**A Comprehensive on Antimicrobial Activity of Garlic Nanoparticle**

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**Abstract**

Garlic (Allium sativum) has been recognized for its potent antimicrobial properties owing to its rich content of organosulfur compounds. In recent years, nanoparticles derived from garlic extracts have emerged as a promising avenue for enhancing antimicrobial activity. This abstract explores the utilization of garlic nanoparticles in antimicrobial treatments, highlighting their fabrication methods and mechanisms of action. The synthesis of garlic nanoparticles involves green chemistry approaches, utilizing aqueous extracts or essential oils from garlic, which are eco-friendly and cost-effective. These nanoparticles exhibit enhanced bioavailability and stability, allowing for sustained antimicrobial efficacy against a broad spectrum of pathogens including bacteria, fungi, and viruses. Moreover, garlic nanoparticles demonstrate synergistic effects when combined with conventional antibiotics, mitigating resistance issues. Mechanistically, they disrupt microbial cell membranes, inhibit vital enzymes, and interfere with cellular signaling pathways. Clinical studies and in vivo experiments underscore their potential in combating infectious diseases while minimizing adverse effects. However, challenges such as standardization of production methods and toxicity profiles necessitate further investigation. In conclusion, garlic nanoparticles represent a promising frontier in antimicrobial therapy, offering novel strategies to combat multidrug-resistant pathogens and improve public health outcomes.

**Keywords:** Garlic exract, Nanoparticle, Characterization& Evaluation, antimicrobial activity.

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**Introduction**

Garlic (Allium sativum) has been famous for its restorative properties and has been utilized for centuries in different societies to treat bacterial contaminations. It has antibacterial, antifungal, antiviral, and antioxidant properties, making it a important common cure. Garlic contains oil-soluble organosulfur compounds, counting allicin, ajoenes, and allyl sulfides, which are dependable for its antibacterial action. Be that as it may, the application of garlic extricate is constrained due to its moo water dissolvability, tall instability, and odor. To overcome these impediments, the definition of nanoparticles containing garlic extricate has been explored. This article points to investigate the detailing and assessment of nanoparticles of garlic extricate for their antimicrobial action[1]. By typifying the unstable compounds of garlic extricate, the nanoparticles can secure and upgrade the steadiness of the extricate, permitting for a more extensive extend of applications. Nanoparticles of garlic extricate can moreover be utilized to make utilitarian materials for a extend of mechanical applications. For case, they can be utilized as antimicrobial coatings for therapeutic gadgets and surfaces, such as catheters and working rooms. They can moreover be consolidated into individual care items, like cleansers and shampoos, to hinder microbial development. In expansion, the nanoparticles can be utilized in nourishment bundling to expand rack life and anticipate decay. The utilize of nanoparticles of garlic extricate in these applications is appealing due to their common beginning and eco-friendly nature. Moreover, the soundness of the nanoparticles makes them appropriate for long-term capacity and utilize. As investigate proceeds to progress in this range, we may before long see more items containing nanoparticles of garlic extract on the market[2]. In the long, run thinks about ought to too center on the potential utilize of nanoparticles of garlic extricate within the treatment and prevention of human illnesses. The antimicrobial properties and steadiness of these nanoparticles make them perfect candidates for medicate conveyance frameworks. For example, they may be utilized to convey drugs straightforwardly to contaminated cells or to target particular regions of the body. Moreover, the nanoparticles may be utilized in combination with other treatments to increment their viability and decrease side impacts. By exploring the potential of these nanoparticles in medication, able to open up unused possibilities for treating bacterial diseases and other infections[3]. It is obvious that nanoparticles of garlic extricate hold awesome guarantee for numerous applications and have much potential for moving forward human health. he potential of nanoparticles of garlic extricate is tremendous and energizing. As investigate proceeds to reveal unused applications, we may before long see these nannoparticles particles being utilized in a wide extend of businesses and items. For illustration, they might be utilized to form more viable and eco-friendly cleaning items or indeed to create unused medical treatments. The conceivable outcomes for these nanoparticles are unending, and as inquire about propels, we are able anticipate to see more items containing garlic extricate nanoparticles on the advertise[4]. With advance ponder, these particles may before long gotten to be an critical portion of our regular lives and offer us other ways to progress our wellbeing and well-being. The definition of nanoparticles of garlic extricate for antimicrobial action was a breakthrough within the field of medication and healthcare. The nanoparticles were designed to have a better surface range, permitting them to enter more profound into the microbial cells and annihilate them. This empowered the garlic extricate to be utilized as an successful antimicrobial operator, with negligible side impacts and poisonous quality[5]. The assessment of these nanoparticles included surveying their adequacy against distinctive sorts of organisms, counting microscopic organisms, infections, parasites, and other microorganisms. The comes about appeared that the garlic extricate was exceedingly compelling against all sorts of organisms tried and had no antagonistic impacts on human cells. This has made it a promising elective to conventional anti-microbials in treating bacterial diseases[6]. The nanoparticles of garlic extricate were too tried for their capacity to anticipate microbial development in several situations. In research facility settings, the nanoparticles were found to be successful in anticipating the development of a wide run of organisms, counting those that cause foodborne sicknesses and other irresistible infections. In expansion, the nanoparticles were too found to be viable against certain sorts of safe microscopic organisms such as those dependable for causing tuberculosis. This has made them a reasonable alternative for treating contaminations that are safe to conventional anti-microbials. Moreover, the garlic extricate nanoparticles have been found to be secure for human utilization and have no unfavorable impacts on human cells. This makes them an alluring choice for treating bacterial diseases in people[7].

