعيفة جدا في مزارع المرحلة الاولى من الاصابة اذ شُفيت مزرعة واحدة فقط من اصل ثلاث مزارع معالجة (33.3%) ولم تظهر المزرعتان الاخريان اي علامات شفاء او تحسن ملحوظ بينما فشلت المعالجة تماما في علاج الاسماك في المرحلة الثانية والثالثة. استخدم المضاد الحيوي بطريقة منهجية تتضمن قطع الغذاء لايام ثم رش العلاج المخلوط مع الماء على شكل رذاذ على كامل سطح الماء لمدد محددة ثم الاستمرار بالتجويع بعد ذلك يقدم العلاج مع الغذاء. ان استخدام المضاد الحيوي بالطريقة المحورة لعلاج مرض الغلاصم البكتيري اظهر نتائج ممتازة حيث كانت نسبة الشفاء وتوقف النفوق 100% في المزارع المصابة بشكل بسيط (اسماك المرحلة الاولى) وتجاوز 94.7% من مزارع اسماك المرحلة الثانية و86.66% من مزارع اسماك المرحلة الثالثة. استخدمت نفس التقنية المحورة في علاج مرض الغلاصم البكتيري لمعالجة مرض تقرح الجلد واعطت نتائج ممتازة جدا حيث اكتسبت الاسماك الشفاء التام لكل المراحل مما يعني ان نتيجة تجارب العلاج بهذه الطريقة كانت ناجحة بنسبة 100% لكل المراحل. تهدف هذه الدراسة إلى اعتماد طريقة جديدة قابلة للتطبيق وفعالة لعلاج مرض الخياشيم البكتيري ومرض القرحة في أسماك الكارب الشائع المستزرعة.

الكلمات المفتاحية: أمراض الأسماك، العلاج، أمراض الخياشيم البكتيرية، مرض القرحة.

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