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To Prepare and Evaluate Silver Nitrate Nanoparticles for Pharmaceutical Application

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Abstract

This study aimed to prepare and evaluate silver nitrate nanoparticles for pharmaceutical applications, by conducting synthesis and characterization of the nanoparticles and evaluating their potential use as a drug delivery system through in vitro studies. The research work concludes that the silver nanoparticles were prepared by green synthesis using Quercetin as a reducing agent. The study also looked at how environmental conditions such as temperature and light, and concentration of Quercetin and silver nitrate, affected the size, shape, and morphology of the particles. It was found that the nanoparticles were affected by changes in these conditions and maximum absorption was observed. The research also found that higher amounts of drug and/or silver nitrate in the synthesis resulted in larger particle size and aggregation. The size of the nanoparticles was found to be inversely proportional to temperature, with higher temperatures resulting in smaller particle size. The Quercetin synthesis of silver nanoparticles showed strong absorption and is being used in various pharmaceutical applications. The method used in the study is a green approach that offers chemical-free, non-toxic, and eco-friendly synthesis of silver nanoparticles.

Keywords: Dirac's elegant, Relativistic, Newtonian point

Introduction

Nanotechnology:

Nanotechnology is an integrative field of system that delivers a smart drug delivery platform to achieve a desired therapeutics effect. A Nano formulation is beneficial for those drugs which has limitations like as poor solubility and poor bioavailability. Nanotechnology performs multiple functions which can deliver the drug particles across the blood brain barrier and responsible for the targeted drug delivery. Nano formulation contains many benefits such as increase the surface area of drug particles, stability, solubility, and permeation of drug should be improved. Dose as well as dosage frequency should be reduced so the adverse effect of drugs also eliminates [1].

Metallic Nanoparticles:

Metallic nanoparticles are emerging platform of novel drug delivery. The surface Plasma resonance and optical properties contains special characteristics of metallic nanoparticles. In the synthesis of metallic nanoparticles chemicals causes toxicity to overcome the toxic material used substitute of living organisms like as bacteria, fungi, and plants. Nano formulations from many past years are also usd for treatment of wound healing. Metallic nanoparticles like silver, gold, copper, titanium, and zinc oxide demonstrate the therapeutic effect over skin wounds [2, 3].

Metallic nanoparticles are interest for applications extending from catalysts and sensing to optics, anti-bacterial activity, and data storage that due to the size and shape- dependent properties. The antibacterial activity of different metal nanoparticles including as silver colloids is related to their size i.e., the smaller is the nuclei of silver the greater is the antibacterial activity. The nanoparticles catalytic activity often depends on their size and their composition, form, size distribution and chemical-physical environment. Hence, an important function for regulating the distribution of size and control over the size. Generally, specified control of shape, size and size distribution is also obtained by changing the method of synthesis, reduction of agents and stabilizers [4].

Gold nanoparticles are providing the field of researchers in chemistry, biology, physics, and medicine. Multiple drugs, antibiotics, vaccines, and antibodies are conjugate with gold nanoparticles to deliver the target delivery. Tao et al. have proposed the use of gold nanoparticles for antimicrobial activity and toxicity [5].

Method of preparation/Synthesis of Metallic Nanoparticles:

Metallic nanoparticles are primarily based on based on top-down synthesis and bottom-up synthesis (Figure.1). The top-down method bulk material disintegrates to deliver the requisite while the bottom-up synthesis nanoforms are generated from atoms and molecules. These methods further split up into separate subclasses based on process, state of reaction and protocols followed. Therefore, the division of preparation metallic nanoparticles are physical, chemical, and biological. Each approach has significance and drawbacks with frequent obstacles like costs, scalability, size distribution and particle sizes [6, 7, 8].

