

Anti-fungal Activity of Ellagic Acid against Different Plant Pathogenic Fungi

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ABSTRACT

Ellagic acid (EA), a polyphenolic compound derived from medicinal plants, is recognized for its diverse biological activities, including anti-inflammatory, anti-mutagenic, anti-cancer, anti-tumor, antibacterial, antioxidant, and antiproliferative effects. This study aimed to evaluate the antifungal activity of ellagic acid against six pathogenic fungi: *Alternaria solani*, *Rhizoctonia solani*, *Botrytis cinerea*, *Fusarium oxysporum*, *Sclerotium rolfsii*, and *Corynespora cassiicola*, using the food poisoning technique. The fungi were exposed to various concentrations of ellagic acid up to its solubility limit. Results indicated that ellagic acid significantly reduced the growth of *Alternaria solani*, with up to an 88% inhibition at the highest concentration. However, no significant growth reduction was recorded in *Rhizoctonia solani*, *Botrytis cinerea*, *Fusarium oxysporum*, *Sclerotium rolfsii*, or *Corynespora cassiicola*. These findings suggest that the strong antifungal effect of ellagic acid against *Alternaria solani*, while its activity against the other fungi was minimal. In conclusion, ellagic acid shows promising potential as an antifungal agent, particularly against *Alternaria solani*, suggesting further investigation into its mechanisms and broader applicability in fungal control.

Keywords: *Alternaria solani*, EA, Food poisoning technique, Fungal mitigation, Fungistatic

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INTRODUCTION

Henri Braconnot, a French chemist and pharmacist, first discovered ellagic acid in 1831. He referred to it as "acide ellagique," a term derived by reversing "galle." Ellagic acid is a biologically active phenolic compound widely found in strawberries, red raspberries, pomegranates, and rose hips. It exhibits well-documented bioactive properties, including anti-inflammatory, anti-mutagenic, anti-cancer, anti-tumor, antibacterial, antioxidant, and antiproliferative effects (Ghudhaib *et al.*, 2010; Evtuyugin *et al.*, 2020; Rossatto *et al.*, 2021). Due to these properties, ellagic acid has become a significant component in the development of cosmetics and pharmaceuticals.

Fungal pathogens pose a substantial threat to global agriculture by causing severe reductions in crop productivity. Notable examples include *Alternaria solani*, which affects potatoes and tomatoes (Niu *et al.*, 2022), *Rhizoctonia solani*, which causes seedling diseases in soybeans (Ajayi-Oyetunde and Bradley, 2018), and *Botrytis cinerea*, responsible for gray mold in various crops (Chen *et al.*, 2022). *Fusarium oxysporum* causes wilt diseases in crops such as tomatoes, cabbage, and bananas (Arie, 2019), while *Sclerotium rolfsii* primarily affects vegetables and fruits, including tomatoes, peppers, melons, and watermelons. Similarly, *Corynespora cassiicola* is a key pathogen causing spot diseases in cotton and soybeans (Manikantha Chowdary *et al.*, 2024). Among these pathogens, *Fusarium oxysporum* f. sp. *lycopersici*

is a significant soil-borne pathogen in tomato plants, often transmitted through infected seeds (Adhikari *et al.*, 2018). It causes xylem blockages in host plants, leading to leaf yellowing, wilting, and eventual plant death (Jangir *et al.*, 2021). Controlling such fungal diseases is critical to safeguarding agricultural productivity.

Chemical fungicides are commonly used to manage fungal infections, including those caused by *Fusarium*. However, these pesticides are associated with environmental persistence, potential toxicity to humans, and the emergence of fungicide-resistant strains (El-Aswad *et al.*, 2023). As an alternative, the use of natural botanical extracts offers a promising eco-friendly solution, minimizing environmental and health risks while maintaining effective disease control (Deresa and Diriba, 2023). For instance, studies have shown that certain plant extracts can effectively inhibit fungal growth. A specific extract from *L. hirta* (M5L, at a concentration of 5 mg/mL) completely suppressed the growth of *P. clavispora* and *C. gloeosporioides*, with effects comparable to standard chemical controls (Hernández-Ceja *et al.*, 2021). With this background, this study seeks to investigate the efficacy of natural botanical extracts, with a focus on ellagic acid, as an environmentally sustainable approach to managing fungal diseases in crops.

