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A Review on the Role of Quercetin in Development of Silver Nanoparticles (AgNPs)

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ABSTRACT

According to the EU Commission, a nanomaterial is a manmade or natural material that contains unbound, aggregated, or agglomerated particles with exterior diameters in the 1–100 nm size range. More than 4,500 years ago, humans exploited the strengthening of ceramic matrixes by incorporating natural asbestos nanofibers. Because of their widespread antibacterial activity, silver nanoparticles (AgNPs) are the most widely employed nanoparticles. Silver nanoparticles are found in 383 of 1628 nanotechnology items. Nanoparticles are synthesized by various materials obtained from natural, biological, phytochemical, bacterial sources, and many more. Quercetin is a widely distributed natural bioflavonoid found in a variety of therapeutic plants. It has anti-oxidant, anti-inflammatory, anti-cancer, and neuroprotective characteristics (Lesjak et al., 2018) qualities. It's also been shown to be a potential reducer in the production of medicinal nanomaterials. Quercetin is a bioflavonoid found in more than twenty plant species and is renowned for its anti-inflammatory, antihypertensive, vasodilator, anti-obesity, anti-hypercholesterolemic, and anti-atherosclerotic properties. It concludes, that choosing Quercetin- a plant material has numerous advantages in the formulation of silver nanoparticles and adds to the effectiveness of drug delivery.

INTRODUCTION

According to the EU Commission, a nanomaterial is "a manmade or natural material that contains unbound, aggregated, or agglomerated particles with exterior diameters in the 1–100 nm size range (Potocnik et al. 2011). According to British Standards Institution, nanoscience is the science and analysis of the matter at the nanoscale, focusing on understanding size and arrangement properties and comparing the emergence of atoms and molecules, as well as bulk material-related distinctions whereas a nanoparticle is a nano-object with three tiny dimensions on the outside. When the longest and shortest axis lengths of a nano-object differ, the terms nanorod or nanoplate are used instead of nanoparticle (BSI, 2011). Nanomaterials (NMs) can have properties that are distinct from those of comparable chemical substances in a bigger dimension. NMs are also known as "materials with at least one dimension in the range of about 1 to 100 nm and show dimension-dependent phenomena," according to the US Food and Drug Administration (USFDA) (FDA, 2011).

NMs are also classified as "materials with any outward nanoscale dimension or having the internal nanoscale surface structure" by the International Organization for Standardization (ISO).

History of nanomaterials

More than 4,500 years ago, humans exploited the strengthening of ceramic matrixes by incorporating natural asbestos nanofibers. More than 4000 years ago, the Ancient Egyptians used NMs for hair color, relying on a synthetic chemical technique to produce 5 nm diameter PbS NPs (Walter et al. 2006). Similarly, "Egyptian blue" was the first synthetic pigment created and utilized by Egyptians in the 3rd century BC using a sintered blend of nanometer-sized glass and quartz (Johnson et al. 2013).

Mesopotamians began employing glazed ceramics for metallic luster designs around the 9th century (Heiligtag & Niederberger, 2013). Chemical synthesis of metallic NPs dates back to the 14th and 13th centuries BC when Egyptians and Mesopotamians began manufacturing glass out of metals, marking the commencement of the metallic nanoparticle era. These materials could be among the first to use synthesized NMs in a practical application. Red glass tinted by surface plasmon stimulation of Cu NPs has been discovered in Frattesina di Rovigo (Italy) from the Late Bronze Age (1200–1000BC) (Artioli et al 2008).

Mie (1908) later revealed the explanation for metal colloids' distinct colors. SiO2 NPs were developed in the 1940s as a carbon black alternative for rubber reinforcing (Mie, 1908).

Silver nanoparticles

Because of their widespread antibacterial activity, silver nanoparticles (AgNPs) are the most widely employed nanoparticles. Silver nanoparticles are found in 383 of 1628 nanotechnology items (Mulfinger et al. 2007). Milk contains silver nanoparticles that reduce microbial multiplication. When silver nanoparticles react with bacteria, they cling to both the cell wall and the cell membrane, inhibiting replication and resulting in cell death. When silver dissolves in the cytosol, it ionizes and forms nanoparticles, which boosts bactericidal activity (Hemalatha & Premnath, 2016).

Synthesis ways of silver nanoparticles

Physical

Metal nanoparticles are made physically via the desiccation condensate process, which can be done with a vacuum tube shell at atmospheric pressure per unit area. The carrier gas is vaporized from the source fabric, which is centered on a boat. Nanoparticles of various components such as Ag, Gold, Pb, and fullerene have been created utilizing vaporization procedures (Rai et al. 2009). In essence, the physical synthesis of AgNPs typically uses physical energy to produce AgNPs with a proximately limited size distribution.