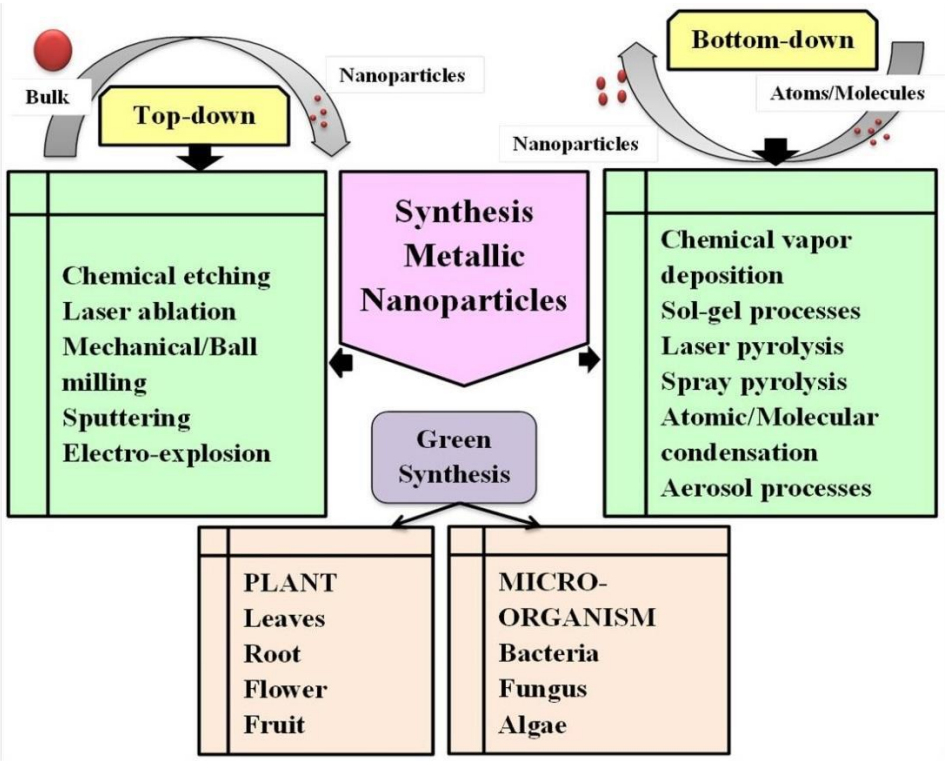


Figure 1: Shows the schematic diagram of metallic nanoparticle synthesis

Scope

Quercetin, a bioflavonoid which is obtained from fruits and plants but due to its poor solubility and bioavailability its use is quite limited. To overcome the limitation of quercetin use the advance nanoformulation that is nanoparticles for the better delivery of drug. Quercetin is having various pharmaceutical effects such as antioxidant, anti-diabetes anti-inflammatory, anti-cancer, etc. A wide range of nanoformulation has be designed and developed to provide the therapeutic delivery of drugs. But the major concern arise is the toxicity, so that will be overcome with the help of green synthesis approach. In the present work of research, prepare and evaluation of silver nitrate for pharmaceutical applications. Therefore the quercetin silver nanoparticles will be used for the in-vivo study of diabetes and wound healing animal models.

- The scope of green synthesis nanoformulation is:
- Targeted drug delivery
- The stability and solubility of drug should be improved
- Dose as well as dosage frequency should be reduced
- Adverse effects of drug should be eliminated
- Bioavailability of drug should be upgraded

It is manifested that essential oil has the hopeful potential for the treatment of arthritis. Though, the low water solubility, high volatility, and instability of essential oil are major concerns and reduce its applicability in medicine. This compound seems to have a new domain and the possibility for therapeutic intervention. A microemulsion is an approach which could solve the aggravation of essential oils use via improving stability, solubility and permeability. Microemulsion can be expected to be equivalent as micellar solutions that solubilize the oil domain in the non-surfactant tail to provide a robust microstructure. Microemulsion is being used to improve targeting of drug throughout treatment of several diseases. The formulation and evaluation of microemulsion containing essential oil was conducted in order to establish a delivery mechanism for treating rheumatic arthritis and the scope of the developing microemulsion is:

- Sustained release
- Controlled release
- Modulation of the kinetics of the drug release
- Decrease toxicity
- Enhanced drugs absorption

Formulation, Development and Evaluation

State, colour and odour of drug quercetin were characterized by visual inspection.

Melting Point:

Melting point of quercetin was determined using capillary method. The capillary was closed from one end than the sample was filled in the capillary tube from the other end. The capillary was kept in the melting point apparatus and the

temperature at which drug melts was noted.

Determination of lamda max:

The UV spectrum of drug quercetin was obtained by UV –Vis spectrophotometer. 10mg drug was dissolved in sufficient quantity of methanol and final volume was filled upto 10ml. The stock solution was prepared and scanned from 200-400nm, so that the recorded spectrum shown the maximum wavelength of drug. The maximum wavelength of drug was help for the determination of drug purity.

