International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
ISSN: 2457-0362
www.ijarst.in

# "An analytical study on the herbal nanoparticles system for the surgery of glaucoma"

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**Abstract:**

Glaucoma, a progressive optic neuropathy, remains a significant cause of irreversible blindness worldwide. Traditional surgical interventions, though effective, often carry risks and complications. In recent years, the exploration of nanotechnology in medicine has opened new avenues for targeted drug delivery and tissue regeneration. This study aims to analyze the potential of herbal nanoparticles in addressing the surgical challenges of glaucoma. The research methodology involves a comprehensive review of existing literature on glaucoma pathophysiology, conventional surgical techniques, and nanotechnology-based approaches. Furthermore, experimental investigations are conducted to synthesize herbal nanoparticles and evaluate their efficacy in a glaucoma surgical model. Preliminary findings suggest that herbal nanoparticles possess promising properties for glaucoma surgery, including enhanced biocompatibility, sustained drug release, and targeted intraocular delivery. Moreover, their inherent anti-inflammatory and neuroprotective effects offer additional therapeutic benefits in mitigating glaucomatous optic nerve damage. This study contributes to the growing body of evidence supporting the integration of nanotechnology and herbal medicine in ophthalmic surgery. The potential implications include improved surgical outcomes, reduced postoperative complications, and enhanced patient compliance. However, further research is warranted to optimize nanoparticle formulations, evaluate long-term safety profiles, and validate clinical efficacy in human trials.

**Keyword:-** Glaucoma, Nanoparticles, Herbal medicine, Surgery, Targeted drug delivery

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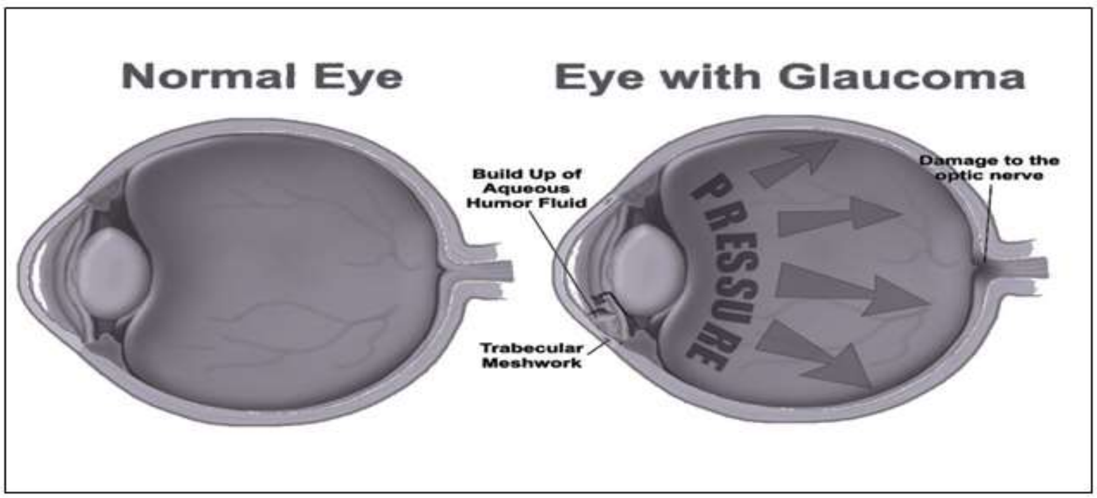
## INTRODUCTION