**Chemical Composition of Garlic Extract**

Garlic extricate is wealthy in different components, counting dampness, fiery remains, unrefined protein, crude fat, and add up to carbohydrates. The particular composition may shift depending on the source and planning strategy. For illustration, garlic bulbs contain around 0.5t, whereas ginger rhizomes contain approximately 3t. The mineral substance of garlic is moderately lower, with 3.5% minerals compared to 9.5% in ginger[8]. Furthermore, ginger features a higher fiber substance of 16.5% compared to 8.5% in garlic. The garlic extricate nanoparticles have been found to be compelling against different microscopic organisms, counting Gram-positive and Gram-negative microscopic organisms, as well as parasites and other microorganisms. Ponders have appeared that these nanoparticles can hinder the development of pathogens such as Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, and Candida albicans[9]. The nanoparticles too displayed antibacterial movement against antibiotic-resistant strains of microscopic organisms. This can be an imperative advantage as anti-microbial resistance is getting to be an progressively genuine issue within the treatment of irresistible disease.

**Antimicrobial Properties of Garlic Extract**

In expansion to the antimicrobial properties of garlic extricate nanoparticles, they have too been found to have antioxidant and anti-inflammatory properties. Ponders have appeared that garlic extricate nanoparticles can diminish oxidative stretch and irritation in cells. This can be advantageous as oxidative push and aggravation are included within the advancement of numerous persistent maladies, such as diabetes, heart illness, cancer, and neurodegenerative illnesses[10]. Moreover, garlic extricate nanoparticles have also been found to be viable in lessening cholesterol levels within the blood. Typically an vital advantage as tall cholesterol levels can increment the chance of cardiovascular infection. At last, garlic extricate nanoparticles may moreover offer assistance secure against certain sorts of cancer by hindering the development of cancerous cells.  Garlic extricate has been broadly considered for its antimicrobial properties[12]. The organosulfur compounds display in garlic, such as allicin and ajoenes, display a wide extend of antibacterial action against both Gram-positive and Gram-negative microbes. These compounds have been appeared to repress the development of different pathogenic microbes, counting Staphylococcus aureus and Escherichia coli. The antimicrobial movement of garlic extricate is credited to its capacity to create disulfide bonds with proteins, compromising the astuteness of bacterial membranes.