Partition coefficient:

Partition coefficient was used to determination of partition of a solute (Drug) between two immiscible solvents. Partition coefficient was determined by using shake flasks method. The method was carried out with n-Octanol, 0.1N HCL, phosphate buffer pH 6.8, phosphate buffer pH 7.4 and water. In each separating funnel added 25:25 ratios of all solvents and then added 10 mg of drug. It was shaken separately for an hour or more and when both phases were mixed together rest them for 24 hours for the separation. When the both phases were separated individually remove them in separate beaker. The prepared the aliquot samples and analyzed the absorbance with UV- Vis spectrophotometer.

Compatibility studies:

Compatibility studies were conducted to ensure the compatibility among the drug, excipients and the physical mixture of drugs and excipients. The physical mixture was kept in the glass vials for 48 hours at room temperature (37ºC). The results were obtained based on visual observations and infrared spectroscopy.

Visual observations:

The sample of physical mixture was observed for any visual changes.

Infrared spectroscopy:

The samples were assessed to IR spectrum for physical and chemical changes. The spectra individual of drug and excipients were compared with the mixtures of drug and excipients.

Organoleptic properties:

The drug was found to be yellowish in colour and practically odourless.

Melting point:

The melting point of quercetin was found to be 314-316ºC as measured by melting point apparatus.

Partition coefficient:

The data of partition coefficient in different solvents (n-Octanol, 0.1N HCL, Phosphate buffer pH 6.8, Phosphate buffer pH 7.4 and water) was listed in table 2.

Table 2: UV analysis of partition coefficient in different solvents

Concentration (ml)	Absorbance (nm)							
	Water	n-Octanol	HCL	n-Octanol	pH-6.8	n-Octanol	pH-7.4	n-Octanol
0.5	0.008	0.039	0.001	0.001	0.001	0.20	0.004	0.034
1.0	0.012	0.469	0.004	0.044	0.002	0.277	0.008	0.145
1.5	0.108	0.643	0.005	0.789	0.005	0.598	0.01	0.231
2.0	0.25	0.745	0.009	0.903	0.008	0.784	0.012	0.363
0.5	0.008	0.039	0.001	0.001	0.001	0.20	0.004	0.034
1.0	0.012	0.469	0.004	0.044	0.002	0.277	0.008	0.145

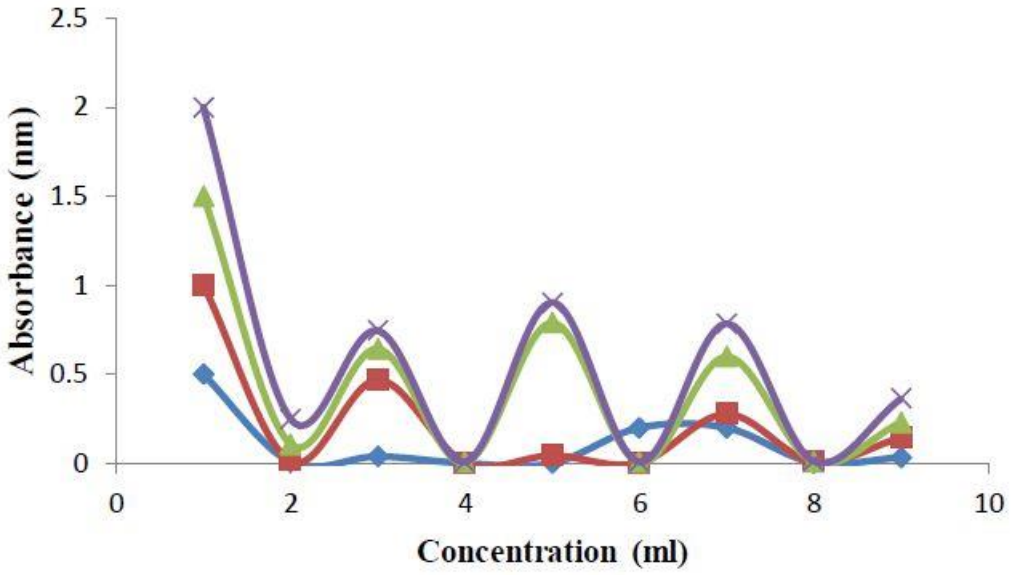


Figure 3: Graph of partition coefficient of drug

Compatibility studies:

The compatibility studies were performed for the physical mixture of the drug and excipients for 48 hours at room temperature (37ºC). The results were observed as follows:

Visual observation:

The result followed that no such prominent changes was observed in the physical mixture. No changes in the state of the drug and excipients were observed. The visual observations suggested that the drug and excipients were compatible.

