Synthesis of Pd nanoparticle and study the effect on Adenosine amino hydrolase (ADA) enzyme activity in blood serum

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Abstract: Chemical reduction with trisodium citrate as the reducing agent resulted in the successful formation of palladium nanoparticles (Pd NPs), and all of the material's components were synthesised in double-distilled water. UV-vis spectroscopy, X-ray diffraction, with Transmission Electron Microscopy were all utilised to investigate the Pd nanoparticles. According to TEM investigations, the average size of the Pd nanoparticles formed was 13.5 - 45 nm. Serum adenosine deaminase (ADA) activity in atherosclerosis patients was tested to see if Pd NPs had any effect. Serum ADA activity was considerably higher in individuals with atherosclerotic disease, both in those treated with Pd nanoparticles and in those who were not ($P<0.01$). Pd nanoparticles significantly lowered blood levels of ADA activity in atherosclerotic disease patients compared to those who did not receive Pd nanoparticles.

Keywords: Pd nanoparticles, Atherosclerosis disease, ADA enzyme

1. Introduction

Nanotechnology is a key achievement in modern science that allows for the creation of materials with unique size, structure, and content [1]. These nano dimensional materials (in the 1–100 nm size range) are thought to act as a link between atomic and bulk materials, exhibiting a variety of chemical, physical, and electrical properties [2]. In chemistry, physics, biology, medicine, and sciences, the study of these qualities has grown increasingly essential [3]. However, in order to exploit nanomaterials, dependable processes are required, and this is still a work in progress [4]. Noble metal nanoparticles have been widely used in a variety of technological applications [5–10], and different wet chemical production methods have been documented [11–13]. Metal and semiconductor nanoparticles have sparked a lot of attention because of their unique features when compared to their bulk counterparts [14-16]. Palladium (Pd) is a noble metal that has been utilized as a catalyst for a long time. Because Pd is a costly metal, recovering and reusing it from used filter cartridges is extremely desirable. Chemical procedures, which are established to reduce metallic ion solutions using reducing agents such sodium trisodium citrates, citrate, sodium borohydride, and so on [17,18], are the most popular way to synthesize mineral nanoparticles. A The presence of

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high levels of cholesterol [19], and especially low-density lipoprotein cholesterol, is a key risk factor for the development of atherosclerosis. While lipid buildup in the arterial wall is a key component in atherogenesis, this is only part of the storey. When seen as a whole, atherosclerotic lesions are best understood as an inflammatory illness that results from a series of very specific cellular and molecular mechanisms [20-24]. Infarction can occur due to atherosclerosis if it occurs in the heart, brain, or limbs, and it is more common in big and medium-sized elastic as well as muscular arteries. Indeed, the first form of lesion, the so-called fatty stripe, is a distinct inflammatory lesion consisting entirely of monocyte-derived macrophages and T cells [26], and it is prevalent in newborns and young children [25]. ADA Adenosine deaminase is an enzyme that catalyses a reaction in the purine metabolic pathway. Another name for this enzyme is adenosine aminohydrolase (ADA). The molecule adenosine deaminase (ADA) catalyses the transformation of adenosine and 2'-deoxyadenosine into inosine and 2'-deoxyinosine. It is essential for the digestion of purines in the diet as well as nucleic acid cycling in tissues [27]. Furthermore, ADA is important for the development of the human immune system [28]. This study aims to see if palladium nanoparticles can block the atherosclerosis-causing enzyme adenosine aminohydrolase (ADA) in the blood of atherosclerosis patients.

2. Experimental

2.1 Synthesis of Pd nanoparticles (Pd NPs)

Palladium nanoparticles were synthesized using a chemical reduction technique in which all of the ingredients of the reactive material were created using double distilled water. In a typical experiment, 25 ml of Pd $(NO_3)_2$ in concentrated 10^{-2} M were heated to boiling. The final concentration of this solution was determined by gradually adding 2 ml of 1% trisodium citrate. The solution was swirled and heated till the color changed during this process. After that, it was taken off the fire and swirled until it was at room temperature.

