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Review article

A review on antibiotics removal during biological waste water treatment

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SUMMARY

The elimination of antibiotics from wastewater is a critical process aimed at alleviating environmental pollution and safeguarding public health. Different ways and technologies such as advanced oxidation processes, membrane filtration, biological treatment and antibiotics chemical treatment are employed to effectively eliminate antibiotics from wastewater. In addition to safeguarding human health from any potential negative consequences linked to water sources tainted with antibiotics, this is crucial to stopping the spread of antibiotic resistance in natural ecosystems, such as farmlands and water bodies. Antibiotics removal from wastewater is not without its difficulties. One of such difficulty is the antibiotics' escape during the treatment of organic waste water. Regular processes like organic filtration, coagulation, flocculation and sedimentation cannot eliminate antibiotics completely. The use of modern biotechnological discoveries such as nanotechnology is needed for complete removal of antibiotics from waste water.

Keywords: antibiotics, antibiotics resistance, waste water treatment, pollution.

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INTRODUCTION

Biological waste water treatment

Biological waste water treatment is a procedure that uses microorganisms to degrade organic contaminants in wastewater [1]. This method relies on the natural ability of bacteria, fungi, and other microorganisms to consume and metabolize organic matter, converting it into simpler, less harmful substances like carbon dioxide, water, and biomass. Activated sludge, trickling filters, and sequencing batch reactors are the three most popular kinds of biological treatment systems [2]. It involves harnessing the natural processes of microorganisms to degrade and remove organic pollutants from wastewater.

Biological wastewater treatment is a versatile and widely used method for treating various types of wastewaters, ranging from municipal sewage to industrial effluents, offering effective removal of organic pollutants with minimal chemical inputs and energy consumption [3].

1.1 Process involved in the treatment of wastewater using biological agents:

1.1.1 Microbial growth: The process begins with the introduction of microorganisms, typically bacteria and sometimes fungi into the wastewater. These microorganisms are either naturally present (autochthonous) in the wastewater or are added (allochthonous) to the system [3].

1.1.2 Aerobic and anaerobic conditions: Depending on the particular treatment technique used, biological therapy can take place in either anaerobic (without oxygen) or aerobic (with oxygen) settings. Anaerobic treatment is slower and creates methane gas, although it can be more economical for some waste kinds. Aerobic treatment is more popular and successful, but it may need more energy for aeration [4].

1.1.3. Organic matter degradation: The microorganisms consume the organic pollutants present in the wastewater as their food source. These pollutants include various organic compounds such as fats, proteins, carbohydrates, and other complex organic molecules [5]

1.1.4. Metabolism and biochemical reactions: As the microorganisms metabolize the organic matter, they enzymatically break down complex molecules into simpler compounds through biochemical reactions. These reactions often involve oxidation, reduction, hydrolysis, and other processes [6].

1.1.5 Biomass formation: The bacteria multiply and expand as they devour organic debris, building up a biomass inside the treatment system. The active microbial population that breaks down contaminants makes up this biomass [7]

1.1.6 Biodegradation products: The organic pollutants are transformed into simpler, less harmful substances such as carbon dioxide, water, biomass, and inorganic compounds. These products are either assimilated by the microorganisms for their growth or released into the treated effluent [8].

1.1.7 Effluent clarification: After biological treatment, the treated wastewater is clarified to remove the biomass and any residual suspended particulates from the liquid effluent. This might include settling, filtering, or other separation processes [9].

1.1.8 Disinfection (Optional): Depending on the intended reuse or discharge of the treated wastewater, disinfection may be performed to reduce the concentration of pathogenic microorganisms. Common disinfection methods include chlorination, UV irradiation, ozonation, and others [10]

1.1.9 Final effluent discharge or reuse: According to Kavindra *et al.*, the treated effluent may be safely released into receiving water bodies or repurposed for a variety of non-potable uses, including industrial operations, irrigation, and toilet flushing. The effluent has undergone considerable reduction in organic contaminants and pathogens.

1.2 Importance of Biological Waste Water Treatment

In addition to encouraging sustainable growth and adherence to legal requirements, biological wastewater treatment is essential for safeguarding the environment, public health, and water resources [12]. Biological wastewater treatment is important for the following reasons:

1.2.1 Pollution control: By eliminating pathogens, nutrients, and organic contaminants from wastewater before it is released into natural water bodies, it helps to reduce environmental contamination [13]. Public health and aquatic habitats are safeguarded by this method.

1.2.2 Compliance with regulations: Many countries have regulations and standards in place that mandate the treatment of wastewater before discharge. Biological treatment provides an effective means of meeting these regulatory requirements [14].

1.2.3 Resource recovery: The recovery of important resources from wastewater, such as nutrients (phosphorus and nitrogen) and energy (biogas produced from anaerobic treatment), can be aided by biological treatment procedures, these materials may be recycled or used, supporting sustainability initiatives [15].