Infrared spectroscopy:

The overall result of compatibility studies suggests no nitration between the drug and excipients. These observations lay

down the basis for the final selection of drug and excipients for the development of nanoparticles.

Formulation, Development and Evaluation

Preparation of silver nanoparticles

Firstly, all the glass wares were properly wash and dried before experiment. Then the stock solution of quercetin was developed by weight 0.1mg quercetin powder in 10 ml methanol then mixed well. In the prepared mixture of 5mM silver nitrate added 0.1ml of quercetin stock solution. Leave the prepared mixture for few minutes after few minutes check the colour of solution. A change in colour from pale yellowish to dark brown has shown the produce of silver nanoparticles.

Methods

Silver nanoparticles synthesis by green approach:

A silver nanoparticle was synthesis by using reduction agent quercetin. Quercetin contains biomolecules so it has to reduce the chance of toxicity and prepared eco-friendly nanoformulation. Quercetin based on the mechanism in which the silver ions get reduced and formation of nanoparticles contains silver. The change in colour showed that the formation of silver nanoparticles started. After few hours their no change in colour while it considered as all silver ions get reduced.

Preparation of nanoparticles with different drug concentration:

The silver nanoparticles were formulated with 5mM solution of silver nitrate. The different drug concentrations such as 1%, 2%, 3%, 4% and 5% was added in dark condition at room temperature (35ºC). All the prepared batches were analyzed to the U.V. spectrophotometer.

Preparation of nanoparticles with different silver nitrate concentration:

Silver nitrate formulation with different concentrations ranging from 2nm, 4nm, 6nm, 8nm and 10 nm were prepared respectively. The fix amount of drug was added in all batches and rest for few minutes. The silver ions get reduced according to time and silver nitrate concentration. The batch of all these concentration was prepared in dark and light condition at room temperature. The readings of prepared batches were taken with the UV –Vis spectrophotometer.

Preparation of nanoparticles with different temperature conditions:

Silver nanoparticles were prepared at different temperatures ranges (20 ºC, 25 ºC, 30 ºC, 35 ºC and 45ºC). To determine temperature effect on the rate of nanoparticles synthesis were analyzed by UV- Vis spectrophotometer. The batches were prepared with the ranges of silver nitrate concentration 2mM, 4mM, 6mM and10mM.

Preparation of nanoparticles on dark or light conditions:

The silver ions were highly reactive and decompose when come to the light exposer. To determine the effect of light and dark conditions prepared the silver nanoparticles in both conditions. The same amount of 5mM silver nitrate solution was prepared with fixed drug

concentration. Analyse the reaction in light and dark conditions by the UV-Vis spectrophotometer.

Characterization of silver nanoparticles

Physical appearance:

All prepared batches of nanoparticles were checked with clarity. It was confirm that silver ions by colour change of solution from colourless to brown.

UV Vis spectrum of nanoparticles: The characterization of silver nanoparticles was done by UV-Vis spectroscopy (Shimadzu UV-1800). The absorption range was used in between 200-800nm. Put the adequate sample of solution in both cuvettes and reading was taken.

Evaluation of silver nanoparticles: The composition, form and morphology of silver nanoparticles are highly influenced by different environmental and physicochemical factors like as light, temperature, concentration of reactant and silver nitrate concentration.

Effect of different drug concentration: The effect drug concentration of silver nanoparticles was observed with the spectra. The drug amount was increased so silver ion reduced faster and more the formation of silver nanoparticles. The amount of drug concentration was directly proportional to the size of nanoparticles and formation.

Effect of silver nitrate concentration: Silver nitrate concentrations were high in amount than the reaction was more; it observed that reflected peak in the absorbance. The Large particle showed the aggregation in the silver nanoparticles, Therefore it caused due to the higher metal ion concentration.