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MATERIAL AND METHODS

Media Preparation

Preparation of Potato Dextrose Agar Plates

Potato dextrose agar (PDA) plates were prepared to serve as a growth medium for fungal culture. The PDA medium was prepared by dissolving commercially available potato dextrose agar powder in distilled water, following the manufacturer's instructions. The solution was autoclaved at 121°C for 15 minutes to ensure sterilization. After autoclaving, the medium was allowed to cool to approximately 45–50°C under aseptic conditions to minimize contamination risks. The sterilized medium was then poured into sterile Petri dishes in a laminar airflow chamber to maintain sterility. Approximately 20 mL of the medium was dispensed into each Petri dish. The plates were left to solidify at room temperature and subsequently pre-incubated at 25–28°C for 24 hours to ensure no contamination occurred during the preparation process. Plates showing any signs of contamination were discarded.

The prepared and pre-incubated PDA plates were stored in a refrigerated environment at 4°C until use. Plates were brought to room temperature prior to inoculation with fungal samples (Liu *et al.*, 2002).

Preparation of Ellagic Acid Ellagic acid was dissolved in dimethyl sulfoxide (DMSO) and incorporated into molten agar to achieve a final high-dose concentration of 250 µg/mL. Two lower concentrations were prepared by serial dilution of the stock solution in DMSO at a 1:1 ratio. These diluted solutions were also added to molten agar to obtain final concentrations of 125 µg/mL and 62.5 µg/mL, respectively (Zuccari *et al.*, 2020).

Culture Source

Fungal cultures were collected from various regions of Pune, India, and one from Indore, India. The following isolates were obtained: *Alternaria solani* (GPS- 18° 42' 52.72" N, 73° 57' 28.23" E) from potato, *Botrytis cinerea* (GPS- 18° 24' 17.30" N, 73° 50' 7.66" E) from strawberry, *Fusarium oxysporum* (GPS- 19° 9' 8.62" N, 73° 58' 31.85" E) from tomato, *Sclerotium rolfsii* (GPS- 18° 56' 31.10" N, 73° 54' 5.72" E) from groundnut, and *Corynespora cassiicola* (GPS- 18° 44' 2.39" N, 74° 8' 1.40" E) from tomato. Additionally, *Rhizoctonia solani* was collected from maize in Indore, India (GPS- 22° 41' 10.00" N, 76° 5' 41.15" E). All fungal samples were isolated from infected plants, cultured, and identified using Internal Transcribed Spacer (ITS)-based molecular identification methods as described by Jain *et al.* (2019).

Preparation of Inoculum

Fungal cultures of *Alternaria solani*, *Rhizoctonia solani*, *Botrytis cinerea*, *Fusarium oxysporum*, *Sclerotium rolfsii*, and *Corynespora cassiicola* were cultivated on potato dextrose agar (PDA) plates and maintained under standard conditions. Mycelial discs (5

mm in diameter) were excised from six-day-old cultures using a sterile cork borer and used as inoculum for the experiments. The cultures were routinely monitored for contamination during subculturing and maintained until further use. All cultures were incubated at 28 ± 1°C (Gupta and Tripathi, 2011).

Screening of six pathogenic fungi cultures against Ellagic Acid

The antifungal activity of ellagic acid was evaluated against six fungal cultures (*Alternaria solani*, *Rhizoctonia solani*, *Botrytis cinerea*, *Fusarium oxysporum*, *Sclerotium rolfsii*, and *Corynespora cassiicola*) using the poisoned food technique (Grover and Moore, 1962). Ellagic acid was incorporated into pre-labeled 60 mm PDA plates. After the addition of the PDA medium, the plates were gently rotated in clockwise and counterclockwise directions to ensure uniform mixing. Plates treated with dimethyl sulfoxide (DMSO) instead of ellagic acid served as controls.

A 5 mm mycelial disc, excised aseptically from six-day-old fungal cultures, was inoculated onto each prepared plate. The plates were incubated at 28 ± 1°C for seven days. On the seventh day, the diameters of fungal colonies were measured to assess growth inhibition. Fungitoxicity was calculated using the formula described by Singh and Tripathi (2011).

