

Synthesis Of Selenium Nanoparticles Using Binary Mixture Extracts Of Moringa Oleifera And Solanum Lycopersicum

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ABSTRACT

Nanoparticles have been developed through green synthesis as an alternative to the conventional chemical synthesis as sustainable and environmentally friendly. The current work involved the production of selenium nanoparticles (SeNPs) through the utilization of a binary mixture of plant extracts, which was then separated by utilization of a binary mixture of plant extracts of the Moringa oleifera and Solanum lycopersicum. The plant material was extracted at a ratio of 1:10 (w/v) of the plant material to the solvent to extract the ethanolic extracts. The two extracts were mixed in equal proportions to produce a combined phytochemical system which will be a reducing as well as a stabilizing agent. The extract solution was reacted with a drop of sodium selenite (Na_2SeO_3) in aqueous solution under controlled conditions. The mixture reactor was stirred on magnetic stirrer at 45-55 Celsius and 1500 to 2500 rpm per hour within one hour. The formation of the observable shift in color of the extract as it shifted to become greenish initially followed by reddish-orange suspension was a sign of the production of selenium nanoparticles. UV-Visible spectroscopic analysis of the presence of nano-particle was performed and total spectral scan depicted characteristic absorption at the wavelength of 250-270nm. The spectral analysis showed that the extract of the binary plant had a broad spectrum of absorption with a narrow and stronger spectrum of absorption in the synthesized SeNPs which means that the selenium ions were successful reduced and the nanoscale particle was formed. As demonstrated in this paper, the green synthesis of selenium nanoparticles by the participation of a binary phytochemical system of Moringa oleifera and Solanum

lycopersicum is possible. This plan denotes that plant-based binary extract systems have promising potential in the environmentally friendly synthesis of nanomaterials.

Keywords— Green synthesis, Selenium nanoparticles, Binary plant extract, Moringa oleifera, Solanum lycopersicum, UV–Visible spectroscopy.

Introduction

Nanotechnology has become one of the emerging scientific studies in the modern world [1], [2], [3], [4]. The ability to handle materials on the nanoscale scale has brought in new possibilities in the use of the same in medicine, agriculture, environmental recovery and materials science [2]. As a rule, nanoparticles range between 1-100nm in diameter and they have different physicochemical properties compared to their bulk counterparts [5]. The underlying effects that result in them are quantum confinement effects and the significantly increased surface to volume ratio in the nanoscale [1].

Other engineered nanomaterials that have also been the result of emerging popularity due to their unique biological and physicochemical properties include selenium nanoparticles (SeNPs) [6]. Selenium is an essential trace element, and it is quite critical in most of the biological functions such as antioxidant defense, immune system regulation, and thyroid hormone metabolism [7]. Selenium is also a part of Seleno-protein in living organisms such as glutathione peroxidase and thioredoxin reductase that are used to defend cells against oxidative damage by reactive oxygen species [2] [8].

However, the use of Selenium supplementation through the conventional means such as sodium selenite or sodium selenate is a problem due to the relative stability between the effective and the toxic dose [9]. Excess use of the soluble selenium salts may cause oxidative stress and cell toxicity [10]. Another alternative is the nanoparticles of selenium as they promise good prospects because their nano structure can easily be released, absorb better and is less toxic to the human being compared to the traditional selenium compounds [2], [11].

The traditional methods of the synthesis of selenium nanoparticles typically allude to both physical or chemical [3]. Physical methods include laser ablation or thermal evaporation, these methods require a high level of equipment and require high amounts of energy [12]. Strong reducing agents such as sodium borohydride or hydrazine are normally employed during the chemical synthesis process and can produce hazardous by-products and require strict disposal of waste [8]. Such inadequacies have brought the increased interest in green synthesis protocols in the context of which biological resources are employed as reducing agents [5].