2.2 Specimen Collection

A total of 35 individuals with atherosclerosis and 35 healthy people were given blood samples to serve as controls. Blood was collected from the patients' veins and left to clot at room temperature, as were those from the controls. After 5 minutes, the samples are centrifuged at (2800 x g) for 5 minutes to separate them.

2.3 Statistical analysis

All of the statistical work was done in Microsoft Office (SPSS version 24). One-Way ANOVA was used to evaluate the data. The resultant data were presented as mean standard deviation (SD), with $p < 0.01$ regarded highly significant.

3- Results and discussion

3.1 XRD patterns

The XRD analysis of produced Pd nanoparticles is displayed in Figure 1. The product exhibits typical crystalline Pd peaks, according to phase identification. There were no peaks attributable to Pd oxides or other contaminants, indicating that Pd nanoparticles are extremely pure. The observed peaks at 2θ degrees 37.967°, 43.839°, 64.316°, and 77.289° correspond to the typical reflection planes (111), (200), (220), and (311), respectively. The diffraction

peaks will expand when nanoparticles are formed. Using Scherrer's equation, the crystallite size of this sample was determined to be 20.5 nm, 12.2 nm, 12.6 nm, and 20.4 nm, respectively, corresponding to the aforementioned varied direction planes. As a result, the average size is roughly 16 nm [29,30].

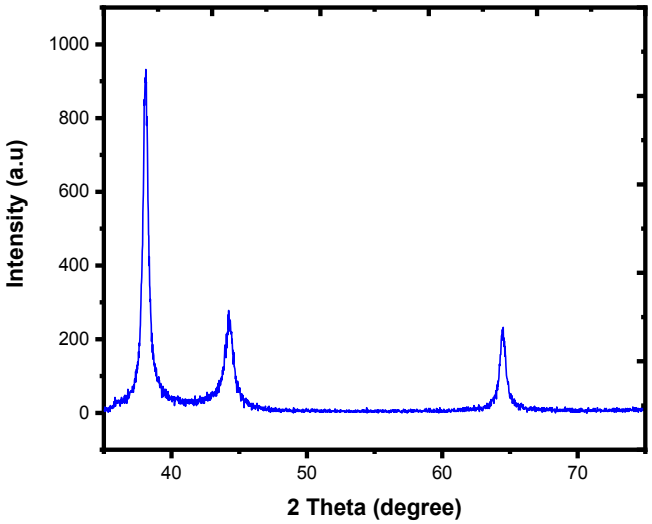

Figure 1. XRD pattern of Pd NPs

3.2 UV-Vis spectroscopy

UV-visible absorption spectroscopy was used to determine the palladium nanoparticles' optical characteristics; this is a popular method for determining the stability of metal nanoparticle production. The UV-Vis spectra of Pd nanoparticles were recorded, and the peak around 410 nm vanished, indicating a considerable change, Figure (2).

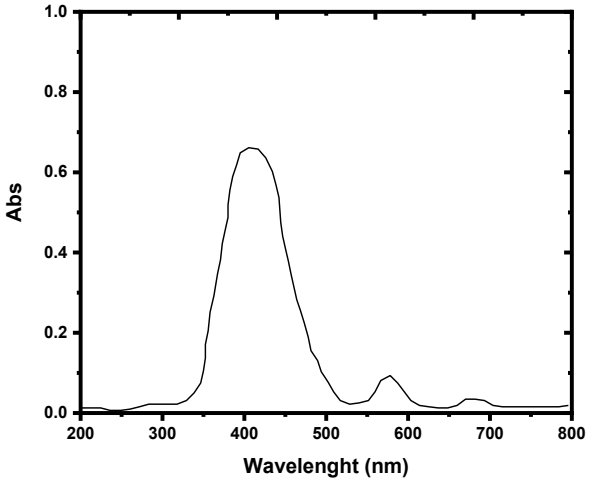

Figure 2. UV-visible absorption of Pd NPs

3.3 TEM study

Pd nanoparticles were analysed for their shape using TEM. Pd NPs measured between 13.5 nm and 48 nm in diameter by TEM were seen to have a spherical form (Figure 3). The

figure shows that all sizes are nanoscale (less than 100 nm), indicating that they are zero-dimensional, which is favored in medical applications.