### Glaucoma

After cataract, glaucoma is the second most common global cause of blindness or vision loss (Majeed et al., 2015). It causes optic nerve degeneration, which affects at least 70 million individuals worldwide (Weinreb et al., 2014; Quigley & Broman, 2006). The optic nerve, which is predominantly found at the back of the eye, is essentially the major nerve to the eye and is in charge of carrying electrical impulses to the brain (Kumaraswamy et al; 2006). It is impacted by the slow, progressive degeneration of the optic nerve axons and retinal ganglion cells (RGC). These causes cause the intraocular pressure to gradually rise, which ultimately results in irreparable damage, ocular neuropathy, and vision loss, as depicted in Figure 1.1. The disease, which is frequently referred to as the "silent thief of sight," affects more than half of the population without them being aware of it at first and becomes severe as a result (Weinreb et al., 2014). (Abdull et al., 2016) Table lists the main glaucoma subtypes. According to the path physiology of glaucoma, there are two potential causes of the rise in intraocular pressure (IOP):




I. A disparity between the aqueous humor (AH production)'s or secretion and drainage rates.

II. Excessive AH syntheses in the eye's anterior chamber.

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Modification or prevention of risk factors, particularly the increased intraocular pressure, is the main objective in the management of glaucoma. There are three potential ways that antiglaucoma medications influence AH dynamics, namely to lower intraocular pressure:

• Reduced AH in the ciliary body and increased AH outflow through the trabecular meshwork.

• A rise in the AH outflow via the uveoscleral pathway (Pathare et al; 2012).

**Table 1.1: Glaucoma subtypes**

| **Glaucoma Types** | | | |
|---|---|---|---|
| **Type** | **Cause** | **Indications** | **Observations** |
| Primary open angle glaucoma | Draining of liquid becomes less efficient (blockage occurring gradually) from the eye leading to pressure building up inside. | Damage to optic nerve leading to loss of vision slowly initially affecting side vision. | Progression of glaucoma is slow but may become a lifelong condition if not treated effectively. |
| Angle closure glaucoma or closed angle glaucoma | Complete blockage of the drainage canal of the eye leading to fast build-up of pressure. | A variety of indications like blurred vision, redness of eye, nausea and vomiting, severe eye pain may occur. | Immediate medical intervention is required for Appropriate treatment else permanent blindness may occur. |
| Congenital glaucoma | Blockage of the fluid drainage canal from birth. | Common symptoms include clouding of cornea, enlarged eyes and sensitivity to light. | A rare form of glaucoma typically affecting children and infants. It should be treated as soon as possible before vision is lost. |
| Secondary glaucoma | An infection or injury in the eye, prolonged use of steroids or a tumor may lead to blockage of drainage canal. | Vision is lost gradually and typically side vision is affected first. | Progression of glaucoma is slow just like in case of open angle glaucoma. Treatment should be Started appropriately. |

It has been estimated that at least 12 million Indians suffer from glaucoma. With 1.5 million people at risk of developing the disease, it is thought to be the third most common cause of blindness in the country, accounting for 12.8% of all cases of blindness. The Glaucoma is more common as people become older; around the age of 40, about 2-3 people out of every 100 are affected. Even in urban areas of major cities, the condition is initially diagnosed in 90% of patients without their knowledge (Quigley., 1996; Dandona et al., 2001).

**Controlled medication administration via the eye**

Since it is the easiest way to treat a variety of ocular problems, the front of the eye is the most practical and often used site for ocular drug delivery. When it comes to drug delivery, the eye can be thought of as having four main target areas: a) the eyelids and conjunctiva, which make up the front pre-ocular structures; b) the cornea, which covers the iris and pupil; c) the anterior and posterior chambers of the eye, along with the tissues that connect them; and d) the vitreous chamber. The best way to distribute the medications to the cornea, preocular, anterior, and posterior portions of the eye is through topical administration. However, because it might be difficult to achieve a sufficient drug concentration after administration, topical drug delivery to the vitreous cavity—which is only occasionally used—remains challenging. Nonetheless, intra-ocular injections or systemic drug delivery can be used to effectively treat diseases of the vitreous cavity (Davies, 2000).