Green synthesis of nanoparticles have also identified alternative successful and green sources in the use of plant extracts [12]. Phytochemicals contained in plant extracts are extremely heterogeneous including flavonoid, phenolic acid, alkaloid, protein and carbohydrates [13]. Such biomolecules can be employed as natural reducer agent by donating an electron to metal ions and converting it to nanoparticles [14], [15]. In addition, many phytochemicals have been utilized as natural stabilizing agents, they prevent aggregation and improve stability of nanoparticles [16], [3], [10], [16], [17].

In most of the studies on the application of plants to the production of nanoparticles,

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the application of isolated plant extracts has been applied [9], [18]. The other approach of interest is binary plant extract systems yet it can be seen that plants produce different phytochemical compositions and thus they may be synergistic during the formation of nanoparticles [19]. The combination and utilization of two-plant sources of investigation could be potentially of the greatest benefit of maximizing the reducing capability, increase the stability of nanoparticles and biological activity of the synthesized nanoparticles [16], [20], [21], [22].

The common characteristic of *Moringa oleifera* is the large numbers of phytochemicals, and antioxidant effects [4] [18]. The leaves of this plant contain flavonoids, phenolic compounds, vitamins and proteins that have high reducing potential [19], [23], [24]. These phytochemicals are found in *Moringa oleifera* and make it a highly promising source of green nanoparticles [25], [24], [26].

Still on the same topic, another plant has been discovered to contain high amounts of bioactive compounds, which include lycopene, phenolic acids, flavonoids and carotenoids and this is *Solanum lycopersicum* (tomato) [7], [27], [28]. These substances are great antioxidants and can be involved in a redox process in order to create nanoparticles [7], [29], [30].

Moringa oleifera and *Solanum lycopersicum* extracts thus can provide a possibly potent phytochemical system, which is capable of reducing the selenium ions and preserving the formed nanoparticles [12], [31], [28]. This is because the proposed paper will analyze the group of green synthesis of selenium nanoparticles using the assistance of ethanolic extracts of the two plants in a binary mixture.

2. Objectives

The specific objectives of the present research were:

1. To prepare ethanolic extracts of *Moringa oleifera* and *Solanum lycopersicum* using controlled extraction conditions.
2. To synthesize selenium nanoparticles using a binary mixture of plant extracts and sodium selenite solution.
3. To monitor nanoparticle formation through visual observation and UV–Visible spectroscopic analysis.
4. To compare the optical properties of the binary extract mixture and the synthesized selenium nanoparticles.

3. Materials and Methods

3.1 Plant Materials

Moringa oleifera and *Solanum lycopersicum* were gathered in the fresh plants in a local agricultural setting. The plant materials were washed with a lot of tap water then washed with distilled water in order to remove dust and other impurities. The plant materials were dried in the shade at room temperature and in well-ventilated environment after washing to conserve phytochemicals that are thermally sensitive. The dried plant materials were then powdered to fine powder using the mortar and pestle. The samples were dried to a fine powder in clean airtight containers till further use.

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3.2 Preparation of Ethanolic Plant Extracts

An extraction by means of ethanol was conducted to extract phytochemicals in the two plant materials. In both the plant samples, a plant material to solvent ratio of 1:10 (w/v) was used to prepare powdered material mixed with ethanol. The mixtures were put in capped containers and left to be soaked during adequate time of extraction with occasional stirring to facilitate phytochemical extraction. The mixtures were extracted after which the mixtures were filtered using whatman filter paper to obtain clear ethanol extracts. An equal amount of the *Moringa oleifera* extract and *Solanum lycopersicum* extract was mixed to create a binary extract mixture. This solution was the reducing and stabilizing solution in the production of selenium nanoparticles.

3.3 Preparation of Sodium Selenite Solution

The precursor used in the preparation of the nanoparticles was sodium selenite (Na_2SeO_3). Sodium selenite was dissolved in a known amount of distilled water to make an aqueous solution. Stirring was done till a solution was obtained.