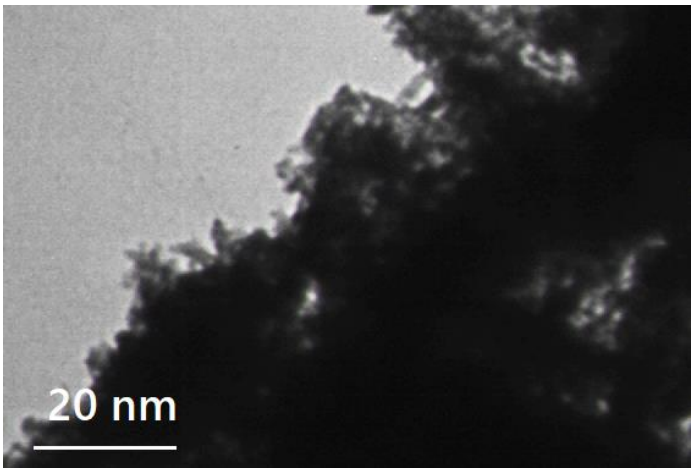

Figure 3. TEM image of Pd NPs

3.4 Effect of Pd nanoparticles on Adenosine aminohydrolase enzyme activity

Table (1): The level of Adenosine aminohydrolase enzyme in the serum of both controls and atherosclerosis patients.

Groups	Adenosine aminohydrolase Mean ± SD	p-value
Control	20.7±10.6	p<0.01
Patients without Pd nanoparticle	48.31±15.52	p<0.01
Patients with Pd nanoparticle	28.73 ±13.45	p<0.01

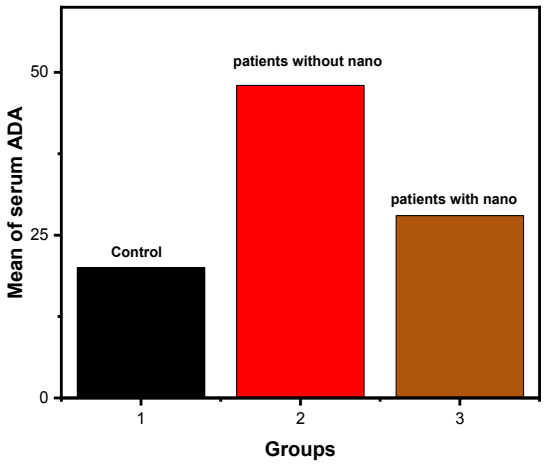

Figure 4. Effect of Pd nanoparticles on Adenosine aminohydrolase enzyme activity

In the present study, researchers quantified ADA levels in the blood serum of atherosclerosis patients and compared their results to those of a healthy control group (Table 1). Patients with atherosclerosis who were given Pd nanoparticles had significantly higher blood ADA enzyme activity compared to those in the control group (P<0.01). The levels of blood ADA

enzyme activity in atherosclerosis patients with Pd nanoparticles were likewise shown to be significantly lower ($P < 0.01$) when compared to serum patients without Pd nanoparticles.

4. Conclusions

Pd NPs were made utilizing a chemical reduction technique in this investigation. Pd NPs with an average size of 13.5 - 45 nm were generated using an aqueous solution of palladium nitrate with trisodium citrate. Pd nanoparticles alter the activity of Adenosine aminohydrolase (ADA) in blood from Iraqi atherosclerosis patients, according to the current study. Pd nanoparticles exhibited a strong inhibitory effect on ADA enzyme activity, according to the findings.

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