**Formulation of Nanoparticles of Garlic Extract**

To make strides the soundness and dissolvability of garlic extricate, nanoparticles containing the extricate are defined. The definition includes the utilize of surfactants, such as Tween 80, and an watery stage containing citric corrosive. The fundamental oil of garlic is blended with the surfactant and gradually included to the watery stage whereas mixing. The proportion of surfactant to oil can be balanced, and the concentration of the fundamental oil can shift from 5% to 25%. Once the nanoparticles are shaped, they can be utilized in different applications[13]. For illustration, they can be joined into topical creams and treatments to treat skin diseases caused by microbes or parasites. In expansion, the nanoparticles can moreover be utilized as an antimicrobial operator in nourishment conservation and water treatment. The nanoparticles have too been found to successfully slaughter microbes in vitro, illustrating their potential utilize in treating bacterial contaminations such as pneumonia and urinary tract contaminations. Besides, garlic extricate nanoparticles have been considered for their potential utilize as a prophylactic operator against certain sorts of irresistible infections. These incorporate intestinal sickness, dengue fever, and HIV/AIDS, which are all In expansion to their potential utilize as a prophylactic specialist, garlic extricate nanoparticles have too been considered for their potential part in cancer anticipation and treatment[14]. Considers have appeared that garlic extricate nanoparticles can repress the development of certain sorts of cancer cells, such as breast cancer cells. This is often ascribed to the organosulfur compounds show in garlic, which can actuate apoptosis or cell passing in cancerous cells. Besides, garlic extricate nanoparticles may too offer assistance secure against oxidative push and irritation by rummaging free radicals and restraining the discharge of provocative cytokines. Hence, garlic extricate nanoparticles may be valuable for both anticipating and treating certain sorts of cancer[15].

**Characterization of Nanoparticles**

The nanoparticles of garlic extricate are characterized utilizing different strategies, counting molecule measure examination, UV-Vis spectroscopy, and transmission electron microscopy (TEM). Molecule measure investigation uncovers the size dissemination of the nanoparticles, which can be affected by the proportion of the scattered stage within the detailing. UV-Vis spectroscopy is utilized to affirm the blend of metal nanoparticles, such as silver, copper, press, and zinc, and their steadiness[16]. TEM permits for the visualization of the nanoparticles and their morphology. In expansion to characterization, the nanoparticles of garlic extricate can moreover be assessed for their adequacy in different applications. For occasion, their antimicrobial movement can be decided by performing a zone of restraint test against microbes and organisms. Their potential utilize in cancer treatment can moreover be examined utilizing cell culture models[17]. This includes uncovering cancer cells to the nanoparticles to decide whether they initiate cell passing or restrain the development of the cancer cells. Besides, creature considers are too conducted to assess the security and adequacy of garlic extricate nanoparticles some time recently they are endorsed for clinical use. Garlic extricate nanoparticles have too been examined for their potential part in medicate conveyance. Ponders have illustrated that these nanoparticles can be utilized to provide drugs such as anti-microbials and antivirals straightforwardly to the location of disease, in this way expanding the adequacy of the drugs[18]. Also, garlic extricate nanoparticles have been investigated as a conveyance framework for chemotherapeutic specialists, permitting for more exact focusing on of cancer cells whereas minimizing harm to solid cells. Moreover, garlic extricate nanoparticles have been appeared to improve the dissolvability and bioavailability of certain drugs, permitting them to be more successfully retained into the body. In this way, garlic extricate nanoparticles may give an compelling stage for focused on sedate conveyance for different helpful applications. Antimicrobial Movement of Nanoparticles The antimicrobial movement of the nanoparticles of garlic extricate is assessed utilizing different strategies, such as disk dissemination and least inhibitory concentration (MIC) tests. These measures measure the hindrance zones and the concentration required to repress bacterial development, individually. The nanoparticles have appeared solid antimicrobial movement against both Gram-positive and Gram-negative microscopic organisms, with a more grounded impact watched on Gram-positive bacteria[19].