3.4 Green Synthesis of Selenium Nanoparticles



Figure 1: Synthetic setup for SeNPs using Binary extract of *Moringa oleifera* and *Solanum lycopersicum*

The phytochemical reduction of selenium ions using the prepared binary plant extract mixture was used to produce selenium nanoparticles. A conical flask was used to combine an equal amount of the binary plant extract mixture with sodium selenite solution. The mixture of the reaction was put on a magnetic stirrer and stirred all one hour under controlled experimental situations. The reaction was synthesized at temperatures between 45 Celsius and 55 Celsius with a stirring rate of 1500-2500 rpm. The conditions are chosen so that interaction between selenium ions and plant phytochemicals can be performed successfully. A change in color of the mixture at the time of the reaction was noticed. The greenish extract slowly turned to reddish-orange suspension, which was the indication of reduction in the selenium ions and the development of selenium nanoparticles.

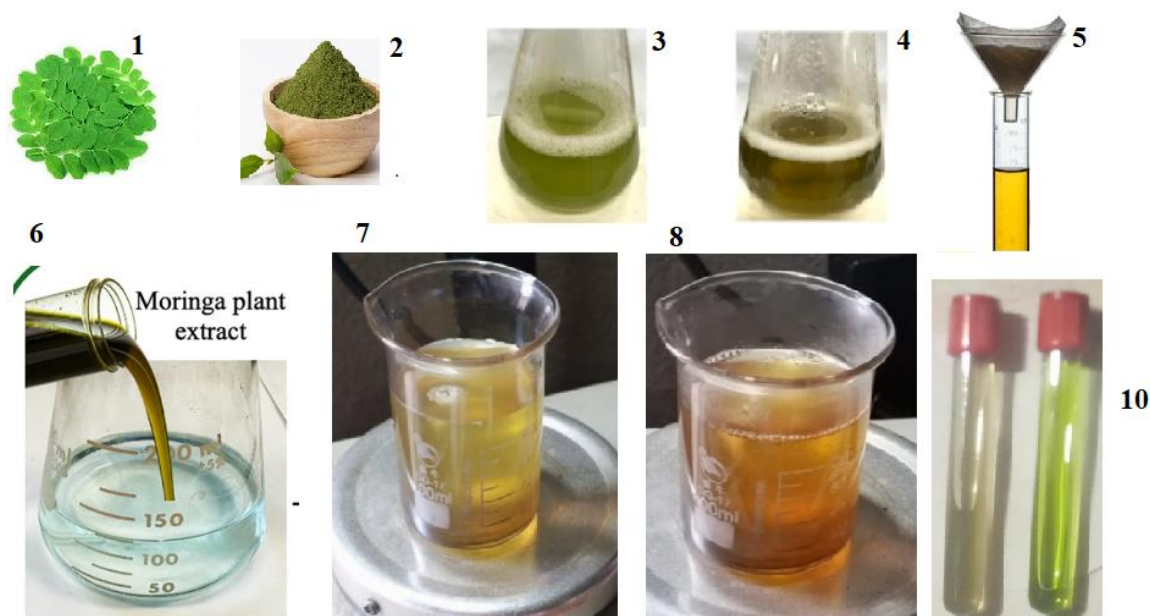


Figure 2: Stepwise synthesis procedures showing the SeNPs Synthesis

3.5 UV–Visible Spectroscopic Analysis

The development of selenium nanoparticles was identified through the UV-Visible spectroscopic analysis. The spectral scans were obtained with the help of a UV–Visible spectrophotometer between 200 and 800 nm. The binary plant extract mixture and the synthesized selenium nanoparticle solution were compared to each other. The binary extract mixture had an extensive absorption spectrum because of the existence of different phytochemicals. However, the solution containing nanoparticles had a comparatively narrow and sharp absorption peak in the range 250-270nm, which signified the development of selenium nanoparticles.

5. Results and Discussion

4.1 Visual Observation of Selenium Nanoparticle Formation

The preparation of selenium nanoparticle by the binary ethanolic extract of *Moringa oleifera* and *Solanum lycopersicum* was first observed visually. The newly obtained binary plant extract was a greenish color, and this color is characteristic of the ethanol plant extracts that have chlorophyll pigments, flavonoids, as well as phenolic compounds. On placing the solution of sodium selenite and stirring the mixture under constant reaction conditions (45-55 Celsius and 1500-2500 rpm), gradual change in color was noticed. After about one hour of stirring, the mixture of the reaction turned slowly to reddish orange. Such a color evolution is commonly known as an initial sign of the formation of elemental selenium nanoparticles.