Formula

$$\text{Percent Inhibition of mycelial growth} = \frac{dc - dt}{dc} \times 100$$

Where, dc – average diameter of fungal colony in control sets

Dt – average diameter of fungal colony in treatment sets

RESULTS

The antifungal activity of ellagic acid was evaluated against *Alternaria solani*, *Rhizoctonia solani*, *Botrytis cinerea*, *Fusarium oxysporum*, *Sclerotium rolfsii*, and *Corynespora cassiicola*, resulting in variable antifungal efficacy (Fig. 1). As shown in Fig. 1, the antifungal activity of ellagic acid at a concentration of 250 µg/mL was evaluated against six phytopathogenic fungi, revealing significant variability in efficacy among the tested species. Table 1 summarizes the percentage of mycelial inhibition for each fungal strain. Among the tested pathogens, ellagic acid exhibited the highest efficacy against *Alternaria solani*, with a significant mycelial inhibition ranging from 63% to 88% across the tested concentrations (62.5–250 µg/mL) (Fig. 2). The strong antifungal effect of ellagic acid against *A. solani* is likely due to its ability to disrupt essential fungal structures and functions, coupled with the pathogen's particular vulnerability to such disruptions.

In contrast, *Rhizoctonia solani*, *Botrytis cinerea*, *Fusarium oxysporum*, *Sclerotium rolfsii*, and *Corynespora cassiicola* displayed only a slight

reduction in mycelial growth, with inhibition levels ranging from 3% to 21% across the same concentrations. The detailed percentages of mycelial inhibition are presented in Table 1. These findings indicate that ellagic acid is highly effective against *Alternaria solani* but shows no significant antifungal activity against *Rhizoctonia solani*, *Botrytis cinerea*, *Fusarium oxysporum*, *Sclerotium rolfsii*, and *Corynespora cassiicola*.

DISCUSSION

In contrast, ellagic acid showed limited antifungal activity against *Rhizoctonia solani*, *Botrytis cinerea*, *Fusarium oxysporum*, *Sclerotium rolfsii* and *Corynespora cassiicola*, with mycelial inhibition ranging between 3% and 21%. These results indicate that the antifungal effect of ellagic acid is pathogen-specific, as these fungi displayed varying degrees of resistance. A possible explanation for this differential response could be related to the structural composition of fungal cell walls and their metabolic ability to detoxify phenolic compounds such as ellagic acid (El-Aswad *et al.*, 2023). For example, *Fusarium* species are known for their robust cell wall integrity and efficient efflux mechanisms, which might limit the penetration or efficacy of ellagic acid (Ekwomadu and Mwanza, 2023).

Furthermore, concentration-dependent effects were observed across all fungal strains. Higher concentrations of ellagic acid generally resulted in greater inhibition, particularly against *A. solani*. However, no significant increase in effectiveness was observed beyond a certain concentration threshold for less susceptible fungi. This suggesting a plateau effect in some less susceptible species, the development of effective treatment regimens for various pathogens would require a balance between concentration and application strategy to avoid potential phytotoxicity and reduce the risk of resistance development. Previous studies have shown that combining ellagic acid with other natural compounds or chemical agents can synergistically enhance its antifungal potential (Singh and Tripathi, 2011; Hernández-Ceja *et al.*, 2021).

The results of this study further support the growing interest in ellagic acid as a sustainable alternative to

synthetic fungicides, particularly in the context of integrated pest management. As environmental and health concerns regarding chemical fungicides rise, natural bioactive compounds like ellagic acid offer an attractive solution due to their minimal environmental impact and potential for safe human consumption (Deresa and Diriba, 2023). However, its limited effectiveness against some pathogens, such as *Rhizoctonia solani* and *Botrytis cinerea*, emphasizes the need for further research into improving the bioavailability and targeted action of ellagic acid. Investigating its mode of action at the molecular level, optimizing formulations, and exploring its synergistic effects with other natural or synthetic compounds will be crucial steps in maximizing its practical applications in crop protection.