**Evaluation and Antioxidant Activity**

The soundness of the nanoparticles is evaluated through different tests, counting thermogravimetric examination and electrical conductivity estimations. Thermogravimetric investigation decides the warm resistance of the nanoparticles and their fixings, whereas electrical conductivity estimations give experiences into their soundness over time and temperature. The antioxidant action of the nanoparticles is assessed utilizing the 2,2‐diphenyl‐1‐picrylhydrazyl strategy, which measures free radical rummaging capacity[20]. In expansion to these tests, the harmfulness of garlic extricate nanoparticles is additionally assessed utilizing cell practicality tests. These measures degree the impacts of the nanoparticles on diverse sorts of cells, such as human fringe blood mononuclear cells . The comes about from these tests are utilized to decide the security of garlic extricate nanoparticles some time recently they are endorsed for clinical utilize. Moreover, animal studies are conducted to assess the pharmacokinetics and pharmacodynamics of garlic extricate nanoparticles. This incorporates evaluating their assimilation, dissemination, digestion system and excretion in different creature models. All these give understanding into the security and viability of garlic extricate nanoparticles as potential medicate conveyance frameworks[21].

**Applications and Future Perspectives**

The detailing of nanoparticles of garlic extricate has opened up modern conceivable outcomes for utilizing garlic's antimicrobial properties. These nanoparticles can be incorporated into different items, such as nourishment and drugs, to upgrade their antimicrobial movement and decrease the need for manufactured additives. The utilize of normal compounds like garlic extricate can contribute to the generation of more secure and more advantageous items. Future inquire about ought to center on optimizing the definition and assessing the nanoparticles' adequacy in numerous applications, as well as conducting clinical considers to set up their potential in complementary medicine[22]. The potential for garlic extricate nanoparticles to be utilized as a sedate conveyance framework is additionally being investigated. The capacity of these nanoparticles to target specific cells and organs within the body, as well as their capacity to ensure drugs from debasement, make them promising candidates for sedate conveyance. Considers have appeared that garlic extricate nanoparticles can be utilized to convey the anti-microbial ciprofloxacin straightforwardly to the lungs, giving an successful treatment for pneumonic infections. Additionally, garlic extricate nanoparticles have been appeared to extend the bioavailability of certain drugs and decrease their poisonous quality[23]. These considers illustrate the potential of garlic extricate nanoparticles in medicate conveyance applications and advance investigate is required to investigate this possibility.The future of garlic extract nanoparticles is promising. With advance inquire about and advancement, these nanoparticles might be utilized to make novel sedate conveyance frameworks that are more successful and have less side impacts than current medications. Furthermore, garlic extricate nanoparticles may be utilized as a normal additive in nourishment and beauty care products, decreasing the require for engineered chemicals that can be hurtful to people and the environment. At last, garlic extricate nanoparticles can be utilized in combination treatments with other drugs to improve their viability or diminish their poisonous quality. All these conceivable outcomes make garlic extricate nanoparticles an energizing zone of investigate that has the potential to revolutionize present day medicine[24].

**Conclusion**

The definition and evaluation of nanoparticles of garlic extricate offer a promising approach to upgrade the solidness and antimicrobial movement of garlic. These nanoparticles can give a common and eco-friendly elective to manufactured antimicrobial specialists. The chemical composition of garlic extract, its antimicrobial properties, and the characterization of the nanoparticles have been investigated. The nanoparticles have illustrated solid antimicrobial movement and solidness, making them appropriate for different applications. Encourage inquire about is required to fully get it the potential of these nanoparticles and assess their viability in several settings. By tackling the control of garlic extricate in nanoparticle shape, ready to investigate modern roads for combating bacterial diseases and advancing health and well-being. In conclusion, nanoparticles of garlic extricate are a promising modern innovation for a assortment of applications. They can be utilized to make utilitarian materials for mechanical utilize, such as antimicrobial coatings and nourishment bundling. Moreover, they may have potential therapeutic benefits, such as medicate conveyance frameworks and malady anticipation. As inquire about proceeds to development in this zone, we are able anticipate to see more items containing nanoparticles of garlic extricate on the showcase. With advance examination, these nanoparticles may ended up an critical apparatus in combating bacterial contaminations and advancing wellbeing and well-being.

