Synthesis of Silver Nanoparticle and Study the Effect on Adenosine Amino Hydrolase (ADA) Enzyme Activity in Blood Serum

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Abstract

Chemical reduction method was used successfully to prepare cubic Ag nanoparticles using trisodium citrate as a reduction agent, all of the materials' ingredients were produced in double distilled water. A UV–vis spectrophotometer, X-ray diffraction (XRD) and Transmission electron microscopy (TEM) were used to analyses the silver NPs. The average size of Ag nanoparticles generated was 8 nm to 42 nm, according to TEM studies. The effect of Ag NPs on the activity of Adenosine amino hydrolase (ADA) in the serum of atherosclerosis patients was studied. Patients with atherosclerotic disease with and without Ag nanoparticles exhibited significantly higher serum levels of ADA activity ($P < 0.01$) as comparative to the healthy group. Individuals with atherosclerotic disease who obtained Ag nanoparticles had significantly reduced blood levels of ADA activity than those who did not obtained Ag nanoparticles.

Keywords: Silver nanoparticles, Atherosclerosis disease, Adenosine amino hydrolase enzyme (ADA)

1. Introduction

The nanotechnology is one of the more promising technologies combined in a wide field of scientific disciplines to impart cutting edge features [1-3]. Nanotechnology is concerned with the design, manufacture, and application of nanometer-sized materials in various domains such as biomedical, medication delivery, cosmetics, energy, and so on [4-7]. Nanoparticle production has been more important in recent years as a result of its great biomedical applications, chemical, optical, and electrical properties [8-10]. Ag NPs are recognized as an important area of research due to their surface Plasmon resonance (SPR) and favor in clinical application over other mineral particles in terms of biocompatibility and non-cytotoxicity [11], Their use in treatment for cancer and scanning, genetic disease diagnostics, and photo-thermal therapy are further examples. [12, 13]. Ag NPs used as gene with many functions transporters due to their well-limited surface-chemistry, biocompatibility and utilize fluorescence

resonance energy transfer (FRET) [14–16]. Chemical methods are the more common way to synthesis of mineral nanoparticle which are setup to decrease of metallic ion solutions with reducing agents like sodium tri-sodium citrates, citrate, sodium borohydride, etc. [17,18]. A Cholesterol levels, particularly low-density lipoprotein cholesterol levels, are a major risk factor for atherosclerosis [19]. Many people actually believe that thermogenesis is exclusively defined by lipid deposition in the arterial wall; however, it is much more than that. In fact, atherosclerotic lesions are a collection of highly specific molecular and cellular processes that, when taken collectively, are best defined as an inflammatory illness [20-24]. Atherosclerosis is much more common in large and medium elastic and elastic arteries, and it can cause hypoxia in the heart, brain, or extremities, which can result in infarct. Actually, the first type of lesion, known as a fatty stripe, is a pure inflamed lesion made up entirely of government has put in place macrophages and T cells, and it is common in newborns and younger kids [25-26]. ADA Purine metabolism is catalyzed by the enzyme adenosine deaminase. Another name for this enzyme is adenosine amino hydrolase, or ADA. ADA converts adenosine and 2'-deoxyadenosine to inosine and 2'-deoxyinosine. It is necessary for the digestion of purines in the food as well as the nucleic acid cycling in tissues [27]. Furthermore, ADA is important for the development of the human immune system [28]. The aim of this study was to see the inhibition effect of silver nanoparticles on Adenosine amino hydrolase (ADA) enzyme in Sera of Patients with atherosclerosis.

Experimental

synthesis of silver nanoparticles (Ag NPs)

Cubic silver nanoparticles (Ag NPs) was synthesized via chemical reducing process, all of reactive

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materials constituents were made in double distilled water. 40 ml of AgNO3 in concentrated 10-3 M were heated to boiling in a typical experiment. 3 mL of 2% tri-sodium citrate was slowly added to this solution (drop per second). During this process, the solution was stirred and heated until the color was changed (pale brown). It was then removed from the heat and swirled until it reached room temperature.

Specimens Collection 2

A total of 40 patients' blood samples were taken with atherosclerosis and 40 healthy persons to be used as control. Venous blood samples were taken from both the patients and the controls and were allowed clotting at room temperature. After 15 minutes, the samples are separated by centrifuge at (1800 x g) for 5 minutes.

Statistical analysis 32

Statistical analysis was performed using Microsoft Office (SPSS version 24). The data was analyzed using One-Way ANOVA. Mean ± standard deviation (SD) were used to expressed of the resulting values, where p< 0.01 was considered a very significant.

