

# Amoxicillin and Favipiravir Bio-Degradation by *Aspergillus Flavus* Fungus

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## Abstract

The aim of this study is to isolate and characterize Amoxicillin and Favipiravir biodegrading fungi as well as determine their characteristics and degradation pathways. The antibiotic-degrading fungus *A. flavus* was isolated from polluted wastewater samples using standard Potato Dextrose agar and Czapek–Dox medium. The biodegradation method was investigated in previous mediums with (Amoxicillin and Favipiravir), as the sole carbon sources. Main degradation intermediates were analyzed by high-performance liquid chromatography (HPLC) and used to deduce the antibiotic degradation pathway of strain *A. flavus* fungal hyphae by Scanning Electron Microscopy before and after 7 days of treatment to find out the accumulation of the antibiotic and morphological changes in fungal hyphae. Fungi can use antibiotics as their sole carbon source. Maximum biodegradation was observed at 91% at the lowest concentration of Amoxicillin. According to HPLC results, the *A. flavus* retention time of standard Amoxicillin was 8.12 minutes after biodegradation, when it broke down into other compounds with retention times of 3.75 minutes by 73.25%, 5.81 minutes by 16.44%, and 8.5 minutes by 8.59. According to standard Favipiravir retention time, it appeared in 3.97 minutes, but after treatment, two materials appeared in 2.20 minutes by area: 62.58% and in 6.16 minutes by area: 20.15%. Scan Electron microscopy images regarding treatment with Favipiravir by *A. flavus* showed an accumulation of particles on the fungal hyphae. This investigation gives insights into the improvement of bio-remediation methods to remove antibiotics from wastewater before they are discharged into rivers.

**Keywords:** Antibiotics, Aqueous solution, bio-remediation, fungi, fungal pellets.

## Introduction

In recent decades, the widespread emergence of matters such as pharmaceuticals, pesticides, and other organic pollutants in the aquatic

environment has been recognized as an emerging environmental issue because it can have negative impacts on the ecosystem and

human health<sup>1</sup>. The main source of these compounds is municipal wastewater treatment plants. A conventional wastewater treatment plant is generally designed to remove high concentrations of mainly biodegradable organic compounds<sup>2</sup>. A major source of pharmaceuticals in the environment is the drug manufacturing factories. Previous studies recorded high concentrations of pharmaceuticals reported downstream from a pharmaceutical company of up to 1 mg/L of carbamazepine in the aquatic environment below a pharmaceutical factory<sup>3</sup>. Membrane processes, and activated carbon is considered a promising alternative to remove pollutants from wastewater, but these techniques are expensive and produce by-products, which are still limiting factors in implementing the advanced treatment technologies as an alternative to an effective wastewater treatment process<sup>4</sup>. Wherefore sewage treatment plants may use biological treatment to treat pharmaceuticals that are no longer metabolized<sup>5,6</sup>. In nature, fungi serve as decomposers, mutualists, and pathogens, which

belong to the group of eukaryotic multicellular organisms. They have hyphal filamentous structures, and fungal cell walls contain chitin, which is a carbohydrate polymer consisting of chains. In addition, fungi are heterotrophic, and saprophytes produce analytic enzymes named laccases and ligninolytic peroxidases<sup>7,8</sup>. The cell wall structure of fungi is of great importance because of the natural chemistry of cell walls. As a result, fungi have developed diverse strategies to combat toxic compounds, such as antibiotics in Basidiomycetes involved in the oxidation of a wide range of pollutant compounds with aromatic structures, including polycyclic aromatic hydrocarbons<sup>9</sup>. These strategies include the use of enzymes for enzymatic processes such as adsorption, mineralization (bio-precipitation), and biotransformation.<sup>10</sup> Biosorption into fungal mycelium plays a key role in the removal of bisphenol A and 17-ethinylestradiol until equilibrium is reached<sup>11,12</sup>. The aim of this study is to evaluate the biodegradation of Amoxicillin and Favipiravir by isolated *A. flavus* fungi.