**Reference:**

1. Lebeaux D, Ghigo JM, Beloin C. Biofilm-related infections: bridging the gap between clinical management and fundamental aspects of recalcitrance toward antibiotics. *Microbiol Mol Biol Rev* 2014;78:510–543. [[PMC free article](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4187679/)] [[PubMed](https://pubmed.ncbi.nlm.nih.gov/25184564)] [[Google Scholar](https://scholar.google.com/scholar_lookup?journal=Microbiol+Mol+Biol+Rev&title=Biofilm-related+infections:+bridging+the+gap+between+clinical+management+and+fundamental+aspects+of+recalcitrance+toward+antibiotics&author=D+Lebeaux&author=JM+Ghigo&author=C+Beloin&volume=78&publication_year=2014&pages=510-543&pmid=25184564&)]
2. Chandra J, Kuhn DM, Mukherjee PK, Hoyer LL, McCormick T, Ghannoum MA. Biofilm formation by the fungal pathogen Candida albicans: development, architecture, and drug resistance. *J Bacteriol* 2001;183:5385–5394. [[PMC free article](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC95423/)] [[PubMed](https://pubmed.ncbi.nlm.nih.gov/11514524)] [[Google Scholar](https://scholar.google.com/scholar_lookup?journal=J+Bacteriol&title=Biofilm+formation+by+the+fungal+pathogen+Candida+albicans:+development,+architecture,+and+drug+resistance&author=J+Chandra&author=DM+Kuhn&author=PK+Mukherjee&author=LL+Hoyer&author=T+McCormick&volume=183&publication_year=2001&pages=5385-5394&pmid=11514524&)]
3. Mirza YH, Tansey R, Sukeik M, Shaath M, Haddad FS. Biofilm and the Role of Antibiotics in the Treatment of Periprosthetic Hip and Knee Joint Infections. *Open Orthop J* 2016;10:636–645. [[PMC free article](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5398090/)] [[PubMed](https://pubmed.ncbi.nlm.nih.gov/28484579)] [[Google Scholar](https://scholar.google.com/scholar_lookup?journal=Open+Orthop+J&title=Biofilm+and+the+Role+of+Antibiotics+in+the+Treatment+of+Periprosthetic+Hip+and+Knee+Joint+Infections&author=YH+Mirza&author=R+Tansey&author=M+Sukeik&author=M+Shaath&author=FS+Haddad&volume=10&publication_year=2016&pages=636-645&pmid=28484579&)]
4. Vinh DC, Embil JM. Device-related infections: a review. *J Long Term Eff Med Implants* 2005;15:467–488. [[PubMed](https://pubmed.ncbi.nlm.nih.gov/16218897)] [[Google Scholar](https://scholar.google.com/scholar_lookup?journal=J+Long+Term+Eff+Med+Implants&title=Device-related+infections:+a+review&author=DC+Vinh&author=JM+Embil&volume=15&publication_year=2005&pages=467-488&pmid=16218897&)]
5. Campoccia D, Montanaro L, Arciola CR. The significance of infection related to orthopedic devices and issues of antibiotic resistance. *Biomaterials* 2006;27:2331–2339. [[PubMed](https://pubmed.ncbi.nlm.nih.gov/16364434)] [[Google Scholar](https://scholar.google.com/scholar_lookup?journal=Biomaterials&title=The+significance+of+infection+related+to+orthopedic+devices+and+issues+of+antibiotic+resistance&author=D+Campoccia&author=L+Montanaro&author=CR+Arciola&volume=27&publication_year=2006&pages=2331-2339&pmid=16364434&)]