Effect of temperature: Size and morphology of synthesised silver nanoparticles have shown the significant effects due to the reaction temperature. Figure showed the variation in the absorption spectra of silver nanoparticles at various temperatures respectively. The reaction temperature varies from 20ºC -40ºC. From the data, it has been found that the absorption rate moved towards the lower wavelength with an increase in the reaction temperature. The result showed that increase in temperature decrease in particle size.

Effect of light or dark conditions: Silver was decomposed with in the explorer in light so the reaction, size and morphology of nanoparticles were changes according to the parameters and conditions. In the dark conditions formation of silver nanoparticles showed better than the light conditions.

Results and Discussion

Nanoparticles were prepared with green approach using silver nitrate and quercetin used as active agent.

Characterization of nanoparticles:

Physical appearance:

All prepared batches of nanoparticles were checked for their colour changes from colourless to brown. The method of reducing silver ions and forming silver nanoparticles was determined for all the formulations prepared.

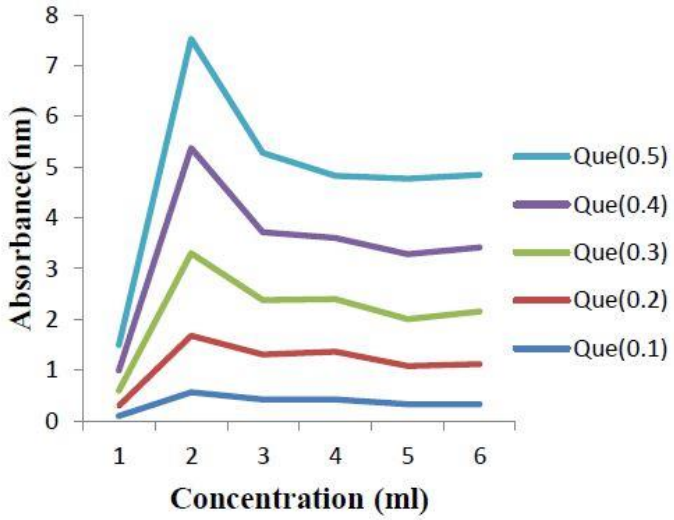
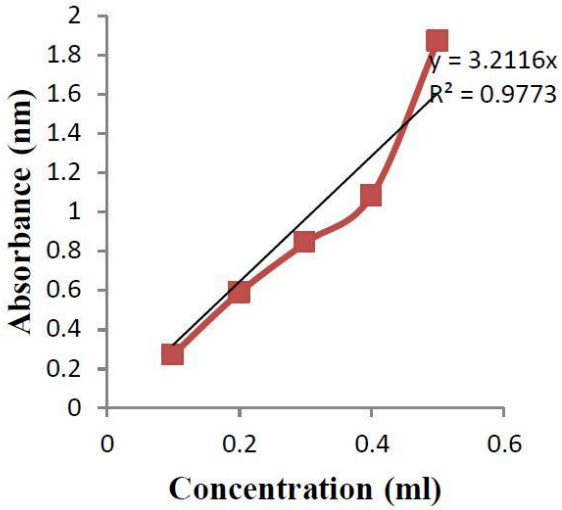


Figure 4: Absorption spectra at various temperature scales 20 ºC, 25 ºC, 30 ºC, 35 ºC and 45ºC of silver nanoparticles



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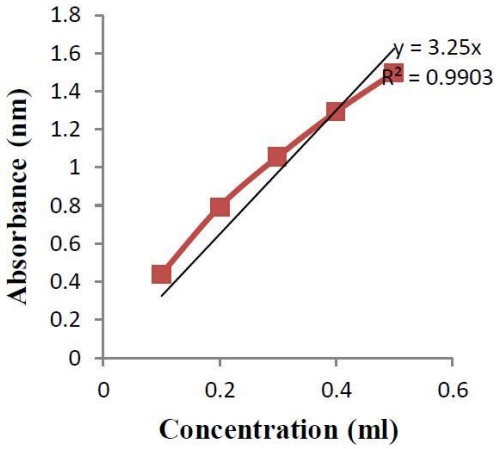