1.2.4 Cost-effectiveness: In many cases, biological treatment can be more cost-effective compared to chemical or physical treatment methods. It often requires less energy and fewer chemical inputs, making it a preferred option for wastewater treatment, especially in large-scale applications [16].

1.2.5 Versatility: Biological treatment systems are versatile and can be tailored to treat various types of wastewater, including municipal sewage, industrial effluents, and agricultural runoff. They can also adapt to fluctuations in wastewater characteristics and flow rates.[17]

1.2.6 Public health protection: Waterborne illnesses and the pollution of drinking water sources are decreased by biological treatment of wastewater, which eliminates pathogens and dangerous microbes [18].

1.2.7 Sustainability: Biological treatment aligns with principles of sustainability by relying on natural processes and minimizing the use of chemicals. It also promotes the reuse and recycling of water and nutrients, contributing to a more sustainable water management approach [19]

2.0 Biological wastewater treatment

Biological wastewater treatment is an important step in the wastewater treatment process that removes pollutants from sources like residences, companies, and other sources [20]. To eliminate any impurities that remain after primary treatment, it is also known as the Secondary Treatment Process [21]. Whereas biological treatment employs microorganisms to break down wastewater impurities, chemical treatment of waste water uses chemicals to react with pollutants present in the wastewater. In order to convert unstable organic wastes into stable inorganic forms through regular cellular processes, this therapy uses bacteria, nematodes, algae, fungi, protozoa, and rotifers [22]. Methods for biologically treating wastewater can be broadly divided into two categories based on the process involved:

1. Biological Aerobic Treatment (in presence of oxygen)
2. Biological Anaerobic Treatment (in absence of oxygen)

2.1 Biological Aerobic Treatment: The biological process of treating wastewater by aerobic means occurs in the presence of oxygen. Biological waste treatment is the fastest and most effective method available, eliminating up to 98% of organic pollutants. Compared to anaerobic treatment, this method effectively breaks down organic contaminants and produces a cleaner water effluent. Numerous procedures are involved in aerobic biological treatment, including trickling filters, aerated lagoons, oxidation ponds, and activated sludge processes. The activated sludge technique is the most commonly utilized for home and industrial wastewater. Aerobic biological treatment will be efficient and stable under all conditions [23].

a. Activated sludge process: The most popular biological waste treatment in the secondary stage of wastewater treatment is the activated sludge technique [24]. A multi-chamber reactor unit that uses highly concentrated microorganisms to break down organics and remove nutrients from wastewater in order to produce high-quality effluent is known as an activated sludge process. According to Larisa *et al.*, [25], this method involves aerating sewage that contains organic matter and bacteria in an aeration tank using a mechanical aerator. This procedure expedites the breakdown of trash. Pumping air into a tank is the basis of aeration in an activated sludge process, as it encourages microbiological growth in the wastewater. Sludge, or the aeration tank's effluent containing the flocculent microbial material, is separated in a settling tank, also known as a clarifier or secondary settler. The activated sludge method is a highly portable, reasonably priced, and effective biological treatment technology for treating sewage and waste water.

b. Trickling filters: This sort of aerobic treatment, also known as percolating or sprinkling filters, is the second most popular kind. Following basic treatment, these filters are frequently employed to remove substances like ammonia from water. Either a digest or a secondary effluent will enter once it settles [26].

c. Aerated lagoons: It is a method of treating waste or wastewater that is aerobic and biological. An aerated lagoon is a treatment pond that has mechanical aeration installed to add oxygen to the water and encourage the wastewater's biological oxidation. Aerated pond effluent can be recharged or reused, but settled sludge needs additional treatment.

d. Oxidation pond: Bacteria, algae, and other organisms that consume the organic stuff in the primary effluent interact in the ponds. Because the wastewater these ponds produce can be put to other uses, they are also productive. Large tracts of land are needed, and the procedure is generally slow. Oxidation ponds are typically utilized in places with sparse populations and plenty of open land [27].

2. Biological Anaerobic Treatment: Using organisms that can survive without oxygen, this treatment method effectively reduces the strength of wastewater. Usually, it does this to the point where the effluent may be released into a municipal sewer system. In comparison to aerobic treatment, very little sludge is generated. Anaerobic therapy happens in numerous phases and is a long process. Wastewater treatment facilities use the biological process of anaerobic digestion to stabilize and break down sludge. The effluent can go through a variety of additional treatments after the procedure is finished. Because it can stabilize the water with minimal biomass production, this approach is allowed. In the anaerobic process, biogas is generated when the bacteria consume the biodegradable material. In all, the process produces carbon dioxide (CO_2) and methane (CH_4) from between 40% and

60% of the organic materials. In comparison to aerobic treatment, very little sludge is generated. Anaerobic treatment happens in numerous phases and is a long process. Wastewater treatment facilities use the biological process of anaerobic digestion to stabilize and break down sludge. After the procedure is finished, the wastewater might go through a variety of further treatments. Because it can stabilize the water with minimal biomass production, this approach is allowed. In the anaerobic process, biogas is generated when the bacteria consume the biodegradable material, the procedure yields methane (CH_4) and carbon dioxide (CO_2) from between 40% and 60% of the organic materials [28].