CONCLUSION

In conclusion, the present study highlights the promising antifungal activity of ellagic acid, particularly against *Alternaria solani*, with significant mycelial inhibition observed across a range of concentrations. This supports its potential as an effective biofungicide for controlling *A. solani*, a major pathogen in solanaceous crops. However, the limited antifungal activity observed against other pathogens such as *Rhizoctonia solani*, *Botrytis cinerea*, *Fusarium oxysporum*, *Sclerotium rolfsii*, and *Corynespora cassiicola* suggests that ellagic acid's antifungal efficacy is pathogen-specific. The varying levels of susceptibility could be attributed to differences in fungal cell wall composition, detoxification mechanisms, and resistance strategies.

While ellagic acid shows great promise as a natural alternative to synthetic fungicides, its efficacy against certain fungal pathogens calls for further research to optimize its use in crop protection. Future studies should focus on enhancing the bioavailability of ellagic acid, improving its formulation for targeted action, and exploring its synergistic effects with other bioactive compounds. The application of ellagic acid as part of integrated pest management strategies can potentially reduce the environmental and health risks associated with chemical fungicides, offering a safer and sustainable solution for managing fungal plant diseases.

Table 1 Mycelial Zone Inhibition in (%)

Pathogens	Mycelial Zone Inhibition in (%) (Mean ± SE)		
	Conc 62.5 µg/mL	Conc 125 µg/mL	Conc 250 µg/mL
<i>Alternaria solani</i>	63	75	88
<i>Rhizoctonia solani</i>	4	7	10
<i>Botrytis cinerea</i>	3	5	8
<i>Fusarium oxysporum</i>	6	9	12
<i>Sclerotium rolfsii</i>	5	11	15
<i>Corynespora cassiicola</i>	8	13	21

Conc – Concentration.