Viscosity and absorption enhancers are widely utilized in the development of ocular formulations to overcome the drawbacks associated with the use of standard formulations for the treatment of eye illnesses and to lengthen the drug-eye contact period. Unfortunately, the issue of poor bioavailability has only been partially resolved by these formulations. Topical medication delivery is not the preferred method for treating the posterior region of the eye. The drug is typically administered locally or systemically; as a result, regular administration of high doses of the drug is necessary to achieve the desired therapeutic concentration of the drug, which may have major unfavorable effects.

## LITERATURE OF THE REVIEW

### Ocular drug administration

A vital area of biopharmaceutical research is now focused on recent improvements in drug delivery methods for delivering medication to the target place in a safe and bio available manner. Each year, there are undoubtedly many improvements in medication delivery, and every bodily component has been investigated as a potential site for activity.

The most difficult task a pharmaceutical scientist must undertake when it comes to drug administration is ocular drug delivery. The drug distribution model that was most likely observed following topical medicine administration to the eye is shown in Figure 2.1. Yet, during the last 20 years, ocular controlled delivery systems have seen significant development. Of all these methods, the formulator's main objective is to get beyond the eye's protective barriers and administer the drugs in a way that greatly lengthens the drug's stay in the eye, which helps to reduce the side effects that are typically brought on by systemic absorption (Achouri et al., 2012).

### Using nanocarriers for medication delivery

Hydrophobic medications have a number of delivery-related difficulties, chief among which is insolubility, which has an impact on bioavailability. In addition to insolubility, other parameters that affect the distribution of water-insoluble pharmaceuticals to the intended site of action include particle size, stability of the systems in vivo, poor permeability, shorter retention, therapeutic effectiveness, side effects, etc (Torchilin., 2004; Sultana et al., 2011; Ameeduzzafar et al., 2014). Nanotechnology suggests enabling conditions that enable targeted drug distribution to the target place in a more controlled/durable manner. The main objectives of nanotechnology include regulating drug release for a predetermined amount of time, affecting the pharmacodynamic and pharmacokinetic properties of a specific drug, delivering the medication to the site of action, improving effectiveness, reducing the side effects and toxicity associated with a specific drug, and last but not least, reducing the frequency of dosing with, occasionally, a reduction in the dose as well (Yih & Al-Fandi., 2006., Gupta et al., 2013; Ameeduzzafar et al., 2014). Advantages

**Pilocarpine Solvent:** A method of evaporation to determine how CS coating might affect the characteristics of PLGA NPs, CS (0.1% and 0.5%) layer coating was applied. Zeta potential measurements and turbid metric studies showed that positively charged NPs were produced, and that for up to 6 hours, these NPs interacted with the mucin in the eye. When in touch with mucin, PLGA NPs coated with 0.5% CS had a more prolonged association. 2009: Yoncheva et al.

**Yoncheva et al., 2011 Pilocarpine** Solvent evaporation process Mucoadhesive polymers such as CS, poloxamer, and sodium alginate were used to coat PLGA NPs. It was determined that CS coated NPs and mucin dispersion interacted probably electrostatically, and the coated NPs were designed to promote the drug's localized residence in the eye.

## SIGNIFICANCE OF THE RESEARCH

A series of eye conditions known as glaucoma harm the optic nerve. The optic nerve, which is predominantly found at the back of the eye, is essentially the major nerve to the eye and is in charge of carrying electrical impulses to the brain (Kumaraswamy et al., 2006). The fluid's (AH) increased pressure causes damage to the eye's optic nerve. The injury eventually causes subtle visual alterations that result in vision loss (Friedman et al., 2004). Modification or prevention of risk factors, particularly the increased intraocular pressure, is the main objective in the management of glaucoma.

Glaucoma is the second most common cause of blindness in the world, right after cataracts. Glaucoma is thought to impact 12 million people in India and is the cause of 12.8% of the nation's blindness (Titcomb, 2008). Glaucoma continues to be the most common cause of blindness in adults over 60, according to National Eye Institute (NEI), a division of the National Institutes of Health (NEI Vision Research- A National Plan 1999-2003).