Whether anaerobic or aerobic biological treatment is chosen for wastewater treatment, it is determined by a number of parameters, including adherence to environmental discharge quality standards[29].
Additional steps, such as UV and chlorination treatment, as well as a variety of filtering choices, such as carbon filtration, reverse osmosis, and ultrafiltration, are frequently added to biological treatments [22].

3.0 Methods for Removing Antibiotics During Biological Wastewater Treatment

3.1 Biological treatment

During biological therapy, the two main mechanisms for removing antibiotics are sludge adsorption and biodegradation [30]. Based on their varying oxygen requirements, biological treatments can be broadly categorized as aerobic, anaerobic, or hybrid techniques. The biological aerated filter system is the primary aerobic technique (BAF). The anaerobic digestion (AD), anaerobic blanket reactor (ABR), anaerobic filters (AF), and up flow anaerobic sludge blanket (UASB) processes are the primary anaerobic technologies. The membrane bioreactor (MBR) and sequencing batch reactor (SBR) procedures are the most widely used combined aerobic and anaerobic techniques. The BAF, AD, SBR, and MBR processes are now the most widely utilized methods for eliminating antibiotics from breeding wastewater, according to [20].

3.1.1 Biological aerated filter system (BAF)

The BAF system is a novel approach to treating sewage that combines filtration and biological contact oxidation. It is divided into three stages: a liquid phase that submerges the solid substance, a gas phase that allows air to enter, and a solid phase that promotes microbial growth. Its tiny size, high level of automation, and cheap running costs are its advantages. The packing encourages the adsorption of sludge due to its strong biofilm adhesion ability and wide specific surface area, which results in a relatively high antibiotic removal efficiency. For instance, the total antibiotic clearance rate using the BAF procedure can reach 89%–91% with a HRT of 40–48 hours and an HLR of 2.8 cm/h [31].

3.1.2 Anaerobic digestion process (AD)

The four steps of anaerobic digestion are
a) Acetic acid and methane production
b) Hydrolysis
c) Acidification,
d) Hydrogen creation.
Since less sludge is produced and no additional aeration equipment or energy investment is needed, the AD process is more advantageous than the conventional activated sludge approach for treating wastewater. Even yet, the ecosystem may still be harmed by the treated wastewater and sludge remnants. The TC and QN

removal rates from wastewater by AD have been reported to be 65% and 85%, respectively, under the following conditions: 1.38–2.16 kg chemical oxygen demand (COD)/m3·d, an operating temperature of 37±1 ∘C, and a HRT of 16 d, [31].

3.1.3 Sequencing batch reactor process

Sewage enters the aeration reaction tank (or tanks) in batches as part of the sequencing batch reactor system. The SBR reactor runs in the following five stages: sludge settling, aerobic phase, anoxic phase, influent feeding, and effluent discharge [32]. Although the SBR process is flexible and saves energy and land, it is difficult to administer and control. Pork wastewater was treated in a prior work using a lab-scale intermittently aerated sequencing batch reactor. The TC removal rate was 88% with a HRT of 3-5 days and a minimum COD load; removal through sludge adsorption and biological degradation accounted for 30% and 58% of the removal, respectively [31].

Huang *et al.,* reported an SM removal rate of around 96%, with biodegradation accounting for nearly all of the removal.

3.1.4 Membrane bioreactor process

A membrane bioreactor process is a kind of biological wastewater treatment technique that blends biological and contemporary membrane separation technologies. The MBR's high energy consumption and operating expenses are drawbacks, but its benefits include a long sludge retention period, flexible operation, low sludge production, and good nitrification performance. According to a prior study, MBRs have a high efficiency of removal (>90%) for SM and TC from swine wastewater, however their removal of QN was less effective (<70%) when the HRT was 33–51 hours. The ability to combine various procedures with existing technology has improved the removal of antibiotics from wastewater used in breeding. For instance, some researchers have compared the efficiency of biofilm MBRs (BF-MBRs) with conventional MBRs in the removal of antibiotics from piggery effluent. Antibiotic removal rates related with the BF-MBR were 87%, 80%, and 45% when the HRT was 5–4, 3–2, and 1d; in contrast, the rates linked with the MBR were only 84%, 57%, and 26%. According to Huang *et al.*, the primary variables influencing the effectiveness of biodegradation are HRT, sludge content, membrane type, water quality (temperature, pH value), and antibiotic properties. A longer sludge retention period and a larger biomass concentration can both enhance the interaction time between the microorganisms and antibiotics, hence improving the removal efficiency of antibiotics. For example, with a 5-day HRT and a COD/total nitrogen ratio of 2.1, an intermittent aeration membrane bioreactor (IAMBR) had a total antibiotic removal rate of 78% to 80%. When the HRT was lowered to three days, the clearance amount of total antibiotics decreased considerably to 4%-53%. Previous research indicated that while using the SBR method to treat swine wastewater, the concentration of suspended matter and pH of the solution affected the removal efficiency of activated sludge. The SMZ clearance rate increases as the concentration of suspended solids increases. The pH of the solution influences the shape of SMZ and surface characteristics of activated sludge, impacting its removal efficiency[33].