Biological

Biosynthetic techniques based on natural reduction components such as polysaccharides, biological microorganisms, bacteria, fungi, plant extraction, and green chemistry have recently been developed as a viable and simple alternative to more complex synthetic chemistry processes. Bacteria could produce inorganic chemicals both intracellularly and extracellularly. Green tea extract was used as a stabilizing agent by Vilchis-Genus Nestor et al. (Wu et al. 2018) to decrease gold-silver nanoparticles in an aqueous medium under environmental conditions.

Photochemical

A desiccation condensate process, which may be done with a vacuum tube shell at atmospheric pressure per unit area, is used to make metal nanoparticles. The carrier gas vaporizes the source fabric, which is centered on a boat. Nanoparticles of a variety of materials, including Ag, Gold, Pb, and fullerene, have already been created utilizing vaporization procedures. In general, the physical synthesis of AgNPs uses physical energy to produce AgNPs with a proximately constrained size distribution (Choudhary & Sekhon, 2012).

Kalishwaralal et al. (2008) also mentioned that AgNP is synthesized by decreasing aqueous Ag + ions and Bacillus licheniform is a supernatant culture (Prabhu & Poulose, 2012).

Fungal-induced formation

Silver nanoparticles have been shown to make Escherichia coli more susceptible than S. aureus. The fungus responded by producing Ag (+) ions, which decreased the precursor extracellular nanoparticles to form in the solution develop (Thompson et al. 2008). To make AgNPs from Aspergillus niger, you must first grow the fungus. Optimal conditions include a temperature of 37°F and a pH of 6.0. In comparison to Staphylococcus aureus, Pseudomonas aeruginosa and Escherichia coli produced superior antibacterial nanoparticles using Pleurotus sajor caju.A silver nitrate membrane quantity of 2,0 mm was required (Zhang et al. 2010).

When Aspergillus fumigates were exposed to silver ion for a few hours, an extraordinary synthesis of AgNPs with a distribution of 525 nm was found. The aggregation of silver nanoparticles is employed for Fusarium oxysporum formation. AgNP's conventional halogen tungsten lamp approach, on the other hand, took less than an hour to create (Kruis et al. 2000).

Plant-induced production

According to a study using antioxidant components from blackberry, blueberry, and pomegranate, as well as turmeric peels, the size of silver nanoparticles formed by these extracts, ranged between 20 and 500 nm, depending on their origin and manufacturing technique (Tsuji et al. 2002). It was discovered to be an excellent catalyst for the creation of the response, resulting in the rapid generation of AgNPs with a molecular dimension of 59 nm in less than 24 hours (Huang & Yang, 2008). The presence of dihydrogen monoxide soluble organics in natural sources was the most important factor in silver ion degradation to AgNPs.

Bacterial induced production

In the production of biogenic silver nanoparticles, the lactobacillus fermentum prevents the growth of Pseudomonas aeruginosa and prevents biofilm formation. Anisotropic nanoparticles made from B. flexus nanoparticles were spherical (12nm) and triangle (61 nm) (Muller et al. 2002). An incubation period of 3–5 days at ambient temperature is required for AgNP to employ B. cereus. Pseudomonas stutzeri AG259 has good silver nanoparticles and a unique shape in the periplasmic area, which was produced from a silver mine (Yguerabide & Yguerabide, 1998).