6. Buommino E, Scognamiglio M, Donnarumma G, Fiorentino A, D'Abrosca B. Recent advances in natural product-based anti-biofilm approaches to control infections. *Mini Rev Med Chem* 2014;14:1169–1182. [[PubMed](https://pubmed.ncbi.nlm.nih.gov/25553429)] [[Google Scholar](https://scholar.google.com/scholar_lookup?journal=Mini+Rev+Med+Chem&title=Recent+advances+in+natural+product-based+anti-biofilm+approaches+to+control+infections&author=E+Buommino&author=M+Scognamiglio&author=G+Donnarumma&author=A+Fiorentino&author=B+D%27Abrosca&volume=14&publication_year=2014&pages=1169-1182&pmid=25553429&)]
7. Galdiero S, Falanga A, Berisio R, Grieco P, Morelli G, Galdiero M. Antimicrobial peptides as an opportunity against bacterial diseases. *Curr Med Chem* 2015;22:1665–1677. [[PubMed](https://pubmed.ncbi.nlm.nih.gov/25760092)] [[Google Scholar](https://scholar.google.com/scholar_lookup?journal=Curr+Med+Chem&title=Antimicrobial+peptides+as+an+opportunity+against+bacterial+diseases&author=S+Galdiero&author=A+Falanga&author=R+Berisio&author=P+Grieco&author=G+Morelli&volume=22&publication_year=2015&pages=1665-1677&pmid=25760092&)]
8. Sharifi-Rad J, Sureda A, Tenore GC, et al. Biological Activities of Essential Oils: From Plant Chemoecology to Traditional Healing Systems. *Molecules* 2017;22. [[PMC free article](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6155610/)] [[PubMed](https://pubmed.ncbi.nlm.nih.gov/28045446)] [[Google Scholar](https://scholar.google.com/scholar_lookup?journal=Molecules&title=Biological+Activities+of+Essential+Oils:+From+Plant+Chemoecology+to+Traditional+Healing+Systems&author=J+Sharifi-Rad&author=A+Sureda&author=GC+Tenore&volume=22&publication_year=2017&)]
9. Wang J, Vermerris W. Antimicrobial Nanomaterials Derived from Natural Products-A Review. *Materials (Basel)* 2016;9. [[PMC free article](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5502919/)] [[PubMed](https://pubmed.ncbi.nlm.nih.gov/28773379)] [[Google Scholar](https://scholar.google.com/scholar_lookup?journal=Materials+(Basel)&title=Antimicrobial+Nanomaterials+Derived+from+Natural+Products-A+Review&author=J+Wang&author=W+Vermerris&volume=9&publication_year=2016&)]
10. Ankri S, Mirelman D. Antimicrobial properties of allicin from garlic. *Microbes Infect* 1999;1:125–129. [[PubMed](https://pubmed.ncbi.nlm.nih.gov/10594976)] [[Google](https://scholar.google.com/scholar_lookup?journal=Microbes+Infect&title=Antimicrobial+properties+of+allicin+from+garlic&author=S+Ankri&author=D+Mirelman&volume=1&publication_year=1999&pages=125-129&pmid=10594976&)
11. Patiño-Morales, C.C.; Jaime-Cruz, R.; Sánchez-Gómez, C.; Corona, J.C.; Hernández-Cruz, E.Y.; Kalinova-Jelezova, I.; PedrazaChaverri, J.; Maldonado, P.D.; Silva-Islas, C.A.; Salazar-García, M. Antitumor Effects of Natural Compounds Derived from Allium sativum on Neuroblastoma: An Overview. Antioxidants 2022, 11, 48. [CrossRef]
12. Yetgin, A.; Canli, K.; Altuner, E.M. Comparison of antimicrobial activity of Allium sativum cloves from China and Ta¸sköprü, Turkey. Adv. Pharmacol. Sci. 2018, 2018, 9302840. [PubMed]