## Materials and Methods

### Fungal Isolates and Fungal Pellets Formation

10 soil samples were taken for this study from the Tigris River in Baghdad, which was polluted with pharmaceuticals, Iraq. After growing fungal isolates were purified and identified based on morphological characteristics, these samples were used to isolate fungi on PDA plates. Two different types of media were used for the growth of fungus, including Potato Dextrose Agar: 200 g of unpeeled, sliced potatoes are boiled in 1 liter of water for 30 minutes. The resulting potato infusion is then filtered through cheesecloth, and the effluent is added together with dextrose, agar, and water. The media was sterilized in an autoclave at 121°C with a flow rate of 15 l/min for 15 minutes, then pouring it into a Petri dish where it can harden before being planted. The yeast extract broth was made by dissolving 20 grams of yeast extract powder and 5 grams of peptone in one liter of distilled water.

The pH of the broth was then corrected to 5.5 by adding drops of 1 M HCL and sodium hydroxide<sup>13</sup>.

### Antibiotics Preparation

Amoxicillin 250 mg as trihydrate by SDI in Iraq was used, and Favipiravir 200 mg by Atabay Pharmaceuticals and Fine Chemicals Inc. in Turkey was used in concentrations of 1 mg/ml in commercially available tablet samples containing the active ingredient. The stock standard solution of favipiravir, which has poor solubility in water, was processed by dissolving it in 70% concentrated methanol. Acetic, boric, and orthophosphoric acids of analytical grade, as well as extremely clean deionized water, were used to create (PBS) buffer (0.04 M in each component, pH 5.5)<sup>14</sup>.

After the DPA culturing was finished, the petri plate was divided into two groups, one of which was used to cultivate *A. flavus*. The other group, however, was

used to work the testes to degrade the antibiotic by fungi pieces. To do this, we made small pits of equal dimensions in the group of petri dishes that did not have any fungal cultivation. of *A. flavus* from the first group.

### Determination of Antibiotics Concentrations by (HPLC) Analysis

A high-performance liquid chromatography method was used to evaluate the amount of amoxicillin and favipiravir eliminated by the fungus. By adding 5 ml of the stock solution to a 250-mL conical flask containing 200 mL of ordinary saline, a concentration of 500 mg/L of antibiotic was attained. Fungal pellets weighing 1 mg were likewise injected and incubated at 25 °C. A 3 mL sample of the culture's aqueous solution was used for the biodegradation investigation after 3, 5, and 7 days. The experiment was conducted using three replicate flasks, each containing fungus pellets and an identical amount of antibiotic. Prior to HPLC analysis, the treated samples were filtered using a 0.45-µm membrane filter. The high-performance liquid chromatography HPLC technique was used to

analyze the antibiotic solution before and after the reaction. The HPLC was performed at a flow rate of 1.0 ml/min for 12 minutes, using a UV detector at 250 nm and a waters model column with symmetry of 250 x 4.6 mm, using methanol as the mobile phase, and a flow rate of 0.1 ml/min for 12 minutes.

Calculating the concentrations of antibiotics extracted by fungus and researching antibiotic removal

$$D = \frac{C_i - C_e}{C_i} * 100$$

where D is the removal percentage,  $C_i$  is the initial absorbance, and  $C_e$  is the absorbance after incubation time<sup>15</sup>.

### Statistical Analysis

Statistical analysis was achieved by using a one-way ANOVA followed by a student t-test to find out the significance difference between different values of incubation periods using SPSS version 16.0 software. Statically significant values were taken at  $P \leq 0.05$ .

## Results and Discussion

### Identification of Isolated Fungal Genera and Its Ability of Pellets Formation

Identifying specific isolates in studies of the morphology of chosen fungi in cotton-shaped colonies in slide culture medium, *Aspergillus niger*, *Aspergillus flavus*, *Aspergillus fumigatus*, *Penicillium* sp., and *Trichoderma* sp. were the five fungal isolates examined for their ability to form pellets. Table. 1, reveals that only *Aspergillus flavus* pellets remained stable after 14 days (after one week). Previous research

demonstrated the Zygomycetes fungi's potential<sup>13</sup>. For this reason, fungal pellet biomass was separated from the culture medium by centrifugation at 4000 rpm for 10 minutes<sup>16</sup>. Antibiotic bio-remediation was assessed by wet biomass of *A. flavus* pellets and absorption by wet and dry biomass at antibiotic concentrations of 250 mg/l and 200 mg/l, respectively. The isolated biomass was then washed three times with normal saline.