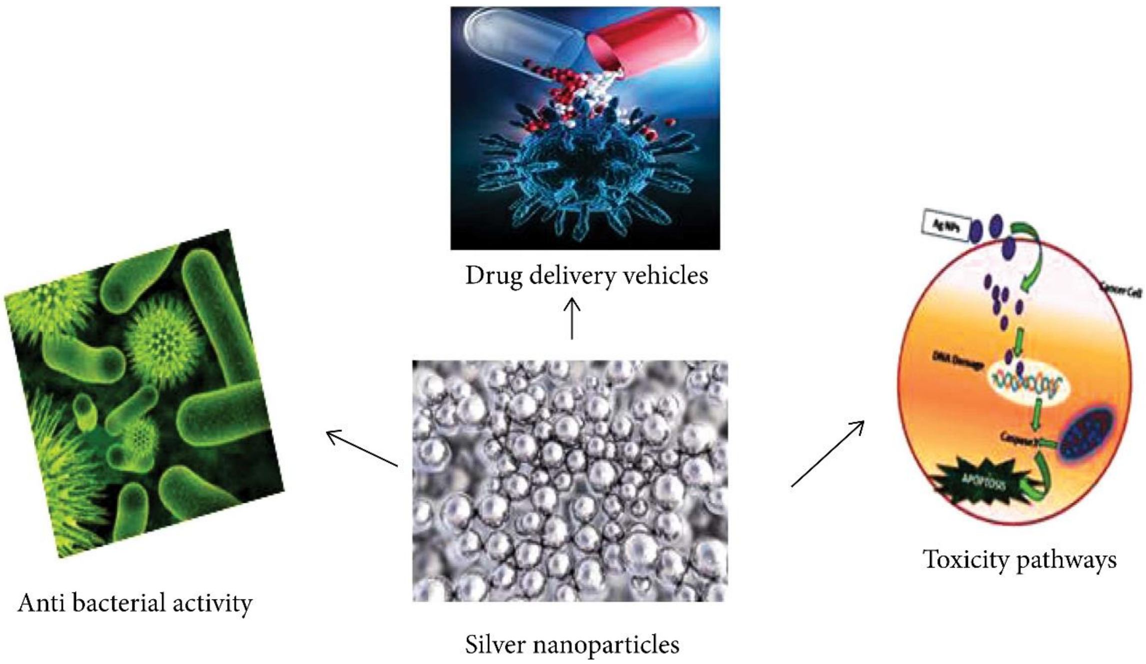

Figure No. 1: Different uses of silver nanoparticles

Quercetin in silver nanoparticles

Quercetin is a widely distributed natural bioflavonoid found in a variety of therapeutic plants. It has anti-oxidant, anti-inflammatory, anti-cancer, and neuroprotective characteristics (Lesjak et al., 2018) qualities. It's also been shown to be a potential reducer in the production of medicinal nanomaterials (Lakshmi & Kim, 2019). Quercetin (QCT) is an antioxidant, antifibrotic, and wound-healing compound. Silver nanoparticles (AgNPs) are a powerful antibacterial, antifungal, and wound-healing agent that is widely used to treat wounds, particularly diabetic and burn wounds.

Hydrodynamic diameter, percent entrapment efficiency (%EE), surface morphology, texture features, the *in-vitro* release of drug, skin irritation study, ex-vivo permeation study (confocal study), and antimicrobial activity were all evaluated by the researchers. The optimum formulation had a hydrodynamic diameter of 44.1nm and a smooth spherical surface shape, with 92.09 % of QCT encapsulated in QCT-AgNPs hydrogel matrix. On S. aureus and E. coli, the antimicrobial study demonstrated that QCT-AgNPs hydrogel outperformed commercialized (MRKT) gel in terms of therapeutic efficacy. In addition, in-vivo studies showed that QCT-AgNPs hydrogel significantly reduced wound gap and increased percent re-epithelialization in an excisional diabetes wound model after 18 days of therapy compared to diabetic control. Finally, this research brings up a new therapy option for diabetic wounds (Badhwar et al. 2021).

Synthesis of Quercetin-Silver nanoparticles

Quercetin (2 mM) stock solution is produced using 1 mM sodium hydroxide solution at pH 8 and maintained at room temperature. Following that, 1 mM of 10 ml silver nitrate is produced, to which 0.1 ml of quercetin solution was added dropwise at room temperature while stirring constantly. The bio-reduction of silver ions (Ag^+) to neutral ions (Ag^0) in the solution was promoted, as demonstrated by the brown hue. The resulting colloidal AgNPs are filtered via a 0.22-micron syringe filter and kept refrigerated (2–8ºC) until the further investigation (Pandian et al. 2021).

The experiment is repeated three times, confirming the method's reliability.

Pharmacological potentials of Quercetin

These are the following pharmacological properties of Quercetin (David et al. 2016) -

Anti-oxidant

Anti-inflammatory

Prophylaxis of Cardiovascular disease

Neurodegenerative disorders

Cancer & apoptosis

Anti-ulcerogenic

Useful in gastritis

Antibacterial

Antiviral

Asthma & Hay fever

Allergies

CONCLUSION

Quercetin is a bioflavonoid found in more than twenty plant species and is renowned for its anti-inflammatory, antihypertensive, vasodilator, anti-obesity, anti-hypercholesterolemic, and anti-atherosclerotic properties (Salvamani et al. 2014). One of the important causes in the development of diseases like hypertension, vascular problems, and metabolic syndrome is free radicals.

It concludes, that choosing Quercetin- a plant material has numerous advantages in the formulation of silver nanoparticles and adds to the effectiveness of drug delivery.

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CONFLICT OF INTEREST

None

REFERENCES

1. Artioli G, Angelini I, Polla A. Phase Transitions. 2008; 81:233–252.
2. Badhwar Reena, Bharti Mangla, Yub Raj Neupane, Kushagra Khanna, and Harvinder Popli. Quercetin-loaded silver nanoparticles in hydrogel matrices for diabetic wound healing. *Nanotechnology*, 32:505102.
3. Considering Whether an FDA-Regulated Product Involves the Application of Nanotechnology. USA: Federal Drug Administration; 2011.
4. David Alexander Victor Anand , Radhakrishnan Arulmoli, and Subramani Parasuraman. Overviews of Biological Importance of Quercetin: A Bioactive Flavonoid. Pharmacogn Rev. 2016 Jul-Dec; 10(20): 84-89.
5. H. Huang and Y. Yang, “Preparation of silver nanoparticles in inorganic clay suspensions,” Composites Science and Technology, vol. 68, no. 14, pp. 2948–2953, 2008.
6. Heiligtag F J, Niederberger M. Mater Today. 2013; 16:262–271.
7. Hemalatha P and A. Premnath, “Study on silver nanoparticle encapsulated curcumin for anticancer activity,” World Journal of Pharmaceutical Research, vol. 5, pp. 958–973, 2016.
8. Johnson-McDaniel D, Barrett C A, Sharafi A, Salguero T T. J Am Ceram Soc. 2013; 135:1677–1679.