These research studies have demonstrated that the biological technique is selective in antibiotic removal, with process and environmental conditions having a significant impact on removal efficiency. As a result, its ability to remove antibiotics from breeding effluent is limited. More research is needed to increase the elimination efficiency of antibiotics using biological techniques [31].

3.1.5 Antibiotics chemical treatment

The chemical treatment method is based on the chemical reaction that occurs between pollutants and chemical oxidizing agents or reactive oxides generated during the reaction process. This reaction breaks down the chemical structure of the pollutants and further transforms them into small, harmless molecules that are non-toxic or achieve complete mineralization and removal, ultimately serving the purpose of harmless treatment or pollutant degradation. Advanced oxidation and strong oxidant oxidation are two common chemical treatment techniques. This section provides an overview of the study and implementation of two distinct chemical treatment techniques for the elimination of antibiotics from water, along with information on the removal mechanism, influencing factors, and treatment efficacy [34].

3.1.6 Strong oxidant oxidation method

This method involves breaking down the chemical structure of the antibiotic to target its electrophilic group, and cause oxidative degradation, the strong oxidant oxidation approach primarily depends on the oxidant's strong oxidizing property. Chlorination has been employed in the investigation of antibiotic degradation in addition to water disinfection [34]. Previous studies have shown that HCLO interacts quickly and readily with both oxytetracycline and chlortetracycline, two antibiotics possessing electrophilic active groups. In another instance, cefadroxil was effectively removed and the activity of the antibiotic was reduced by electrically generated active chlorine. Comparably, it was discovered by Zheng *et al.*, that electrogenerated active chlorine had a higher rate of antibiotic removal; levofloxacin was removed at a rate of roughly 75%, while ciprofloxacin and norloxacin were removed at a rate that was almost 100%. The chlorination process has a better removal effect on antibiotics, but it also produces byproducts that are frequently more harmful, which restricts its use and furthers study into the technique. For instance, it has been found that the oxidative breakdown product of the antibiotic levofloxacin has a higher biological toxicity than the halogenated disinfection byproducts formed during the chlorination degradation process [35]. Similarly, it was discovered by Zhu *et al.*, that the chlorination breakdown of sulfamethoxazole produces brominated and iodized disinfection byproducts, which are more hazardous than the parent chemical, when bromide and iodide ions are present in the solution [36]. Furthermore, pH plays a significant role in the chlorinated antibiotic elimination process. By influencing the presence of oxidants and the protonation of antibiotics, pH can have an indirect impact on the elimination of antibiotics [34].

3.1.7 Advanced oxidation process (AOPs)

Advanced oxidation process is oxidation technology that uses the primary oxidant to break down and mineralize organic contaminants in water—strong oxidizing hydroxyl radicals (OH) generated in processes. By breaking chemical bonds or causing reactions like electron transfer, addition, and substitution, the OH oxidizes organic pollutants. This results in the pollutants' breakdown into small, easily degradable organic matter molecules as well as CO_2 and H_2O. According to [31] the most popular AOPs for eliminating antibiotics from breeding effluent are the Fenton, ozonation, and electrochemical oxidation processes.

3.1.8 Electrochemical Oxidation

Electrochemical oxidation is a method that produces strong oxidants like OH, HO_2, and O_2- to destroy pollutants using electrode reactions. Previous research by Miyata *et al*., demonstrated that the degradation efficiency of Total chlorine from cattle and poultry wastewater was up to 99% following 6 hours of electrochemical treatment using Na_2SO_4 as the electrolyte and Ti/IrO_2 as the anode. The flow-through electro-oxidation technique effectively eliminated antibiotics such as sulfadimidine and norfloxacin, as well as NH_4+-N and Chemical oxygen demand (COD) [38]. Huang *et al*., found that removing Tetracycline antibiotics (TC), Oxytetracycline (OTC),Chlortetracycline (CTC), and Oxidant level adjustment (OLA) from simulated livestock wastewater with a voltage of 5V, pH of 9, aeration for 3 hours, and electrolysis for 2 minutes resulted in 98%, 91%, 91%, and 99% removal rates, respectively.