**Table 1. Removal percentage D% and fungal Pellets forming of isolated fungi Antibiotics R**

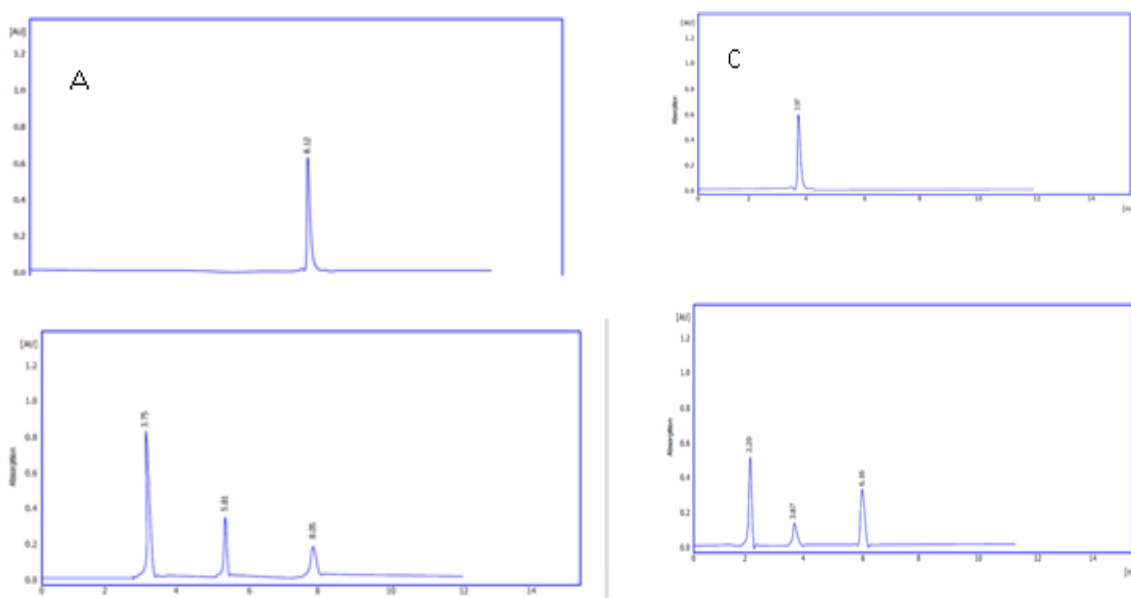
Fungi Isolates	Pellet formation ability after 7 days	Mean ± SD with 250 mg Of Amoxicillin	Mean ± SD with 200 mg Of Favipiravir
<i>Aspergillus niger</i>	Able	66±1.7b	67± 0.7 b
<i>Aspergillus flavus</i>	Able	90 ±0.5a	4.1 ±92 a
<i>Aspergillus fumigatus</i>	able-Non	67±0.3 b	67±0.3 b
.sp <i>Mucor</i>	able-Non	77±b3.1	77 ± 1.1b
.sp <i>Trichoderma</i>	able-Non	87±5.0 b	88±0.3 b

Different letters represent significant 0.05  $\geq$  difference at P .

### Characterization of Antibiotics Bio Degradation by HPLC and SEM

According to the method, the results appeared after fungi activation and antibiotic addition (Amoxicillin, Fig. 1 A: chromatography, Amoxicillin 10 ppm control). Degradation of antibiotics to two types, Amoxicillin and Favipiravir, in both methods, but to varying degrees according to results. The growth of *A. flavus* was active, which means that antibiotic

did not prevent growth, and the fungal enzyme activity is perhaps double the metabolic processes and receiving the degradation. The rationale for using this relatively high concentration range was the possible application of fungal bioremediation technology in the treatment of drug manufacturing effluents. Previous studies indicated that *Aspergillus* species were able to depredate pollutants in aerobic or anaerobic environmental conditions and can produce a high quality of compost by degradation<sup>15,17</sup>.