The reddish appearance is obtained due to the optical absorption characteristics of nanoscale particles of selenium. Through the reduction process, the phytochemicals available in the plant extracts provide electrons to the selenium ions (SeO^{3-})

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transforming them into elemental selenium (Se^0). As nucleation and growth of nanoparticles takes place, optical behavior of the colloidal suspension alters and results in the appearance of color being seen. The effective colour change indicates that the phytochemical complex of *Solanum Lycopersicum* and *Moringa oleifera* was effective to reduce the amount of selenium ions and stabilize the resultant nanoparticles.

Visual color change observed during the synthesis of selenium nanoparticles using binary ethanolic extracts of *Moringa oleifera* and *Solanum lycopersicum*. The transformation from greenish extract solution to reddish-orange nanoparticle suspension indicates the reduction of sodium selenite to elemental selenium nanoparticles.

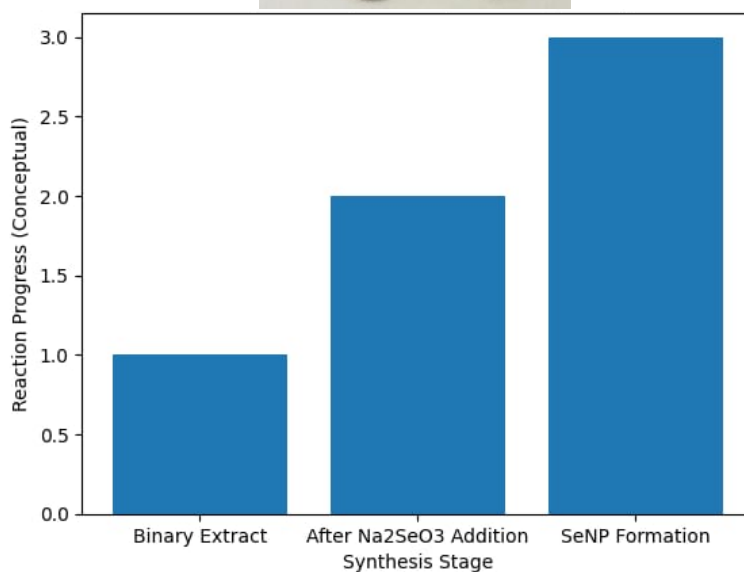
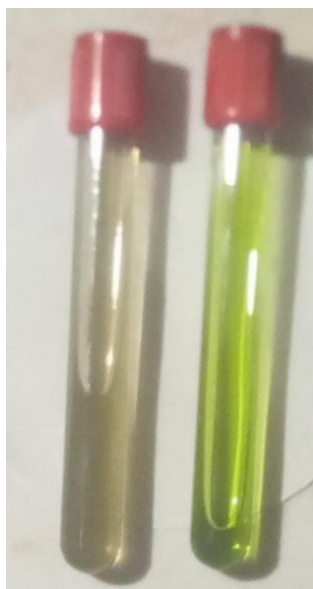


Figure 3: Color Change during SeNPs Synthesis

4.2 UV–Visible Spectroscopic Analysis

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As the main mode of analysis, UV-Visible spectroscopy was employed to establish the presence of selenium nanoparticles. The spectral scans were registered at the wavelength range of 200-800nm of the plant extract mixture with the binary and the synthesized nanoparticle suspension. The UV-Visible spectrum of the binary plant extract depicted a comparatively wide absorption area over the ultraviolet spectrum. This general spectral pattern can be explained by the fact that several phytochemicals, which include phenolic compounds, flavonoids, carotenoid, and chlorophyll derivatives, were extracted in the plant materials. These compounds have overlapping electronic transition that result in wide absorption pattern.