The effectiveness of removing antibiotics from wastewater is impacted by coexisting chemicals, according to earlier research. Because the addition of citric acid altered the pH of the wastewater, the maximum OLA, Tetracycline test (TCT), and OTC clearance rates were achieved (69%, 56%, and 58%), when the concentration of citric acid was 0.02 M. The OLA, OTC, TC, and CTC clearance rates peaked at 71%, 68%, 60%, and 74%, respectively, at 0.175 M of acetic acid. The wastewater became more acidic due to overly high acetic acid concentrations, which in turn reduced the rate at which antibiotics were removed by causing competition between the electrode particles for organic matter adsorption. Sodium dodecyl sulfonate (SDS) increased the rate of OLA removal (removal rate was 100% at 0.02 M SDS concentration); however, SDS strongly inhibited the rate of TC removal (removal rate was 25% at 0.02 M SDS dosage). Furthermore, as the concentration of SDS increased, the rate of OTC and CTC clearance reduced [31].

3.1.9 Ozonation process

The direct oxidation of ozone and the indirect oxidation via the production of free radicals are the two processes by which ozone-based antibiotics degrade. Ozone is an electrophilic reactant that can effectively remove antibiotics TC, Sulfonamide (SM), and Quinolone (QN) by attacking their aromatic rings and unsaturated double bonds. Previous research by Huang *et al*., demonstrated that the ozonation technique could remove TC, SM, and QN antibiotics from piggery wastewater at levels as high as 96%–98% with an ozone concentration of 7.8 mg/L and treatment for 20 min [31].

Furthermore, significant volumes of ·OH can be produced by combining the procedure of ozone oxidation with ultraviolet radiation (UV), hydrogen peroxide (H_2O_2), or catalysts, which will then break down organic contaminants. According to earlier studies, the ozone/H_2O_2 coupling system greatly increased the elimination rate of CTC in wastewater from 30% to 65% as compared to ozone oxidation alone [20].

3.1.10 Fenton Process

H_2O_2 and Fe2+, the reagents in the Fenton process, combine to form OH radicals, which oxidise and break down antibiotics. In order to accelerate the breakdown of antibiotics from biogas slurry by microwave-assisted Fenton oxidation, microwave irradiation was used. The removal rates of OTC, TC, CTC, and OLA were 93%, 91%, 88%, and 67%, respectively, at an H_2O_2 concentration of 40 mg/L, Fe^{2+} concentration of 12 mg/L, initial pH of 4, microwave radiation period of 2 minutes, and microwave radiation power of 445 W. Fe^{3+} + OH + OH− Fe^{2+} + H_2O_2. It is easy to see how H_2O_2 and Fe^{2+} doses effect efficiency. Aside from that, the pH influences the reaction rate [31].

In previous studies of microwave-assisted Fenton oxidation of antibiotics in biogas slurry, the H_2O_2 input, Fe^{2+} concentration, and initial pH of the water all affected antibiotic removal efficiency. The removal efficiencies of OTC, TC, CTC, and OLA rose initially before levelling off with an increase in H_2O_2 input. Research has indicated that producing OH is facilitated by a suitable rise in H_2O_2 concentration, which enhances the effectiveness of antibiotic elimination.

The OH generation rose in response to an increase in Fe^{2+} concentration, which raised the four antibiotics' removal efficiency. In contrast, the removal efficacy of the four antibiotics decreased when the water sample's original pH increased. This is so because the initial pH has an impact on Fenton's reagent's oxidation-reduction potential [31].

3.1.11Antibiotic Physical Treatment

The physical treatment of water involves the enrichment and transfer of impurities using physical means. The study applications of three distinct techniques—ionic resins, membrane filtration, and adsorption—for the elimination of antibiotics from water are reviewed in this part. Treatment effectiveness, removal mechanisms, and influencing factors are also covered [39].

Adsorption Method

Adsorption techniques that are based on the characteristics of adsorbent materials have been extensively researched and used in the investigation of antibiotic physical removal. According to [34], adsorbent materials are quick, effective, and affordable for treating antibiotics. In addition to van der Waals forces between adsorbents and adsorbates, electrostatic, hydrogen bonding, Π–Π, and hydrophobic forces, which can effectively adsorb and remove pollutants in water, the majority of adsorbent materials have special and superior physical properties that allow them to provide more active adsorption sites for adsorbates. As a result, the majority of recent studies on antibiotic adsorption use materials based on carbon.

According to earlier studies, compared to double- and multi-walled carbon nanotubes, single-walled carbon nanotubes have a higher porosity and a bigger specific surface area. Single-walled carbon nanotubes had an adsorption capacity of up to 520 mg/L for ciprofloxacin and 375 mg/L for oxytetracycline, respectively. Hydrophobic and electrostatic interactions were the primary mechanisms by which the antibiotics were remove [34].