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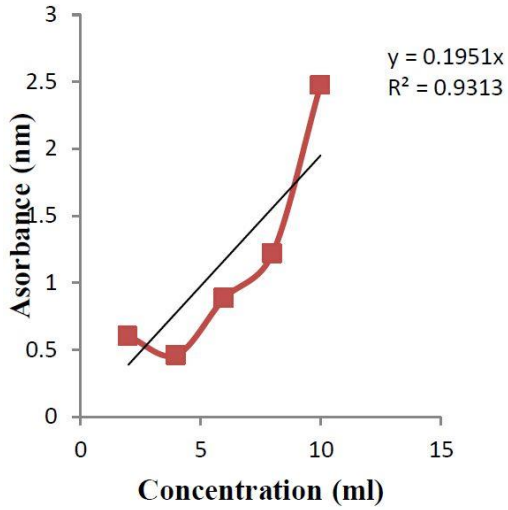
Figure 5: Silver nanoparticles spectra obtained at different drug concentrations in a) dark and b) light conditions



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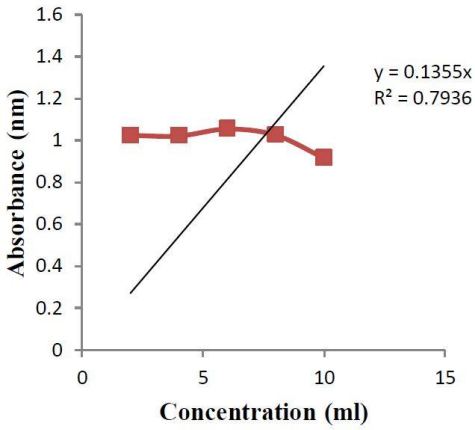

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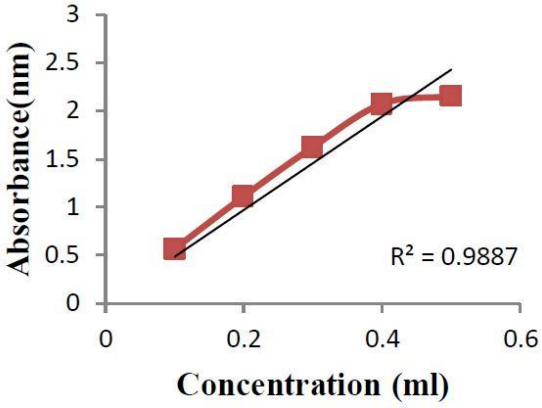
Figure 6: Silver nanoparticles spectra obtained at various silver nitrate concentrations in a) dark and b) light conditions



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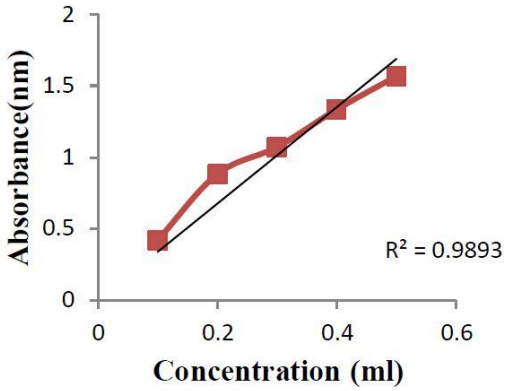
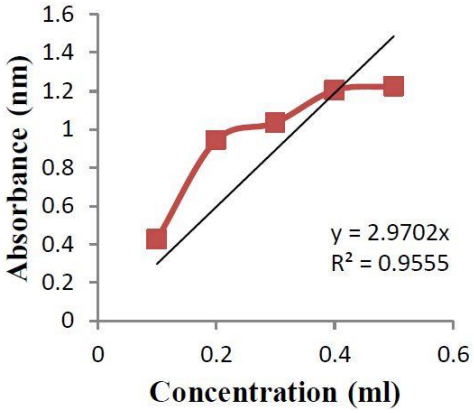
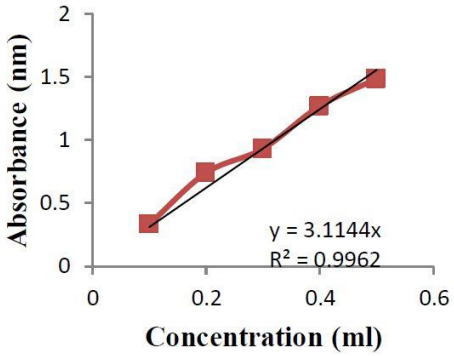