**Figure 1. Results of High performance Chromatography A: Amoxicillin control, B: Amoxicillin after 7 days of treatment, C: Favipiravir control, D: Favipiravir after 7 days of treatment .**

*Aspergillus spp.* has proven its ability to degrade some chemical materials, such as pesticides and soil compounds. The compounds break down at different rates, depending on their physiochemical properties<sup>18</sup>. By many methods, the removal of chemical compounds can be accomplished by biological or chemical methods<sup>19</sup>. Other researchers confirmed its ability to remove and break down bioremediation of some agricultural and industrial chemicals in soil and show HPLC results, Favipiravir appeared in 3.97 minutes, Fig. 1, but after treating it by *A. flavus* the peak appeared in 2.20 min. by area :62.58% and in

6.16 min. by area: 20.15% Fig. 1. Researchers' observation through the diagram was that Amoxicillin appeared in 8.12 minutes in chromatography HPLC while in treatment by *A. flavus* after the fifth day of treatment HPLC test recorded the peak in 3.75 minutes and 73.25%, in 5.81 minutes by 16.44%, and in 8.5 minutes by 8.59. Fig. 1:A,B. This refers to receiving degradation by fungi because of the formation of another material in less than 8 minutes. According to the results, *A. flavus* was efficient in decomposing Amoxicillin and Favipiravir because of its ability to decompose in environmental conditions (soil, plants) due to its

production of cell wall degrading enzyme<sup>20</sup>. Despite the differences between the two cases in ratio decomposition, *A. flavus* has endoglucanase (EG) and -glucosidase (BGL). Cell degrading enzyme production is the key to speeding up the rate of decomposition<sup>6</sup>.

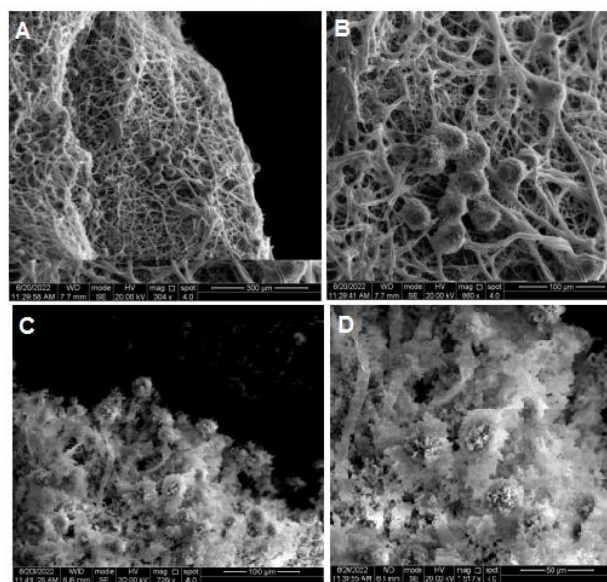
Fungi can degrade organic compounds when activated with enrichment media, and this ability was confirmed in *A. flavus* when the ratio of nutrition: N, P, and K content in the nutritional medium was<sup>21</sup>. The rate of degradation was different between the tested antibiotics, Favipiravir was more than Amoxicillin depending on its solubility and toxicity to the environment, as previous findings showed that degradation of pharmaceuticals by fungi completed in the seventh day of treatment<sup>22</sup>.

In this study, according to decomposition level, it appears in the results of the HPLC chromatography that according to the structure of the antibiotics ( Amoxicillin and Favipiravir) in Fig. 1, fungi cell wall structure can cause antibiotic restriction due to different charge between them, whereas fungi cell wall charge is negative, so the chemical structure of antibiotics contains effective chemical groups, making it easy for fungi to restrict it, and then decomposing it by enzymatic activities, according to the chemical composition of both antibiotics, degradation of it by fungi was easy due to the presence of an effective group and a positive amino group; HPLC refers to that for Favipiravir it is more degradable than other antibiotics<sup>23, 24</sup>.

Results of previous studies and research reported that other fungi like *Tricoderma* produce some active enzymes that can convert material to soluble sugar due to their ability to dismantle proteins since the group that was in Amoxicillin and, Favipiravir has amine proteins<sup>23</sup>. Fungi

produce different types of analytic enzymes involved in antibiotics degradation which improved by the phylogenetic analysis and gene sequencing of these proteins<sup>24,25</sup>.

Other studies confirmed the role of cytochrome P 450 in hydroxylated diclofenac metabolites. Since the presence of hydroxyl group in the chemical structure of both antibiotics, it is expected to receive hydroxylated diclofenac metabolites<sup>26</sup>. In comparison between treating Amoxicillin and Favipiravir, *A. flavus* degradation was better on Favipiravir more than Amoxicillin clearly during HPLC and SEM Fig. 2, resulting in a greater amount of Favipiravir degradation. This may be due to enzymatic activities for fungi that were active in decomposing structural bonds for Favipiravir. As it became clear from SEM Fig. 2, *A. flavus* is able to restrict the antibiotic (Favipiravir) better than Amoxicillin. These findings should encourage sustainable waste management protocols in the agriculture industry and lower environmental pollution<sup>27-29</sup>.