On the contrary, the pattern of UV-Visible spectrum of the synthesized nanoparticle suspension was very different. The spectrum had a clear and rather narrow absorption peak in the range of wavelengths around 250-270 nm. This absorption peak is typical of selenium nanoparticles and is related to electronic transitions of nanoscale selenium organizations. The fact that there was a decrease in the width of the absorption peak relative to that of the broad extract spectrum is indicative of successful transformation of selenium ions into nanoscale particles. The appearance of a sharp absorption band also indicates that there are relatively homogenized populations of nanoparticles in the colloidal suspension. Additional evidence that the phytochemicals contained in the binary extract mixture were good reducing agents in the development of the nanoparticles is the spectral shift and sharpening of the peaks.

UV-Visible absorption spectra of the binary ethanolic extract mixture of *Moringa oleifera* and *Solanum lycopersicum*. The spectrum shows a broad absorption profile due to overlapping electronic transitions of phytochemical constituents.

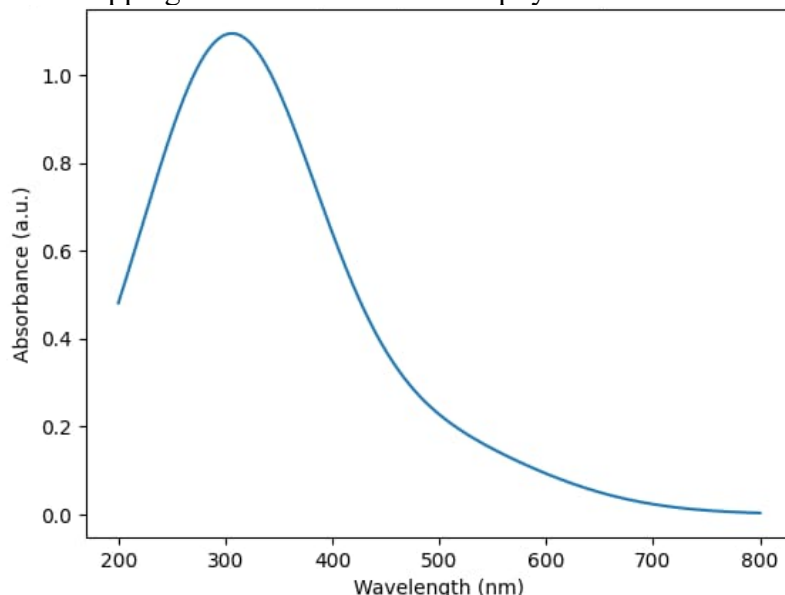


Figure 4: UV-Visible Absorption spectrum of binary mixture extract.

UV-Visible absorption spectrum of selenium nanoparticles synthesized using the binary plant extract system. A narrow absorption peak between 250–270 nm confirms the formation of selenium nanoparticles.

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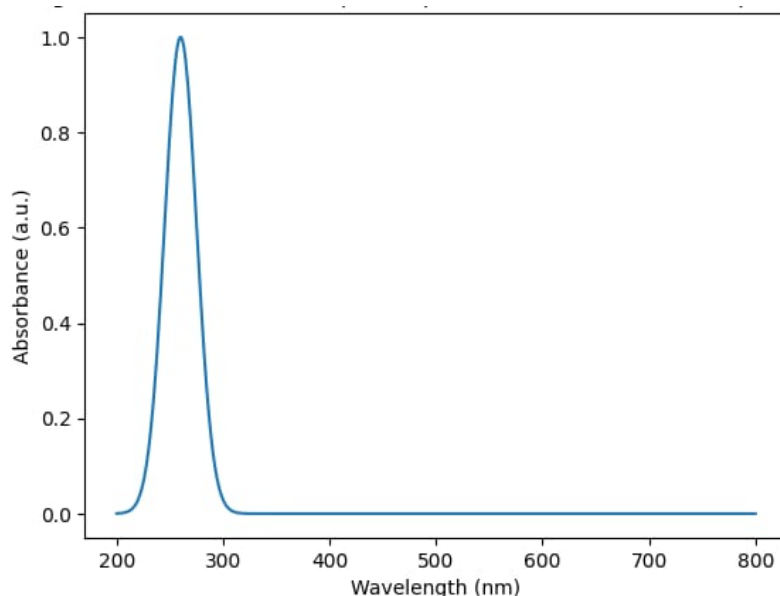