Absorbance(nm)
Concentration (ml)
R² = 0.9893

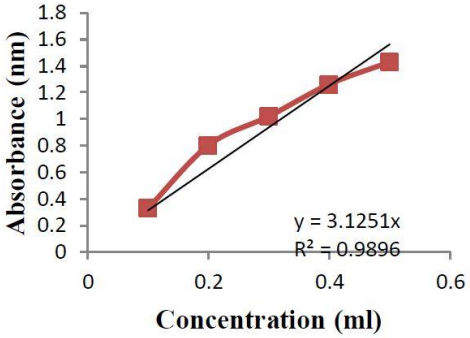
b)


Absorbance (nm)
Concentration (ml)
y = 2.9702x
R² = 0.9555

c)

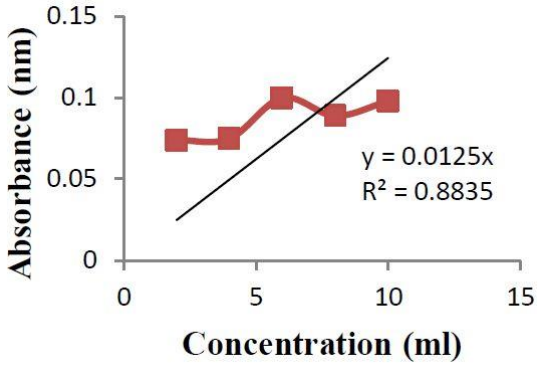

Absorbance (nm)
Concentration (ml)
y = 3.1144x
R² = 0.9962

d)


Absorbance (nm)
Concentration (ml)
y = 3.1251x
R² = 0.9896

e)

Figure 7: Silver nanoparticles spectra obtained at different temperatures a) 40ºC b) 35 ºC c) 30 ºC d) 25 ºC e) 20 ºC in the light conditions



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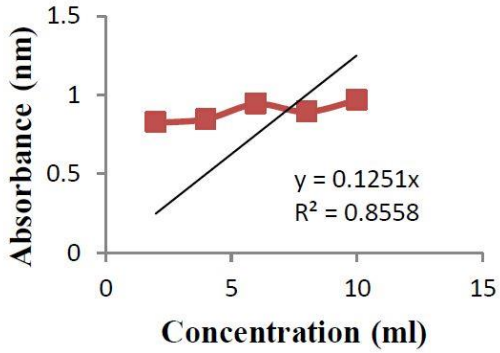

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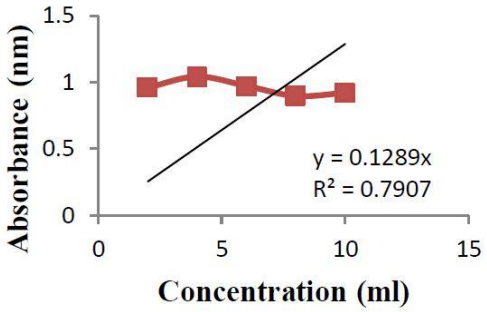

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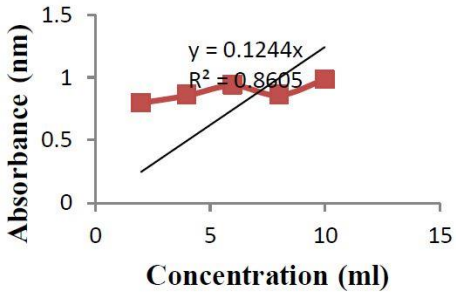
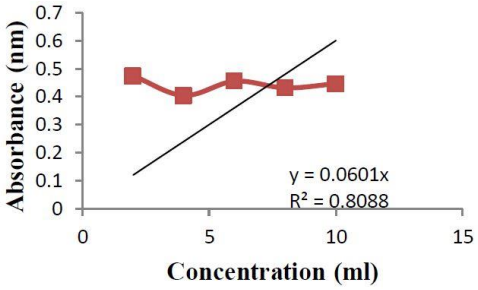


d)



e)

Figure 8: Silver nanoparticles spectra obtained at different silver nitrate concentrations in the conditions a) dark and b) light

Conclusion

The research work concludes that the silver nanoparticles prepared by green synthesis. Quercetin acts as reducing agent, mainly responsible for reduction of silver ions into nanoparticles. Studied the effects of change in environmental conditions namely temperature and effect of light, also studied effects of change in concentration of quercetin and silver nitrate during the synthesis. It was noted that the size, shape, and morphology of particles were altered with change in these conditions and maximum absorption was observed. Higher the amount of drug (reducing agent) and/or silver nitrate in the synthesis, the larger is the size of nanoparticles and hence causes aggregation. Nanoparticle size was found to be inversely proportional to the temperature, so the higher temperature shows smaller particle size. Quercetin synthesis of silver nanoparticles showed strong absorption and is being used in various pharmaceutical applications. Green approach offers chemical free, non-toxic, and eco-friendly synthesis of silver nanoparticles.