2. Results and discussion

UV-Vi's spectroscopy analysis

UV-visible absorption spectroscopy, a significant and widely used technique for determining metal nanoparticle formation stability, was used to calculate the optical characteristics of silver nanoparticles. Ag nanoparticles display high electromagnetic wave absorption in visible region due to surface Plasmon resonance (SPR). Due to stimulation in the UV-visible spectrum, Ag NPs exhibit a yellowish – brown color in aqueous solution, depending on particle size [29]. The Plasmon band of Ag NPs suspensions is depicted in Figure (1), with a typical absorbance band for nanoparticles located at 425 nm.

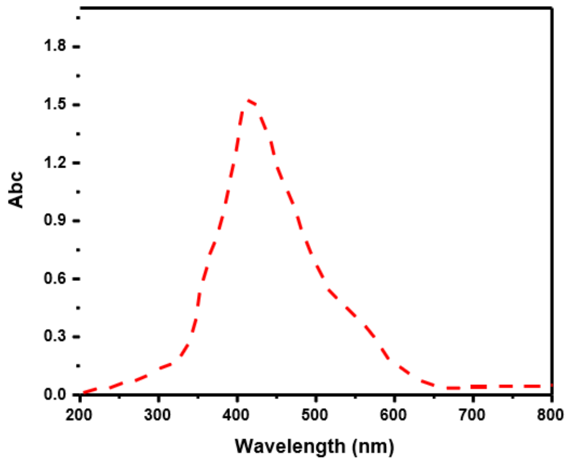

Figure (1): UV-Visible absorption of Ag NPs

3. Transmission Electron Microscopy3

TEM measurements was used to explain different shapes and sizes of mineral nanoparticles. in the present study Ag NPs was analyze through TEM, that clearly showed spherical shape of Ag NPs Figure (2) with sizes ranging from 8 nm to 42 nm. It was noticed from the image that all sizes are within the nanoscale, which is less than 100 nm, that is, they are zero-dimensional, which is preferred in medical applications. The cubic shape is also very clear through the measurement.

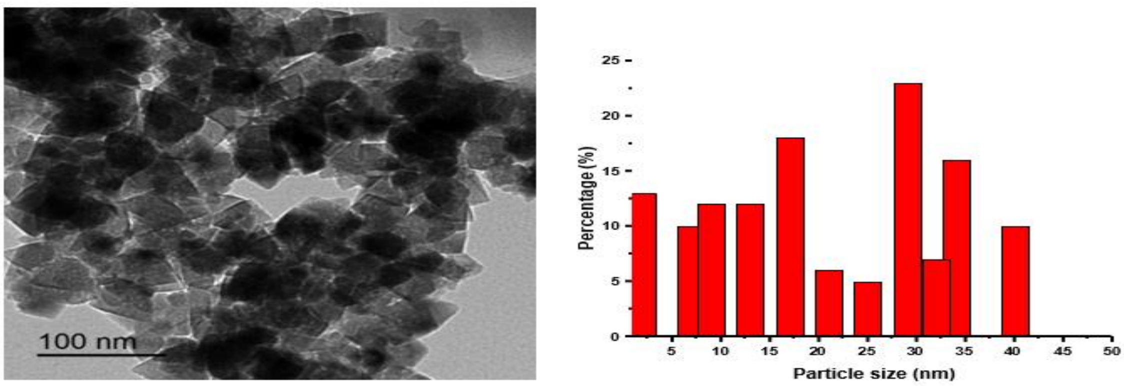

Figure (2) TEM images of Ag nanoparticles

Figure (2) TEM images of Ag nanoparticles

XRD patterns 3

The representative X-ray diffract gram of the produced Ag NPs is presented in Figure

It should be noted that the four XRD pattern diffraction peaks of 37.88˚, 45.12o, 64.43o and 76.29° are referred to the 111, 200, 220 and 311 planes shows that the produced Ag NPs were basically crystalline [30]. on the other hand, the peaks are noticeably widened, indicating that the substance is made up of very small Ag crystallites. The nanoparticles' XRD patterns have many size-dependent characteristics, resulting in abnormal peak placements, heights, and widths. The crystal size (s) of cubic Ag NPs was appreciated utilizing the Debye-Scherrer equation and was to be 11.67 nm [30].

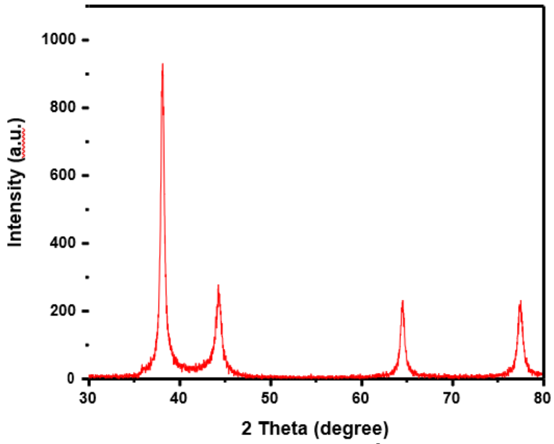

Figure (3): XRD pattern of Ag NPs

Effect of Ag nanoparticles on Adenosine aminohydrolase enzyme activity

In the current study, the level of ADA was measured in sera of patients with atherosclerosis and compared with the control group, Table (1) and figure 4.