**Figure 2. Scanning Electron Microscope A and B: Control without treatment, C and D: after 7 days of treatment with *A. flavus*.**



## Conclusion

This study confirms that *A. flavus* is a novel amoxicillin flavonol-degrading strain. The production of active compounds and degradation rates vary among the tested antibiotics, with Favipiravir showing higher degradation compared to Amoxicillin. This

discrepancy can be attributed to its solubility and environmental toxicity. These findings offer a new, environmentally-friendly, and cost-effective approach for treating antibiotic wastewater.

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## Authors' Declaration

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are ours. Furthermore, any Figures and images, that are not ours, have been

- included with the necessary permission for re-publication, which is attached to the manuscript.
- Ethical Clearance: The project was approved by the local ethical committee at University of Babylon.

## Authors' Contribution Statement

R. H. H. A. designed the study and S. S. M. A. performed the experiments, analyzed data, and wrote the initial draft of the manuscript. A. M.

J. A. supervised, reviewed and validated the experiment. All authors revised and approved the manuscript.

## References

1. Ben Y, Fu C, Hu M, Liu L, Wong MH, Hung M, et al. Human health risk assessment of antibiotic resistance associated with antibiotic residues in the environment: A review. *Environ Res.* 2019; 169: 483–493. <https://doi.org/10.1016/j.envres.2018.11.040>.
2. Polianciuc SI, Gurzău AE, Kiss B, Ștefan MG, Loghin F. Antibiotics in the environment: causes and consequences. *Med Pharm Rep.* 2020; 93(3): 231. <https://doi.org/10.15386/mpr-1742>.
3. Cardoso O, Porcher JM, Sanchez W. Factory-discharged pharmaceuticals could be a relevant source of aquatic environment contamination: review of evidence and need for knowledge. *Chemosphere.* 2014 ;115: 20-30. <https://doi.org/10.1016/j.chemosphere.2014.02.004>
4. Ikehata K, Jodeiri Naghashkar N, Gamal El-Din M. Degradation of aqueous pharmaceuticals by ozonation and advanced oxidation processes: a review. *Ozone: Sci. Engin.* 2006 Dec 1; 28(6): 353-414. <https://doi.org/10.1080/01919510600985937>.
5. Rakaa J. Preparation of Nanoparticles in an Eco-friendly Method using Thyme Leaf Extracts. *Baghdad Sci J.* 2020; 17(2 (SI)): 0670.
6. Flannigan B. *The Mycota: A comprehensive treatise on fungi as experimental systems for basic and applied research. X. Industrial Applications* edited by HD Osiewacz (hardback) Springer-Verlag, Heidelberg, Germany. *Mycologist.* 2003; 17(1): 45-6. <https://doi.org/10.1017/S0269915X03211010>
7. Aracagök YD, Göker H, Cihangir N. Biodegradation of diclofenac with fungal strains. *Arch. Environ. Prot.* 2018; 4 (1): 55–62. <https://doi.org/10.24425/118181>.
8. Al Qarni H, Collier P, O'Keeffe J, Akunna J. Investigating the removal of some pharmaceutical compounds in hospital wastewater treatment plants operating in Saudi Arabia. *Environ Sci Pollut Res.* 2016; 23: 13003-14. <https://doi.org/10.1007/s11356-016-6389-7>.
9. Garcia-Rubio R, de Oliveira HC, Rivera J, Trevijano-Contador N. The fungal cell wall: *Candida*, *Cryptococcus*, and *Aspergillus* species. *Front Microbiol.* 2020;10: 2993. <https://doi.org/10.3389/fmicb.2019.02993>.
10. Zaynitdinova LI, Juraeva RN, Tashpulatov JJ, Kukanova SI, Lazutin NA, Mavjudova AM. Influence of Silver and Copper Nanoparticles on the Enzymatic Activity of Soil-Borne Microorganisms. *Baghdad Sci*