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Provides a summary of the main ocular and systemic adverse effects associated with the use of the general class of glaucoma medicines. Generally, systemic adverse symptoms such bradycardia, headache, hypotension, renal calculi, aplastic anaemia, etc. are also seen. The most prevalent ocular side effects include miosis, follicular conjunctivitis, transitory myopia, hyperemia, and mydriasis dryness. Thus, intensive research is being done to discover the best herbal medications for an effective and improved treatment of glaucoma with little to no side effects in order to combat the side effects connected with these treatments.

The oldest type of medicine known to man is called "herbalism" or "botanical medicine," but the term "herbal medicine" is more commonly used. Because of their therapeutic or medicinal properties, it is widely used. As analytical and quality control techniques evolve and new research demonstrates the effectiveness of herbs in the treatment and prevention of disease, herbal medicine is becoming more widely accepted. Increased emphasis on using plant materials as a source of medicine has resulted from factors including growing population, insufficient drug supply, prohibitive cost of treatment, side effects of synthetic drugs, and development of resistance to currently used drugs for the treatment of infectious diseases. Drugs for a range of human illnesses (Pathare et al., 2012)

**OBJECTIVE OF THE STUDY**

With so many potential pharmacological dosage forms available today, treating glaucoma comes with a lot of negative effects. It has been suggested to create a for skolin nano particulate dosage form to lessen the negative effects while improving the pharmacokinetic and pharmaco dynamic profile.

The study's primary goals and objectives are to:

1. Create and improve nanocarrier systems for improved bioavailability.
2. To improve mucoadhesive property's effect on corneal retention of nanocarriers.
3. Evaluation of the created nanocarriers in a glaucoma model in vitro and in vivo.

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## HYPOTHESIS OF RESEARCH

Based on the study's rationale, it can be hypothesized that our designed (Forskolin loaded CS coated PLGA NP's) nanocarrier would have improved bioavailability and sustained action because of smaller particle size and improved mucoadhesive property, which would be useful in reducing the frequency of dosing, improved effect, and lower nasolacrymal drainage.

## RESEARCH METHODOLOGY

The following phases comprise the research approach in summary.

1. Drug characterization: Physical characteristics and spectral analyses were used to assess the drug's genuineness (FT-IR, DSC, XRD and NMR spectroscopic techniques).

2. Development of analytical methods: For the analysis of the substance, analytical techniques were created. For the quantitative measurement of drugs in formulated formulations, in-vitro release samples, and ex vivo permeation samples, two methods, HPTLC and UPLC MS/MS, have been established.

3. Preformulation studies: Preformulation testing refers to all research conducted on therapeutic compounds in order to produce a dosage form that is stable and appropriate for biopharmaceutical use. Many aspects of the development of the drug, excipients, and formulation were studied during the preformulation research, including:

a) Determining the drug's solubility in various solvents: The drug's solubility was investigated in several solvents.

b) The drug's partition coefficient was calculated using the shaking flask method with n-octanol/isotonic phosphate buffer at pH 7.4.

c) Drug excipient interaction study: FT-IR and DSC characterization were used to examine the physical interactions between the drug and excipients in order to identify any chemical interactions.

**Conclusion**

In conclusion, the utilization of herbal nanoparticles presents a promising avenue for addressing the surgical challenges posed by glaucoma. Through enhanced biocompatibility, targeted drug delivery, and neuroprotective effects, these nanoparticles offer a multifaceted approach to managing the progression of this sight-threatening condition. The integration of nanotechnology and herbal medicine holds potential for improving surgical outcomes, minimizing postoperative complications, and enhancing patient quality of life. However, further research is necessary to optimize nanoparticle formulations, assess long-term safety profiles, and validate clinical efficacy in human trials. By advancing our understanding of glaucoma pathophysiology and leveraging innovative therapeutic modalities, we can strive towards more effective and personalized treatments, ultimately reducing the burden of blindness associated with this chronic disease.

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