Table (1): Adenosine aminohydrolase level in sera of controls and atherosclerosis patients.

Groups	Adenosine amino hydrolase Mean ± SD	p-value
Control	21.643±11.58	p<0.01
Patients without *nanoparticle*	44.17±12.43	p<0.01
Patients with *nanoparticle*	26.46 ±12.97	p<0.01
p<0.01= highly significant		

The results have shown a highly significant increase (P < 0.01) in the levels of serum of ADA enzyme activity in atherosclerosis patients with and without Ag nanoparticle in comparison to a control group. A highly significant decrease (P < 0.01) also has shown in the levels of serum of ADA enzyme activity in atherosclerosis patients with Ag nanoparticle compared to serum patients without Ag nanoparticle.

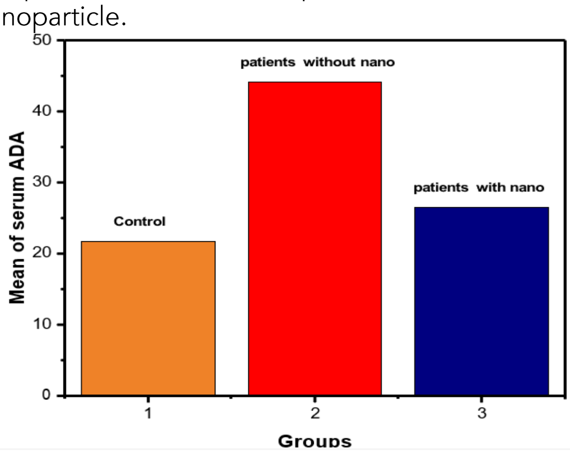

Figure (4): ADA level measured in sera of control and patients (with and without Nano)

4. Conclusions

In this study, Ag NPs were produced using a chemical reduction method. Using an aqueous solution of silver nitrate with trisodium citrate, Ag NPs with an average size of 8nm to 42nm were produced. The current study describe how Ag nanoparticles affects the activity of Adenosine amino hydrolase (ADA) in serum from Iraqi atherosclerosis patients. The results revealed that Ag nanoparticles had a significant inhibitory effect on ADA enzyme activity.

References

Rheima, A. M., Aboud, N. A., Jasim, B. E., Ismail, A. H., & Abbas, Z. S. (2021). Synthesis and structural characterization of ZnTiO3 nanoparticles via modification sol-gel prosses for assessment of their antimicrobial activity. International journal of pharmaceutical research, 13(1).

Rheima, A. M., Mahmood, R. S., Hussain, D. H., & Abbas, Z. S. (2020). Study the Adsorption Ability of Alizarin Red Dye from Their Aqueous Solution on Synthesized

Rheima, A. M., Aboud, N. A., Jasim, B. E., Ismail, A. H., & Abbas, Z. S. (2021). Synthesis and structural characterization of ZnTiO3 nanoparticles via modification sol-gel prosses for assessment of their antimicrobial activity. International journal of pharmaceutical research, 13(1).

Salman, A. T., Ismail, A. H., Rheima, A. M., Abd, A. N., Habubi, N. F., & Abbas, Z.

S. (2021, March). Nano-Synthesis, characterization and spectroscopic Studies of chromium (III) complex derived from new quinoline-2-one for solar cell fabrication. In Journal of Physics: Conference Series (Vol. 1853, No. 1, p. 012021). IOP Publishing.

A.H. Ismail, H.K. Al-Bairmani, Z.S. Abbas, et al., Nano-synthesis, spectroscopic characterisation and antibacterial activity of some metal complexes derived from Theophylline. Egyptian Journal of Chemistry. 2020, 63(7): 1-5.