- J. 2022; 19(6(Suppl.): 1487.  
<https://doi.org/10.21123/bsj.2022.6532> .
11. Al-Shammari R H, Alsaady M H M, Ali S S M. The efficiency of biosynthesized zinc oxide nanoparticles by *Fusarium* sp. against isolated from common carp eggs in fish hatchery. *Int J Aquat Biol.* , 2022; 10 (5): 378-383. <https://doi.org/10.22034/ijab.v10i5.1741>.
  12. Santosa I, Grossmana MJ, Sartorattob A, Ponezib AN, Durranta LR. Degradation of the recalcitrant pharmaceuticals carbamazepine and 17 $\alpha$ -ethinylestradiol by ligninolytic fungi. *Chem Eng.* 2012; 27: 169-74. <https://doi.org/10.3303/CET1227029>.
  13. Al-Shammari RH, Ali SS, Hussin MS. Efficient Copper Adsorption from Aqueous Solution by *Dictyuchus* sterile Pellets. *Nat. Environ. Pollut. Technol.* 2023 ;1;22(2): 905-912 <https://doi.org/10.46488/NEPT.2023.v22i02.033>.
  14. Hofmann U, Schlosser D. Biochemical and physicochemical processes contributing to the removal of endocrine-disrupting chemicals and pharmaceuticals by the aquatic ascomycete *Phoma* sp. UHH 5-1-03. *Appl Microb Biotechnol.* 2016; 100: 2381-99. <https://doi.org/10.1007/s00253-015-7113-0>.
  15. Islan GA, Rodenak-Kladniew B, Noacco N, Duran N, Castro GR. Prodigiosin: A promising biomolecule with many potential biomedical applications. *Bioengineered.* 2022; 13(6): 14227-58. <https://doi.org/10.1080/21655979.2022.2084498>
  16. Wu B, Hussain M, Zhang W, Stadler M, Liu X, Xiang M. Current insights into fungal species diversity and perspective on naming the environmental DNA sequences of fungi. *Mycology.* 2019; 10(3): 127-40. <https://doi.org/10.1080/21501203.2019.1614106>.
  17. Sendra-García A, Martínez-Gómez MA, Albert-Marí A, Jiménez-Torres NV, Climente-Martí M. Quantitative and qualitative control of antineoplastic preparations: Gravimetry versus HPLC. *J Oncol Pharm Pract.* 2019; 25(5): 1204-16. <https://doi.org/10.1177/1078155219834999>.
  18. Khalil M R, Hameed G S, Hanna D B. The most common route of administration used during COVID-19. *Al Mustansiriyah J Pharma Sci.* 2023; 23(1): 81-90. <https://doi.org/10.32947/ajps.v23i1.990>.
  19. Makhrib M A, Al-Shammari R H. Congo Red Removal by Self-Immobilized *Aspergillus terreus*. *Annals of Agri-Bio Research.* 2023; 28(1):12-7. <https://agribiop.com/wp-content/uploads/2019/11/12-17>.
  20. Peciulyte A, Anasontzis G E, Karlström K, Larsson P T, Olsson L. Morphology and enzyme production of *Trichoderma reesei* Rut C-30 are affected by the physical and structural characteristics of cellulosic substrates. *Fungal Genet Biol.* 2014; 72: 64-72. <https://doi.org/10.1016/j.fgb.2014.07.011>.
  21. Ryan D, Leukes W, Burton S. Improving the bioremediation of phenolic wastewaters by *Trametes versicolor*. *Bioresour Technol.* 2007; 98(3): 579-87. <https://doi.org/10.1016/j.biortech.2006.02.001>.
  22. Zin NA, Badaluddin NA. Biological functions of *Trichoderma* spp. for agriculture applications. *Ann Agric Sci.* 2020 ; 65(2): 168-78. <https://doi.org/10.1016/j.aoad.2020.09.003>.
  23. Rahmadhani CA, Harahap Y, Rahman TA. HPLC-DAD quantification of favipiravir in whole blood after extraction from volumetric absorptive microsampling devices. *J Chromatogr B.* 2023; 15; 1215: 123547. <https://doi.org/10.1016/j.jchromb.2022.123547>
  24. Raheem SS, Al-Dossary MA, Al-Saad HT. Laboratory study for biodegradation of oxymatrine insecticide by single and mixed cultures of fungi isolated from agriculture soils in Basrah Governorate, Iraq. *Baghdad Sci J.* 2019; 16(1): 10-7. DOI: <http://dx.doi.org/10.21123/bsj.2019.16.1.0010>
  25. Sharma PR, Sharma M, Raja M, Singh DV, Srivastava M. Use of *Trichoderma* spp. in biodegradation of Carbendazim. *Indian J Agric Sci.* 2016; 86(7): 891-4. <http://dx.doi.org/10.56093/ijas.v86i7.59770>
  26. Santosa I, Grossmana MJ, Sartorattob A, Ponezib AN, Durranta LR. Degradation of the recalcitrant pharmaceuticals carbamazepine and 17 $\alpha$ -ethinylestradiol by ligninolytic fungi. *Chem Eng.* 2012; 27: 169-74. <https://doi.org/10.3303/CET1227029>
  27. Benoliel B, Torres FA, de Moraes LM. A novel promising *Trichoderma harzianum* strain for the production of a cellulolytic complex using sugarcane bagasse in natura. *SpringerPlus.* 2013; 2(1): 1-7. <https://doi.org/10.1186/2193-1801-2-656>.
  28. Asif MB, Hai FI, Singh L, Price WE, Nghiem LD. Degradation of pharmaceuticals and personal care products by white-rot fungi—a critical review. *Curr. Pollut. Rep.* 2017 Jun; 3: 88-103 <https://doi.org/10.1007/s40726-017-0049-5>.
  29. Aracagök YD, Göker H and Cihangir N . Biodegradation of diclofenac with fungal strains. *Arch Environ Prot.* 2018; 44 (1): 55–62. <https://doi.org/10.24425/118181> .