Membrane Technology

Wastewater flows through tiny membrane pores where contaminants are caught and redirected. Reverse osmosis, ultrafiltration, nano filtration, and microfiltration are the key components of the techniques. The benefits of membrane technology are low cost, low work efficiency, and ease of use [31]. Although there haven't been many reports of membrane technology being used in wastewater treatment facilities to treat antibiotics, there may be uses for the technology in other wastewater kinds as well. For instance, the combination of UV/ozone and nanofiltration with sewage treatment facilities resulted in an 87% antibiotic removal rate, along with 40% reduction in dissolved organic carbon (DOC), 4.6-fold increase in biodegradability, and 58% reduction in ecotoxicity. Membrane technology may also be utilized to eliminate additional contaminants from wastewater utilized in breeding. Previous studies have shown that swine wastewater may be efficiently treated with reverse osmosis and nanofiltration to remove different ARGs, nitrogen, phosphorus, and other contaminants. Consequently, more research was to be done on the use of membrane technology to extract antibiotics from wastewater used in breeding [31].

Ion Resin Method

In addition, studies on magnetic ion exchange resins have started to be applied, and bound antibiotics are also known to exist as ions [31]. The structure of the magnetic ion exchange resin is made up of a polyacrylic acid matrix, magnetization components that have the ability to function as a weak magnet, and a quaternary amine functional group. Magnetic ion exchange resins can quickly absorb contaminants because they have larger specific surface areas and smaller particle sizes than typical ion exchange resins. It was found that the ibuprofen adsorption by magnetic anion resin originated from hydrogen bonding, Vander Waals interaction, electrostatic interaction, and π–π interaction, whereas the sulfadiazine adsorption was primarily attributed to functional groups and effective adsorption sites of resin anion exchange.

Additionally, earlier studies discovered that magnetic cationic resin has an adsorption effect that is 5.5–13.5 times greater than that of monomer adsorption, and it can efficiently remove coexisting copper ions and tetracycline at the same time [31].

4.0 Possible Limitations in the Removal of Antibiotics during Biological WasteWater

Treatment

A few factors may limit the removal of antibiotics during the natural wastewater treatment process. These include the fact that antibiotics degrade slowly in their natural environment, which may contribute to their persistence in soil and water [31]. The wastewater treatment and reproduction capacity is comparatively lower than that of urban water systems, which results in inadequate antibiotic ejection and atmospheric release [31]. Furthermore, factors including ecological factors and process water quality conditions can affect how well antibiotics are expelled. Antibiotics may remain in the profluent due to the inability of standard wastewater treatment facilities to completely remove them [39]. Furthermore, unmetabolized antibiotics that are transferred by humans or other living things may serve as a test for the complete removal of antibiotics from wastewater [39]. Consequently, there are restrictions on the complete removal of these mixes, even though organic wastewater treatment cycles can remove antibiotics through biodegradation and other mechanisms.

5.0 Challenges in the Removal of Antibiotics during Biological Waste Water Treatment

In wastewater treatment facilities, antibiotics are a major natural concern. A few challenges during the treatment of organic wastewater include the removal of antibiotics. As [40] point out, antimicrobials cannot be completely eliminated by routine cycles such as organic filtration, coagulation, flocculation, and sedimentation. Antibiotic deposits in wastewater are also incredibly low, but they nonetheless catch analysts' attention since they can lead to the emergence of microorganisms that are resistant to toxins [41]. Thirdly, a major test is the existence of anti-infection opposition properties and safe microorganisms in crude source water and wastewater treatment facilities [39].

Lastly, compared to the biodegradation method of disposing of personal care goods and medications, the usage of antibiotics is restricted. Finally, the increased discharge of antibiotics is caused by the increasing amount of unmodified dynamic fixes from veterinary and human sources in wastewater [39]. The key to a fantastic evacuation may lie in combining layer procedures with state-of-the-art oxidation cycles, adsorption, and organic medications [40].

6.0 CONCLUSION

According to this study, the performance of wastewater treatment is noticeably impacted negatively when antibiotics are present in the wastewater. Due to the wastewater biological population's ability to develop antibiotic-resistant bacteria, antibiotics in wastewater reduce the growth potential of microorganisms and their concentrations in the bioreactor. Depending on the kind, antibiotics have varying effects on wastewater treatment efficiency.

Biological waste water treatment help in protecting the environment, public health and water resources whereby promoting sustainability development.

Antibiotics are significant natural worry in wastewater treatment plant, the removal of antibiotics during organic wastewater treatment causes difficulties. Regular cycles like filtration, coagulation flocculation and sedimentation cannot completely eliminate antibiotics.

7.0 Future prospects

The future of antibiotic removal from wastewater looks promising as new technologies are being developed to combat antibiotic resistance. Advanced oxidation procodures such as ozonation and ultraviolet irradiation have shown great promise in removing antibiotics from wastewater. Additionally, nanotechnology and bioremediation are other techniques that are being explored for their potential in removing antibiotics. More research could be carried out in this field on how antibiotics can be easily removed from waste water bodies.