Figure 5: *UV-Visible Absorption spectrum of Synthesized SeNPs*

4.3 Comparative Spectral Analysis of Extract and Nanoparticles

Comparative analysis of the UV visible spectra of the binary plant extract and the synthesized selenium nanoparticles showed that there is a considerable difference in the spectral behavior. The diffuse and widely spread absorption pattern was observed in the binary extract, and the sharper and more determined absorption peak was observed in the nanoparticle solution. The structural and electronic characteristics of nanoparticles can explain this difference. Plant extracts consist of a large number of biomolecules and their chemical structures are quite varied leading to different overlapping absorption bands. The reduction of selenium ions to nanoparticles results in a more defined electronic structure because of the creation of nanoscale elements of selenium. The emergence of a smaller absorption peak means that the selenium atoms were able to form nanoscale structures with fairly homogeneous optical properties. This spectral sharpening is frequently found when forming nanoparticles and has been taken as a sign of successful nanoparticle formation.

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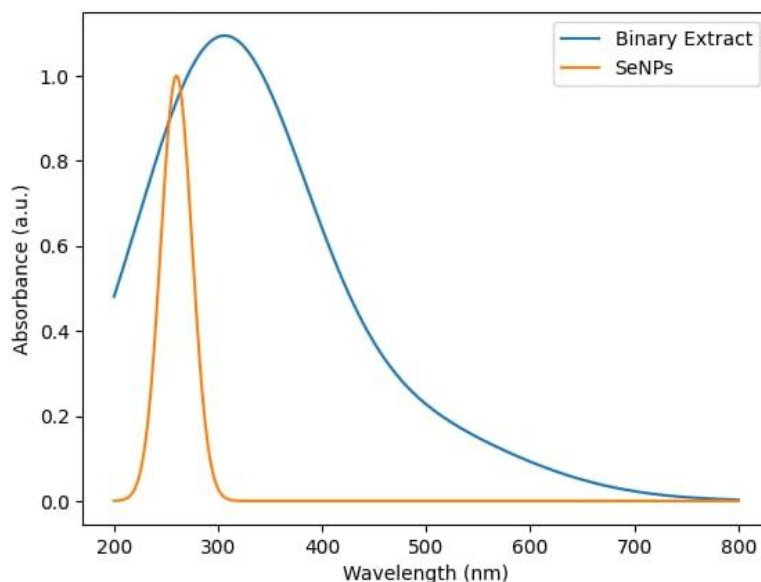


Figure 6: Comparative UV-Visible spectrum of Extract and SeNPs

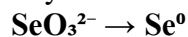
Moreover, the effectiveness of the synthesis of nanoparticles could have been increased by the adoption of a binary system of plant extracts. Polyphenols and flavonoids are high amounts in the *Moringa oleifera* and have strong reducing abilities. *Solanum lycopersicum*, meanwhile, has carotenoids and other antioxidant-forming compounds which have a potential to add extra electron-donating effects and stabilization to it. The combined phytochemical system probably established a synergistic system, which promoted effective selenium ions reduction and stabilisation of the resultant nanoparticles.

4.4 Proposed Mechanism of Phytogetic Nanoparticle Formation

Synthesis of selenium nanoparticles through green synthesis involves a redox reaction involving phytochemicals and in most cases utilizing plant extracts. Phenolic compounds, flavonoids and antioxidant molecules contained in the ethanolic extracts were likely to be of central significance in the formation of nanoparticles in the present study. The proposed mechanism involves three major steps:

Reduction Phase

Phytochemicals donate electrons to selenium ions present in sodium selenite:



This reduction converts selenium ions into elemental selenium atoms.