## المعالجة الحيوية لمضادات الاموكسيلين والفافيرافير بواسطة الفطريات الخيطية

رنا هادي حميد الشمري<sup>1</sup>، شيماء ساطع محمد علي<sup>2</sup>، اياد محمد جبر المعموري<sup>3</sup>

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### الخلاصة

الهدف من هذه الدراسة هو عزل وتوصيف الفطريات القادرة على التحليل الحيوي للأموكسيسيلين و الفافيرافير وكذلك تحديد خصائصها ومسار التحلل. تم عزل الفطر الاسبرجلس من عينات المياه العادمة الملوثة باستخدام أجار البطاطا ووسط الجابك. تم دراسة المعالجة الحيوية في الوسط السابق باستخدام Amoxicillin و Favipiravir كمصدر وحيد للكربون. تم التحري عن المواد الناتجة من التحلل بواسطة كروماتوجرافيا سائلة عالية الأداء (HPLC) واستخدمت لاستنتاج مسار تحلل المضادات الحيوية بواسطة الفطر اسبرجلس. تم فحص الخيوط الفطرية عن طريق المجهر الإلكتروني الماسح قبل وبعد 7 أيام من العلاج لاكتشاف تراكم المضادات الحيوية والتغيرات الشكلية في الخيوط الفطرية. إذ يمكن للفطريات اعتماد المضادات الحيوية كمصدر وحيد للكربون. إذ لوحظ أقصى قدر من التحلل الحيوي هو 91% عند أقل تركيز من اموكسيلين. وفقاً لنتائج HPLC كان زمن الاحتجاز للأموكسيسيلين القياسي 8.12 دقيقة بعد التحلل الحيوي إلى مركبات أخرى مع زمن احتجاز 3.75 دقيقة بنسبة 73.25% ، وفي 5.81 دقيقة بنسبة 16.44% وفي 8.5 دقيقة بنسبة 8.59 ، وفقاً لمعيار احتباس فافيبيرافير. ظهر الوقت في 3.97 دقيقة ولكن بعد العلاج ظهرت مادتان في 2.20 دقيقة. حسب المنطقة: 62.58% وفي 6.16 دقيقة. حسب المنطقة: 20.15%. لاو حظ تراكم جزيئات Favipiravir على الخيوط الفطرية *A. flavus*. تعطي هذه النتائج رؤى في تحسين طريقة المعالجة الحيوية لإزالة المضادات الحيوية من مياه الصرف الصحي قبل تصريفها في الأنهار .

الكلمات المفتاحية: فطريات، كريات الفطريات، مضادات حيوية، معالجة حيوية، وسط مائي .