Ismail, A. H., Al-Bairmani, H. K., Abbas, Z. S., & Rheima, A. M. (2020, November). Nano metal-complexes of theophylline derivative: synthesis, characterization, molecular structure studies, and antibacterial activity. In IOP Conference Series:

Materials Science and Engineering (Vol. 928, No. 5, p. 052028). IOP Publishing.
Ismail, A. H., Al-Bairmani, H. K., Abbas, Z. S., & Rheima, A. M. (2020). Synthesis, Characterization, Spectroscopic and Biological Studies of Zn (II), Mn (II) and Fe (II) Theophylline Complexes in Nanoscale. Nano Biomed. Eng, 12(3), 253-261.
A.H. Ismail, H.K. Al-Bairmani, Z.S. Abbas, et al., Nanoscale synthesis of metal (II) theophylline complexes and assessment of their biological activity. Nano Biomed. Eng., 2020, 12(2): 139-147.
Kamil, A. F., Abdullah, H. I., & Mohammed, S. H. (2021). Cibacron red dye removal in aqueous solution using synthesized CuNiFe2O5 Nanocomposite: thermodynamic and kinetic studies. Egyptian Journal of Chemistry, 64(11), 5-6.
Kamil, A. F., Abdullah, H., Rheima, A. M., & Mohammed, S. H. (2021). Photochemical synthesized NiO nanoparticles based dye-sensitized solar cells: a
comparative study on the counter electrodes and dye-sensitized concentrations. JOURNAL OF OVONIC RESEARCH, 17(3), 299-305.
E.E. Connor, J. Mwamuka, A. Gole, C.J. Murphy, M.D. Wyatt, Small 1 (2005) 325–327.
Verma, S., et al., A facile synthesis of broad plasmon wavelength tunable silver nanoparticles in citrate aqueous solutions by laser ablation and light irradiation. Colloids and Surfaces A: Physicochemical and Engineering Aspects 2017. 527: p. 23- 33.
Hosseinpour-Mashkani, S.M., M. Maddahfar, and A. Sobhani-Nasab, Novel silver- doped NiTiO3: auto-combustion synthesis, characterization and photovoltaic measurements. South African Journal of Chemistry, 2017. 70: p. 44-48.
Koduru, J.R., et al., Phytochemical-assisted synthetic approaches for silver nanoparticles antimicrobial applications: A review. Advances in colloid and interface science, 2018.
Yuhan Lee, Soo Hyeon Lee, Jee Seon Kim, Atsushi Maruyama, Xuesi Chen, Tae Gwan Park, J. Control. Release. 155 (2011) 3–10.
16- M.C. Daniel, D. Astruc, Chem. Rev. 104 (2004) 293–346.
- I.H. El-Sayed, X. Huang, M.A. El-Sayed, Nano Lett. 5 (2005) 829–834.71
S.S. Shankar, A. Rai, A. Ahmad, M. Sastry, Rapid synthesis of Au, Ag, and bimetallic Au core-Ag shell nanoparticles using neem (Azadirachta indica) leaf broth, J. Colloid Interface. Sci. 275(2004) 496-502.
Cleeman, J. I., & Lenfant, C. (1998). The national cholesterol education program: progress and prospects. Jama, 280(24), 2099-2104.
Ross R, Glomset JA. Atherosclerosis and the arterial smooth muscle cell: proliferation of smooth muscle is a key event in the genesis of the lesions of atherosclerosis. Science 1973;180:1332-9.
Idem. The pathogenesis of atherosclerosis. N Engl J Med 1976;295: 369-77, 420-5. 22- Ross R. The pathogenesis of atherosclerosis — an update. N Engl J Med
1986;314:488-500.
Idem. The pathogenesis of atherosclerosis: a perspective for the 1990s. Nature 1993;362:801-9.
Idem. Atherosclerosis: a defense mechanism gone awry. Am J Pathol 1993;143:987- 1002
Napoli C, D'Armiento FP, Mancini FP, et al. Fatty streak formation occurs in human fetal aortas and is greatly enhanced by maternal hypercholesterolemia:
intimal accumulation of low density lipoprotein and its oxidation precede monocyte recruitment into early atherosclerotic lesions. J Clin Invest 1997;100:2680-90.
Stary HC, Chandler AB, Glagov S, et al. A definition of initial, fatty streak, and intermediate lesions of atherosclerosis: a report from the Committee on Vascular Lesions of the Council on Arteriosclerosis, American Heart Association. Circulation 1994;89:2462-78
Lee, G.; Lee, S. S.; Kay, K. Y.; Kim, D. W.; Choi, S., & Jun, H. K. (2009). Isolation and characterization of a novel adenosine deaminase inhibitor, IADA-7, fro Bacillus sp. J-89. Journal of enzyme inhibition and medicinal chemistry, 24(1), 59-64.
Mills, G. C.; Schmalstieg, F. C.; Trimmer, K. B.; Goldman, A. S.; & Goldblum, R.
M. (1976). Purine metabolism in adenosine deaminase deficiency. Proceedings of the National Academy of Sciences, 73(8), 2867-2871.
Zook, J.M., et al., Measuring silver nanoparticle dissolution in complex biological and environmental matrices using UV–visible absorbance. Analytical and bioanalytical chemistry, 2011. 401(6): p. 1993.
Manning R, Ewing, J. (2009). . RACQ vehicles technologies. Temperatures in cars survey. RACQ Vehicles Technologies. 2009:1-21.