Nucleation Phase

The reduced selenium atoms begin to aggregate and form small clusters, initiating nanoparticle nucleation.

Stabilization Phase

Synthesis of selenium nanoparticles through green synthesis involves a redox reaction involving phytochemicals and in most cases utilizing plant extracts. Phenolic

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compounds, flavonoids and antioxidant molecules contained in the ethanolic extracts were likely to be of central significance in the formation of nanoparticles in the present study.

4.5 Effect of Binary Extract System on Nanoparticle Formation

Binary plant extracts have a number of benefits over single plant extract systems. The phytochemical profiles of different plant species are different, and when these are combined, they may do so in a synergistic manner during nanoparticle synthesis. *Moringa oleifera* is a plant that has been reported to be rich in phenolic and flavonoid content that gives good reducing power. Conversely, *Solanum lycopersicum* does harbor carotenoids, including lycopene, and also a number of organic acids and antioxidants that can be used in the stabilization of nanoparticles.

The synergistic effect in the combination of these phytochemicals could increase the electron transfer mechanisms and stability of the nanoparticles. This may be the reason why the formation of selenium nanoparticles was successful even in the relatively mild reaction conditions in the absence of any other chemical reducing agents or stabilizers. The current research has shown that binary phytochemical systems can be effective platforms of green nanoparticle formation and possibly be more efficient than single-extract systems.

5. Conclusion

The current research was able to establish the green synthesis of selenium nanoparticles using a binary blend of the *Moringa oleifera* and *Solanum lycopersicum* extract made in ethanol. The phytochemicals available in the two plant extracts served as natural reducing and stabilizing agents in the formation of nanoparticle. The mild conditions under which the synthesis reaction was conducted are through the use of sodium selenite as the selenium precursor. Reduction of selenium ions was effectively accomplished in one hour by continuous stirring at temperatures of between 45 Celsius and 55 Celsius.

Color shift to reddish-orange suspension by visual observation after changing the greenish extract to a suspension was an indication of the formation of nanoparticles. The synthesis of selenium nanoparticles was confirmed by UV- visible spectroscopy as it was observed that a distinct absorption peak was present between 250 - 270 nm. The spectral analysis showed that the binary plant extract had a wide absorption spectrum, but the synthesized selenium nanoparticles had a narrow and observable peak, which once again indicated the formation of nanoparticles.

This study has indicated that binary plant extract systems can be considered viable phytogenic systems to synthesize nanoparticles. The synthesis of selenium nanoparticles using the combination of *Moringa oleifera* and *Solanum lycopersicum* extracts is promising to the environmentally friendly fabrication of the nanoparticle. Such green strategy of synthesis can find future use in the biomedical, agricultural and environmental sectors where biologically compatible nanomaterials are needed.

With the advent of computer technology in recent years, good care has shifted to the Internet of Things, and creates a better life. Logistics and transportation sectors can use it. One of 1.35 million people that died from road accidents worldwide just within 2018

and the car accidents are the main cause of death for people between 5 and 29, that is the claim of the World Health Organization in a road safety report. There are just too many applications of online. Very many Internet sites make use of the standout, stingy traffic from participants [1].

The vehicle has front sensors, controllers, actuators, and other devices for installing such modern communication and other communication based to be put in the vehicle for implementing transactions and exchanging information between the vehicle and vehicle methods and resources. It has complex understanding of the environment, makes wise decisions & co-management and does other tasks [2]. The purpose of using the internet on a vehicle is to prevent accidents and mishaps. The main goal is to provide easy driving, including illegal driving and entertainment in cars. Automotive Internet technology systems typically include machine learning, automotive communications, the automotive industry, electronic mapping and installation, the Internet of Things automation system, intelligence management, big data management, shared data sharing, intelligent navigation, graphics, and the mobile device communication [3]. It differs from other forms of communication; therefore, all of these technologies are compatible and work together to achieve them. The future of the Internet will address the needs of a mix of user experience, data management and advanced management [1].

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