REFERENCES

1. Haripriyan U., Gopinath K. , Arun J., and Govarthanan, M. (2022). Bioremediation of organic pollutants: A mini review on current and critical strategies for wastewater treatment. *Archives of Microbiology*, 204(5):286.

2. Hussain A., K., Sachan R., S, and Sachan, A. (2021). Biological wastewater treatment technology: Advancement and drawbacks. In *Microbial Ecology of Wastewater Treatment Plants,* pp. 175-192.

3. Ahammad, S. Z., Graham, D. W., and Dolfing, J. (2020). Wastewater treatment: *Managing Water Resources and Hydrological Systems*, pp. 561-576

4. Samer, M. (2015). Biological and chemical wastewater treatment processes. *Wastewater treatment engineering*, *150*(10.5772): 61250.

5. Dignac, M. F., Ginestet, P., Rybacki, D., Bruchet, A., Urbain, V., & Scribe, P. (2000). Fate of wastewater organic pollution during activated sludge treatment: nature of residual organic matter. *Water research*, *34*(17):4185-4194.

6. Wolfe, N., and Hoehamer, F. (2003). Enzymes used by plants and microorganisms to detoxify organic compounds. *Phytoremediation: Transformation and control of contaminants*, pp. 159-187.

7. Saini, S., Tewari, S., Dwivedi, J., & Sharma, V. (2023). Biofilm-mediated wastewater treatment: a comprehensive review. *Materials Advances*, *4*(6): 1415-1443.

8. Maier, R. M., & Gentry, T. J. (2015). Microorganisms and organic pollutants. In *Environmental microbiology* (pp. 377-413). Academic Press.

9. Rakesh S A, Santosh K S., Shweta S., and Megha S. (2016). Wastewater treatment by effluent treatment plants. *SSRG International Journal of Civil Engineering 3 (12):29-35*

10. Zhuang, Y., Ren, H., Geng, J., Zhang, Y., Zhang, Y., Ding, L., & Xu, K. (2015). Inactivation of antibiotic resistance genes in municipal wastewater by chlorination, ultraviolet, and ozonation disinfection. *Environmental Science and Pollution Research*, *22*:7037-7044.

11. Kavindra K. K., Ramendra S., Qazi Mohammad S.J ., Pooja, T., Jonathan, A.L, Niraj K. J, Mohammed H. S., Pradeep K, Vijay T & Janne R. (2021). Wastewater treatment and reuse: a review of its applications and health implications. *Water, Air, & Soil Pollution 232: 1-28.*

12. Saravanan A., Kumar P., Jeevanantham S., Karishma S., Tajsabreen B., Yaashikaa, P., & Reshma, B. (2021). *Effective water/wastewater treatment methodologies for toxic pollutants removal*: Processes and applications towards sustainable development. *Chemosphere*, *280*, 130595.

13. Amrita P., Yiliang H., Martin J., Martin R & Karina Y. G.(2014). Emerging contaminants of public health significance as water quality indicator compounds in the urban water cycle *Environment international 71, 46-62.*

14. Perry L., Jaeho B & Jeonghwan K. (2011). Domestic wastewater treatment as a net energy producer–can this be achieved? *Environmental science & technology 45 (17):7100-7106.*

15. Ma, H., Guo, Y., Qin, Y., & Li, Y. Y. (2018). Nutrient recovery technologies integrated with energy recovery by waste biomass anaerobic digestion. *Bioresource technology*, *269*: 520-531.

16. Gao, H., Scherson, Y. D., & Wells, G. F. (2014). Towards energy neutral wastewater treatment: methodology and state of the art. *Environmental science: Processes & impacts*, *16*(6): 1223-1246.

17. Younas, F., Mustafa, A., Farooqi, Z. U. R., Wang, X., Younas, S., Mohy-Ud-Din, W., Ashir Hameed, M., Mohsin Abrar, M., Maitlo, A., Noreen, s., & Hussain, M. M. (2021). Current and emerging adsorbent technologies for wastewater treatment: trends, limitations, and environmental implications. *Water*, *13*(2):215.

18. Olaolu, D. T., Akpor, O. B., & Akor, C. O. (2014). Pollution indicators and pathogenic microorganisms in wastewater treatment: implication on receiving water bodies. *International Journal of environmental protection and policy*, *2*(6): 205-212.

19. Jhansi, S. C., & Mishra, S. K. (2013). Wastewater treatment and reuse:

sustainability options. *Consilience*, (10): 1-15.

20. Russell, D. L, (2019). *Practical wastewater treatment*. Global environmental Operations Inc. John Wiley & Sons, pp. 227-229.

21. Ziajahromi, S., Neale P., Rintoul L., & Leusch F. (2017). Wastewater treatment plants as a pathway for microplastics: *development of a new approach to sample wastewater-based microplastics*. Water research, 112:93-99.

