CHAPTER 2

SCOPE AND OBJECTIVE OF THE PRESENT INVESTIGATION

In the previous chapter, an elaborate discussion has been carried out regarding the different techniques used for the synthesis of hydrogel, silver nanoparticles and hydrogel silver nanocomposites. However, the preparation of nanoparticles by different methods have the following limitations:

- Synthesis of nanoparticles by a variety of chemical and physical methods may have considerable impact on the environment because of the use of toxic and perilous chemicals as reducing and capping agents [1].
- These methods are technically laborious and economically expensive [2].
- The biological methods have been suggested as possible environmental friendly alternatives [3] but involves an elaborated process of culturing and maintaining of the cell.
- One of the biggest limitations in evaporation-condensation method is the imperfections in the surface structure of the product.
- Microbe mediated synthesis also produces waste products that are more harmful to the environment [4].
Keeping in view of the above drawbacks, the green synthesis employing plants extract have emerged as a simple and viable alternative to more complex synthetic procedures to obtain silver nanoparticles.

2.1. **Advantages of plant mediated nanoparticle synthesis**

The benefits of using plant extracts for the production of silver nanoparticles include

- Economical protocol compared to chemical and microbial methods
- Availability of variety of plants to synthesis silver nanoparticles
- Abundance of raw materials
- Environment friendly
- Rapid and single-step method for the biosynthetic process
- Non-pathogenic
- Safe for human therapeutic use
- The nanoparticles are obtained without using high temperature, pressure, energy and toxic chemicals
- High reproducibility
- Suitable for large scale synthesis
- Ecofriendly plant extracts contain biomolecules, which act as both reducing and capping agents that form stable and shape-controlled nanoparticles [5]
Scope and objective of the present investigation

- Control over the size and shape of the nanoparticles
- Easy purification of the synthesised nanoparticles
- Concentration of reducing agent is higher as the plant extracts are used in aqueous form [6]

Considering the immense potentiality of plant extracts in the synthesis of silver nanoparticles, the biosynthetic method has now become an viable and greener technique as compared to other conventional methods.

2.2. Hydrogel templates

Nano silver is the most widely applied material in nanotechnology. For that reason, silver nanoparticles have been incorporated into hundreds of personal and professional products ranging from surgical and food handling tool to children’s toy and engineered scaffolds designed for tissue regeneration. One of the most beneficial uses of nano silver has been a powerful antibacterial agent. In addition, silver nanoparticles are considered as non-toxic and eco-friendly antibacterial material. However, they have poor binding capacity with surfaces and tends to agglomerate due to high active surface area. In order to stabilize and control the nanoparticle morphologies various polymers [7], biological macromolecules [8], latex particles [9], mesoporous inorganic materials [10], dendrimers [11], microgels or hydrogels [12], colloidal systems [13], and others were used.
An interesting feature of many biological entities is their ability to act as templates in the synthesis, assembly and organization of nanometre scale materials to fabricate well-defined micro and macro scale structures [14]. Among the known novel approaches, hydrogels have been used as potential templates or nanopots to synthesise nanoparticles that brought a concept for newer composite/ hybrid materials [15]. They bear excellent compatibility with biomolecules, cells and tissues and are more appropriate for the fabrication of silver nanoparticles than the conventional non-aqueous or polymeric systems. Hydrogels with large free space among the cross-linked networks are not only act as reservoirs for massive nanoparticles loading, but also function as a nanoreactor template for the nucleation and growth of nanoparticles. Moreover, these nanocomposite systems possess, by synergetic effects between their organic and inorganic components, new properties such as enhancement in mechanical toughness, large deformability, high swelling/deswelling rates, excellent electrical conductivity, high transparency and remarkably strong antibacterial activity in combination with a fairly low toxicity against human tissues. Furthermore, the size and morphology of the nanoparticles can be controlled by the functionalization of hydrogels, varying the cross-linking density of networks and modification of the hydrogels.
2.3. **Hydrogel silver nanocomposites**

The synthesis of metal nanoparticles immobilized in hydrogel composites provide substantial properties enhancements, even at low nanoparticles content. They can sustainably release metallic ions and subsequently control bacterial cell adhesion and growth over an extended time period [16]. Among the diverse methods available for the preparation of hydrogel silver nanocomposites, infiltration of metal ion into a pre-formed hydrogel, followed by activating reduction is the notable one [17]. Recently, there has been a demand for biopolymeric nanocomposites that are derived from polysaccharides. The advantages of these biopolymers compared to synthetic polymers are their sustainability, biodegradation properties and base components as non-toxicity [18-19].

Considering the importance of green synthesis for the preparation of silver nanoparticles and also the use of hydrogel networks for embedding the silver ions and reducing it to silver nanoparticles *in situ*, the present investigation is carried out. The primary idea of this research is to synthesize biodegradable semi interpenetrating hydrogel networks using cross-linked poly (acrylamide) with different polysaccharides, gelatin (protein) and hydroxyapatite (mineral) through an optimized redox reaction. The further idea is to incorporate Ag⁺ ions by the addition of silver nitrate...
solution and reducing it to silver nanoparticles \textit{in situ} using \textit{Azadirachta Indica} (Neem) plant extract. The final objective of this investigation is to evaluate the synthesized polymeric hydrogel silver nanocomposites in biomedical and pharmaceutical fields.

The main objectives of these investigations are

- To synthesise the following polymeric hydrogel silver nanocomposites (HSN) using \textit{Azadirachta Indica} (Neem) plant extract.
  1. Poly (Acrylamide / Carboxymethylcellulose / Starch) Hydrogel Silver Nanocomposites denoted as CSPAAHSN
  2. Poly (Acrylamide / Starch / Gum acacia) Hydrogel Silver Nanocomposites denoted as GSPAAHSN
  3. Poly (Acrylamide / Almond gum) Hydrogel Silver Nanocomposites denoted as AGPAAHSN
  4. Poly (Acrylamide / Sodium Alginate) Hydrogel Silver Nanocomposites denoted as SAPAAHSN
  5. Poly (Acrylamide / Gelatin) Hydrogel Silver Nanocomposites denoted as GEPAAHSN
  6. Poly (Acrylamide / Xanthan gum) Hydrogel Silver Nanocomposites denoted as XPAAHSN
Scope and objective of the present investigation

7. Poly (Acrylamide / i- Carrageenan) Hydrogel Silver Nanocomposites denoted as ICPAAHSN

8. Poly (Acrylamide / Hydroxyapatite) Hydrogel Silver Nanocomposites denoted as HAPAAHSN

❖ To characterize the synthesized polymeric hydrogel silver nanocomposites by

1. UV-Visible diffused reflectance spectra (DRS)

2. Fourier transform infrared spectra (FT-IR)

3. High resolution scanning electron microscopy (HR-SEM)

4. Energy dispersive X-ray analysis (EDX)

5. Transmission electron microscopy (TEM)

6. X-Ray diffraction studies (XRD)

7. Dynamic light scattering technique (DLS)

8. Thermogravimetric analysis (TGA)

❖ To evaluate the synthesized polymeric hydrogel silver nanocomposites in biomedical and pharmaceutical fields such as

1. Antimicrobial agent

2. Drug delivery vehicle

3. Anticancer studies

4. Personal hygiene products
5. Body water retainers and stomach bulking agents

6. Super absorbent hydrogel in Agricultural field
REFERENCES