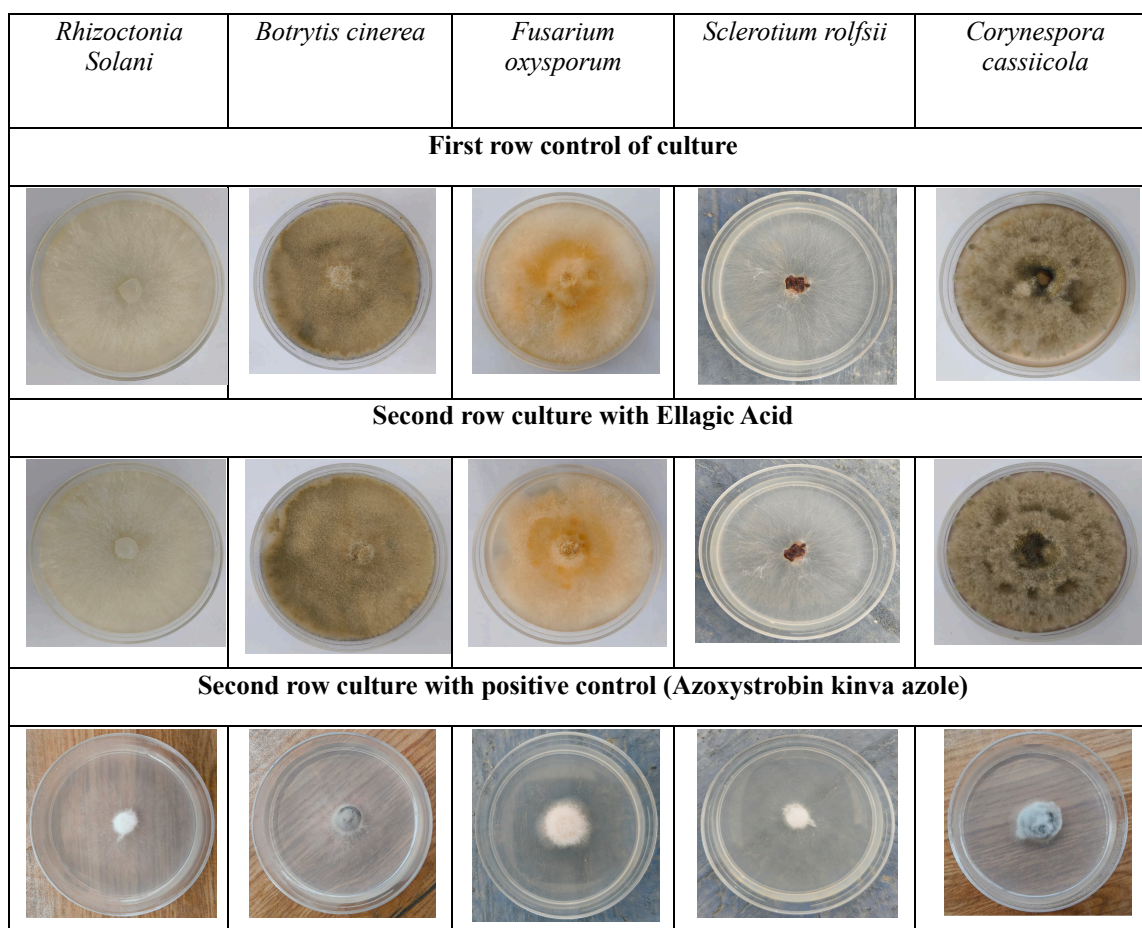


Fig 1. Fungal cultures at highest tested concentration of 250 µg/mL.

a1 and a2: *Rhizoctonia Solani*; b1 and b2: *Botrytis cinerea*; c1 and c2: *Fusarium oxysporum*; d1 and d2: *Sclerotium rolfsii*; e1 and e2: *Corynespora cassiicola*.

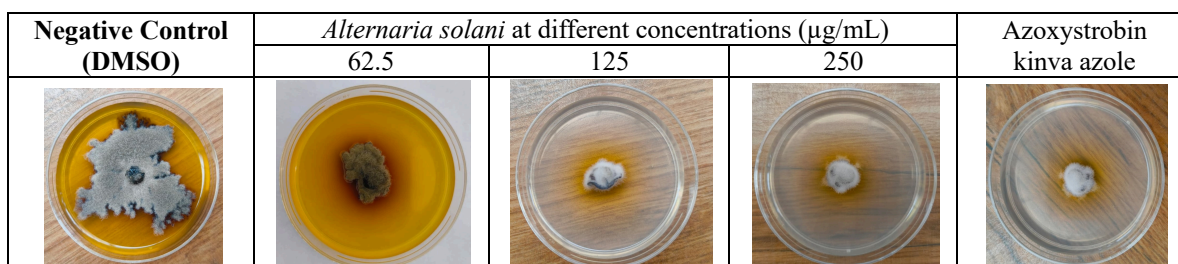


Fig 2. *Alternaria solani* at different concentrations.

Ct: Control; A: 62.5 µg/mL; B: 125 µg/mL; C: 250 µg/mL.

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Author's contributions

First author designed the study, reviewed the results, and wrote the first draft of the manuscript. All other authors contributed to the review and revision of the manuscript and participated in drafting the final version. All authors have read and approved the final manuscript for publication.

Compliance with ethical standards

Ethical issues: None.

REFERENCES

- Adhikari M, Kharel N, Gaire L, Poudel R, Shrestha SM, Gaire SP, Acharya B. (2018). In Vitro Evaluation of Different Chemicals against *Rhizoctonia solani* by Poisoned Food Technique. *Field Crop*. 1(2): 5-8. <http://fc.biopublisher.ca>.
- Ajayi-Oyetunde OO, Bradley CA. (2018). *Rhizoctonia solani*: taxonomy, population biology and management of *Rhizoctonia* seedling disease of soybean. *Plant Pathol*. 67:3-17.