22. Jain, D. (2021). Biological Treatment Process for Industrial Waste. *Peer Reviewed & Referred Journal* 8(4):1492-1499.

23. Yarlagadda, V, N., & Manjunath S. (2019). Aerobic granular sludge process: a fast growing biological treatment for sustainable wastewater treatment. *Current Opinion in Environmental Science & Health 12:57-65.*

24. Orhon, D., Babuna, F. G., & Karahan, O. (2009). *Industrial wastewater treatment by activated sludge*. IWA publishing.

25. Larisa S, Y., Veronika Z., Marina, K., Henryk, S. (2019). New approaches in biological wastewater treatment aimed at removal of organic matter and nutrients *Ecological Chemistry and Engineering S 26 (2):331-343*.

26. Bahram R., Ebrahim A. (2021). Wastewater treatment processes—techniques, technologies, challenges faced, and alternative solutions. *Soft computing techniques in solid waste and wastewater management, pp.35-53*.

27. Dalu, J.M & Ndamba J. (2003). Duckweed based wastewater stabilization ponds for wastewater treatment (a low cost technology for small urban areas in Zimbabwe). *Physics and Chemistry of the Earth, 28 (20-27):1147-1160.*

28. Christy, P. M., Gopinath, L. R., & Divya, D. (2014). A review on anaerobic decomposition and enhancement of biogas production through enzymes and microorganisms. *Renewable and Sustainable Energy Reviews*, *34*:167-173.

29. Samer, M. (2015). Biological and chemical wastewater treatment processes. *Wastewater treatment engineering*, *150*(10.5772): 61250.

30. Tiwari, B., Sellamuthu, B., Ouarda, Y., Drogui, P., Tyagi, R. D., & Buelna, G. (2017). Review on fate and mechanism of removal of pharmaceutical pollutants from wastewater using biological approach. *Bioresource technology*, *224*: 1-12.

31. Huang A, Yan M, Lin J, Xu L, & Gong H. (2021). A Review of Processes for Removing Antibiotics from Breeding Wastewater. *International Journal on Environmental Resources and Public Health*. 18(9):4909.

32. Fernandes, H., Hoffmann, H., Antonio, R. V., & Costa, R. H. (2014). The Role of Microorganisms in a Full-Scale Sequencing Batch Reactor Under Low Aeration and Different Cycle Times. *Water Environment Research*, *86*(9):800-809.

33. Polesel, F., Andersen, H. R., Trapp, S., & Plósz, B. G. (2016). Removal of Antibiotics in Biological Wastewater Treatment Systems; A Critical Assessment Using the Activated Sludge Modelling Framework for

Xenobiotics (ASM-X). *Environmental science & technology*, *50*(19): 10316-10334.

34. Huang, S., Yu, J., Li, C., Zhu, Q., Zhang, Y., Lichtfouse, E., & Marmier, N. (2022). The effect review of various biological, physical and chemical methods on the removal of antibiotics. *Water*, *14*(19):3138.

35. Zheng, S., Wang, Y., Chen, C., Zhou, X., Liu, Y., Yang, J., Geng, Q.,Chen, G., Ding, Y., and Yang, F. (2022). Current progress in natural degradation and enhanced removal techniques of antibiotics in the environment: A review. *International Journal of Environmental Research and Public Health*, *19*(17):10919.

36. Zhu, J., Yang, L., Wang, M., Zhang, Q., Zhang, Y., & Li, Y. (2022). The influence of bromide and iodide ions on the sulfamethoxazole (SMX) halogenation during chlorination. *Science of The Total Environment*, *848*, 157687.

37. Miyata, M., Ihara, I., Yoshid, G., Toyod, K., & Umetsu, K. (2011). Electrochemical oxidation of tetracycline antibiotics using a Ti/IrO2 anode for wastewater treatment of animal husbandry. *Water Science and Technology*, *63*(3): 456-461.

38. Lang, Z., Zhou, M., Zhang, Q., Yin, X., & Li, Y. (2020). Comprehensive treatment of marine aquaculture wastewater by a cost-effective flow-through electro-oxidation process. *Science of the total environment*, *722*, 137812.

39. Al-Wasify, R., Alruwaili, M., Aljohani, F., Hamed, S., & Ragab, S., (2023). The Efficiency of Wastewater Treatment Plants for the Removal of Antibiotics. 05/2023 doi: 10.5772/intechopen.111999

40. Nasrollahi, N., Vatanpour, V., & Khataee, A. (2022). Removal of antibiotics from wastewaters by membrane technology: Limitations, successes, and future improvements. *Science of the Total Environment*, *838*, 156010.

41. Awanish, K., and Dharm, P., (2018). Antibiotic resistance and wastewater: Correlation, impact and critical human health challenges. *Journal of Environmental Chemical Engineering*, 6(1): 52-58