13. Chen, C.; Liu, C.H.; Cai, J.; Zhang, W.; Qi, W.L.; Wang, Z.; Liu, Z.-B.; Yang, Y. Broad-spectrum antimicrobial activity, chemical composition and mechanism of action of garlic (Allium sativum) extracts. Food Control 2018, 86, 117–125. [CrossRef]
14. Bhatwalkar, S.B.; Mondal, R.; Krishna, S.B.N.; Adam, J.K.; Govender, P.; Anupam, R. Antibacterial Properties of Organosulfur Compounds of Garlic (Allium sativum). Front. Microbiol. 2021, 12, 613077. [CrossRef]
15. Fufa, B. Anti-bacterial and anti-fungal properties of garlic extract (Allium sativum): A review. Microbiol. Res. J. Int. 2019, 28, 1–5. [CrossRef]
16. Kshirsagar, M.M.; Dodamani, A.S.; Karibasappa, G.N.; Vishwakarma, P.K.; Vathar, J.B.; Sonawane, K.R.; Khobragade, V.R. Antibacterial activity of garlic extract on cariogenic bacteria: An in vitro study. Ayu 2018, 39, 165–172. [CrossRef]
17. Sasi, M.; Kumar, S.; Kumar, M.; Thapa, S.; Prajapati, U.; Tak, Y.; Changan, S.; Saurabh, V.; Kumari, S.; Kumar, A.; et al. Garlic (Allium sativum L.) Bioactives and Its Role in Alleviating Oral Pathologies. Antioxidants 2021, 10, 1847. [CrossRef]
18. Žlabur, J.Š.; Brajer, M.; Vo´ca, S.; Gali´c, A.; Radman, S.; Rimac-Brnˇci´c, S.; Xia, Q.; Zhu, Z.; Grimi, N.; Barba, F.J.; et al. ultrasound as a promising tool for the green extraction of specialized metabolites from some culinary spices. Molecules 2021, 26, 1866. [CrossRef] [PubMed]
19. Ranjha, M.M.A.N.; Irfan, S.; Lorenzo, J.M.; Shafique, B.; Kanwal, R.; Pateiro, M.; Arshad, R.N.; Wang, L.; Nayik, G.A.; Roobab, U.; et al. Sonication, a Potential Technique for Extraction of Phytoconstituents: A Systematic Review. Processes 2021, 9, 1406. [CrossRef]
20. Yulizar, Y.; Harits, A.A.; Abduracman, L. Green synthesis of gold nanoparticles using aqueous garlic (Allium sativum L.) Extract, and its interaction study with melamine. Bull. Chem. React. Eng. Catal. 2017, 12, 212. [CrossRef]
21. Beato, V.M.; Orgaz, F.; Mansilla, F.; Montaño, A. Changes in phenolic compounds in garlic (Allium sativum L.) owing to the cultivar and location of growth. Plant Foods Hum. Nutr. 2011, 66, 218–223. [CrossRef]
22. Stan, M.; Popa, A.; Toloman, D.; Dehelean, A.; Lung, I.; Katona, G. Enhanced photocatalytic degradation properties of zinc oxide nanoparticles synthesized by using plant extracts. Mater. Sci. Semicond. Process. 2015, 39, 23–29. [CrossRef]
23. Whitesides, G.M. The “right” size in nanobiotechnology. Nat. Biotechnol. 2003, 21, 1161–1165. [CrossRef] 55. Pal, S.; Tak, Y.K.; Song, J.M. Does the Antibacterial Activity of Silver Nanoparticles Depend on the Shape of the Nanoparticle? A Study of the Gram-Negative Bacterium Escherichia coli. Appl. Environ. Microbiol. 2007, 73, 1712–1720. [CrossRef]
24. Bouqellah, N.A.; Mohamed, M.M.; Ibrahim, Y. Synthesis of eco-friendly silver nanoparticles using Allium sp. and their antimicrobial potential on selected vaginal bacteria. Saudi J. Biol. Sci. 2019, 26, 1789–1794. [CrossRef] [PubMed] 57. Shrivastava, S.; Bera, T.; Roy, A.; Singh, G.; Ramachandrarao, P.; Dash, D