3. Arie T. (2019). *Fusarium* diseases of cultivated plants, control, diagnosis, and molecular and genetic studies. *J Pestic Sci.* 44(4):275-281. <https://doi.org/10.1584/jpestics.J19-03>.
4. Chen H, He S, Zhang S, Li W, Liu, S. (2022). The Necrotroph *Botrytis cinerea* BcSpd1 Plays a Key Role in Modulating Both Fungal Pathogenic Factors and Plant Disease Development. *Front Plant Sci.* 13:820767. <https://doi.org/10.3389/fpls.2022.820767>.
5. Deresa EM, Diriba TF. (2023). Phytochemicals as alternative fungicides for controlling plant diseases: A comprehensive review of their efficacy, commercial representatives, advantages, challenges for adoption, and possible solutions. *Heliyon*, 17:9(3), e13810. <https://doi.org/10.1016/j.heliyon.2023.e13810>.
6. Ekwomadu TI, Mwanza M. (2023). *Fusarium* Fungi Pathogens, Identification, Adverse Effects, Disease Management, and Global Food Security: A Review of the Latest Research. *Agriculture* 13(9):1810. <https://doi.org/10.3390/agriculture13091810>
7. El-Aswad AF, Aly MI, Alsahaty SA, Basyony ABA. (2023). Efficacy evaluation of some fumigants against *Fusarium oxysporum* and enhancement of tomato growth as elicitor-induced defense responses. *Sci Rep.* 11;13(1):2479. <https://doi.org/10.1038/s41598-023-29033-w>
8. Evtugin DD, Magina S, Evtuguin DV. (2020). Recent Advances in the Production and Applications of Ellagic Acid and Its Derivatives. A Review. *Molecules.* 25(12):2745. <https://doi.org/10.3390/molecules25122745>
9. Ghudhaib KK, Hanna ER, Jawad AH. (2010). Effect of ellagic acid on some types of pathogenic bacteria. *J. of Al-Nahrain University* 13(2):79-85.
10. Gupta SK, Tripathi SC. (2011). Fungitoxic Activity of *Solanum torvum* against *Fusarium sacchari*. *Plant Protect. Sci.* 47(3):83–91.
11. Hernández-Ceja A, Loeza-Lara PD, Espinosa-García FJ, García-Rodríguez YM, Medina-Medrano JR, Gutiérrez-Hernández GF, Ceja-Torres, LF. (2021). In Vitro Antifungal Activity of Plant Extracts on Pathogenic Fungi of Blueberry (*Vaccinium* sp.). *Plants.* 10(5):852. <https://doi.org/10.3390/plants10050852>
12. Jain A, Sarsaiya S, Wu Q, Lu Y, Shi J. (2019). A review of plant leaf fungal diseases and its environment speciation. *Bioengineered.* 10(1):409-424. <https://doi.org/10.1080/21655979.2019.1649520>.
13. Jangir P, Mehra N, Sharma K, Singh N, Rani M, Kapoor R. (2021). Secreted in xylem genes: drivers of host adaptation in *Fusarium oxysporum*. *Front. Plant Sci.* 12:628611. <https://doi.org/10.3389/fpls.2021.628611>
14. Liu Y, Tortora G, Ryan ME, Lee HM, Golub LM. (2002). Potato dextrose agar antifungal susceptibility testing for yeasts and molds: evaluation of phosphate effect on antifungal activity of CMT-3. *Antimicrob Agents Chemother.* 46(5):1455-61. <https://doi.org/10.1128/AAC.46.5.1455-1461.2002>.
15. Manikantha Chowdary GBS, Jameema G, Vimala Charishma K. (2024). Collar and stem rot pathogen- *Sclerotium rolfsii*: A review. *Plant Archives.* 24(1):67-72. <https://doi.org/10.51470/PLANTARCHIVES.2024.v24.no.1.010>
16. Niu Z, Zheng L, Yang P, Wang J, Tian M, Pan Y, Zhao D, Yang Z, Zhu J. (2022). Detection of *Alternaria solani* with high accuracy and sensitivity during the latent period of potato early blight. *Front Microbiol.* 13:1016996. <https://doi.org/10.3389/fmicb.2022.1016996>.
17. Rossatto FCP, Tharmalingam N, Escobar IE, D'azevedo PA, Zimmer KR, Mylonakis, E. (2021). Antifungal activity of the phenolic compounds ellagic acid (Ea) and caffeic acid phenethyl ester (cape) against drug-resistant candida auris. *J. Fungi.* 7(9):763. <https://doi.org/10.3390/jof7090763>
18. Singh J, Tripathi NN. (1999). Inhibition of storage fungi of black gram (*Vigna mungo*) by some essential oils. *Flavour Fragrance J.* 14:1-4. [https://doi.org/10.1002/\(SICI\)1099-1026\(199901/02\)14:1<::AID-FFJ735>3.0.CO;2-R](https://doi.org/10.1002/(SICI)1099-1026(199901/02)14:1<::AID-FFJ735>3.0.CO;2-R)
19. Zuccari G, Baldassari S, Ailuno G, Turrini F, Alfei, S, Caviglioli G. (2020). Review Formulation strategies to improve oral bioavailability of ellagic acid. *Applied Sci.* 10(10):3353. <https://doi.org/10.3390/app10103353>.