9. Kruis F E, H. Fissan, and B. Rellinghaus, "Sintering and evaporation characteristics of gas-phase synthesis of sizeselected PbS nanoparticles," Materials Science and Engineering: B, vol. 69, pp. 329–334, 2000.
10. Lesjak M., Beara I., Simin N., Pintać D., Majkić T., Bekvalac K.et al. (2018) Antioxidant and anti-inflammatory activities ofquercetin and its derivatives. J. Funct. Foods. 40: 68–75.
11. Mie G. Ann Phys (Berlin, Ger) 1908; 330:377–445.
12. Mulfinger L, S. D. Solomon, M. Bahadory, A. V. Jeyarajasingam, S. A. Rutkowsky, and C. Boritz, "Synthesis and study of silver nanoparticles," Journal of chemical education, vol. 84, no. 2, p. 322, 2007.
13. Muller R. H., M. Radtke, and S. A. Wissing, "Solid lipid nanoparticles (SLN) and nanostructured lipid carriers (NLC) in cosmetic and dermatological preparations," Advanced drug delivery reviews, vol. 54, pp. S131–S155, 2002.
14. Choudhary N and B. S. Sekhon, "Potential therapeutic effect of curcumin-an update," Journal of Pharmaceutical Education and Research, vol. 3, no. 2, p. 64, 2012.
15. Nanoparticles. Vocabulary. London, United Kingdom: British Standards Institution; 2011; PAS 71:2011.
16. Pandian Sureshbabu Ram Kumar, Selvaraj Kunjiappan, Vigneshwaran Ravishankar, Velmurugan Sundarapandian. Synthesis of quercetin-functionalized silver nanoparticles by rapid one-pot approach**.** BioTechnologia vol. 102 (1) C pp. 75–84 C 2021.
17. Potocnik J. Off J Eur Communities: Legis. 2011; L 275:38–40.
18. Prabhu S and E. K. Poulose, "Silver nanoparticles: mechanism of antimicrobial action, synthesis, medical applications, and toxicity effects," International nano letters, vol. 2, no. 1, pp. 1–10, 2012.
19. Rai M, A. Yadav, and A. Gade, "Silver nanoparticles as a new generation of antimicrobials," Biotech Advances, vol. 27, pp. 76–83, 2009.
20. Salvamani S, Gunasekaran B, Shaharuddin NA, Ahmad SA, Shukor MY. Antiartherosclerotic effects of plant flavonoids. *Biomed Res Int 2014.* 2014:480258.
21. Thompson D G, A. Enright, K. Faulds, W. E. Smith, and D. Graham, "Ultrasensitive DNA detection using oligonucleotide− silver nanoparticle conjugates," Analytical chemistry, vol. 80, no. 8, pp. 2805–2810, 2008
22. Tsuji T, K. Iryo, N. Watanabe, and M. Tsuji, "Preparation of silver nanoparticles by laser ablation in solution: influence of laser wavelength on particle size," Applied surface science, vol. 202, no. 1-2, pp. 80–85, 2002.
23. Vu X. H., T. T. T. Duong, T. T. H. Pham, D. K. Trinh, X. H. Nguyen, and V. S. Dang, "Synthesis and study of silver nanoparticles for antibacterial activity against Escherichia coli and Staphylococcus aureus," Advances in Natural Sciences: Nanoscience and Nanotechnology, vol. 9, no. 2, article 025019, 2018.
24. Walter P, Welcomme E, Hallégot P, Zaluzec N J, Deeb C, Castaing J, Veyssière P, Bréniaux R, Lévêque J-L, Tsoucaris G. Nano Lett. 2006; 6:2215–2219.
25. Yguerabide J and E. E. Yguerabide, "Light-scattering submicroscopic particles as highly fluorescent analogs and their use as tracer labels in clinical and biological applications: II Experimental characterization," Analytical biochemistry, vol. 262, no. 2, pp. 157–176, 1998.
26. Zhang L, L. Laug, W. Munchgesang et al., "Reducing stress on cells with apoferritin-encapsulated platinum nanoparticles," Nano Letters, vol. 10, no. 1, pp. 219–223, 2010