REFERENCES

1. Chellappan, D. K., Yee, N. J., Kaur Ambar Jeet Singh, B. J., Panneerselvam, J., Madheswaran, T., Chellian, J., … Dua, K. (2019). Formulation and characterization of glibenclamide and quercetin-loaded chitosan nanogels targeting skin permeation. Therapeutic Delivery. https://doi.org/10.4155/tde-2019-0019
2. Harish K K, Nagasamy V, Himangshu B, Anuttam K. Metallic Nanoparticle: A Review. Biomed J Sci &Tech Res 4(2)-2018. doi: 10.26717/ bjstr.2018.04.001011.
3. Felipe Oyarzun-Ampuero, Alejandra Vidal, Miguel Concha, Javier Morales, Sandra Orellana and Ignacio Moreno-Villoslada, "Nanoparticles for the Treatment of Wounds", Current Pharmaceutical Design (2015) 21: 4329. https://doi.org/10.2174/1381612821666150901104601
4. Abou El-Nour, K.M., Eftaiha, A.A., Al-Warthan, A. and Ammar, R.A., 2010. Synthesis and applications of silver nanoparticles. Arabian journal of chemistry, 3(3), pp.135-140. https://doi.org/10.1016/j.arabjc.2010.04.008
5. Tao C. Antimicrobial activity and toxicity of gold nanoparticles: research progress, challenges and prospects. Lett Appl Microbiol. 2018;67(6):537-543. doi:10.1111/lam.13082
6. Khan, I., Saeed, K. and Khan, I., 2019. Nanoparticles: Properties, applications and toxicities. Arabian journal of chemistry, 12(7), pp.908-931. https://doi.org/10.1016/j.arabjc.2017.05.011
7. Heerak Chugh, Damini Sood, Ishita Chandra, Vartika Tomar, Gagan Dhawan & Ramesh Chandra (2018) Role of gold and silver nanoparticles in cancer nano-medicine, Artificial Cells, Nanomedicine, and Biotechnology, 46:sup1, 1210-1220, DOI: 10.1080/21691401.2018.1449118
8. Tran, Q. H., Nguyen, V. Q., Le, A. Silver nanoparticles: synthesis, properties, toxicology, applications and perspectives. Adv. Nat. Sci.: Nanosci. Nanotechnol. 4 (2013) 033001 (20pp). https://doi.org/10.1088/2043-6254/aad12b
9. Wani, Md.Y., Hashim, Md.Ali. Nanotoxicity:Dimensional and morphology concerns. Advances in physical chemistry, 2011(450912), pp. 1-15.
10. Swathy, B., 2014. A review on metallic silver nanoparticles. IOSR J Pharm, 4(7), pp.2250-3013.
11. 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(6), 1712–1720.
12. Wu, T.; Duan, X.; Hu, C.; Wu, C.; Chen, X.; Huang, J.; Cui, S. Synthesis and characterization of gold nanoparticles from Abies spectabilis extract and its anticancer activity on bladder cancer T24 cells. Artif Cell Nanomed B, 2019, 47(1), 512–523.
13. Sohail, A. MohammadCancer Targeted Metallic Nanoparticle: Targeting Overview, Recent Advancement and Toxicity Concern. Curr Pharm Design, 2011, 17(18), 1834–1850.
14. Vimbela, G.; Ngo, S.M.; Fraze, C.; Yang, L.; Stout, D.A. Antibacterial properties and toxicity from metallic nanomaterials. Int J Nanomedicine, 2017, 12, 3941–3965.
15. Her, S.; Jaffray, D.A.; Allen, C. Gold nanoparticles for applications in cancer radiotherapy: Mechanisms and recent advancements. Adv Drug Deliv Rev. 2017, 109, 84–101.