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Silver Nanoparticle-Based Delivery of Mebeverine: A Targeted Approach for Irritable Bowel Syndrome

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INTRODUCTION & AIM

Long-term care of irritable bowel syndrome (IBS) is frequently necessary, but traditional treatments are constrained by their non-specific distribution, inconsistent gastrointestinal absorption, and brief duration of action. Nanoparticle-based medication delivery presents a potential technique for targeted and sustained release directly at the afflicted intestinal region. Silver nanoparticles (AgNPs) in particular, contain attractive physicochemical and biological features that can be further enhanced through functionalization with medicinal compounds.

The pharmacological profile of mebeverine hydrochloride, a musculotropic antispasmodic that is frequently used to lessen gastrointestinal smooth-muscle spasms, may be altered and may be improved by incorporating it into AgNPs. By combining experimental tests with DFT-based in silico analysis, this study aims to assess the targeted spasmolytic, anti-inflammatory, and cytocompatibility effects of mebeverine-loaded AgNPs and clarify their impact and therapeutic potential for the treatment of IBS.

METHOD

- *Synthetic Protocol*
- *Ex Vivo Spasmolytic Activity*
- *In Vitro Inhibition of Albumin's Denaturation*
- *TEM, DLS and Zeta Potential*

RESULTS & DISCUSSION

Mebeverine (Figure 1) is a commonly used musculotropic antispasmodic for controlling IBS, acting through direct relaxation of gastrointestinal smooth muscle without the typical anticholinergic side effects. It efficiently alleviates stomach pain, spasms, and bowel discomfort, although a key hurdle in IBS therapy remains ensuring focused delivery to the colon. Nanoparticles offer a prospective option because of their variable size, high surface reactivity, and capacity to be functionalized with medicinal compounds. They are effective platforms for drug delivery and other biological applications because they can enhance drug stability, solubility, membrane transport, and circulation time.

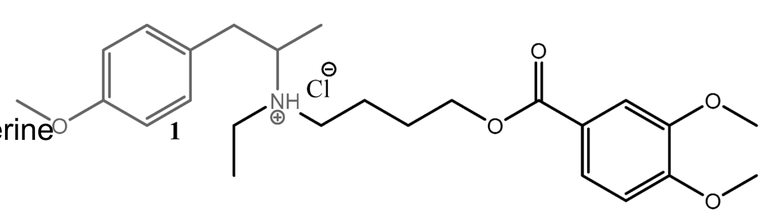


Figure 1. Structure of mebeverine hydrochloride (**1**)

The synthesized AgNPs were characterized using different analytical techniques, such as UV-Vis, Transmission electron microscopy (TEM), dynamic light scattering (DLS), and Zeta potential.

The TEM images confirmed the synthesis of smaller spherical particles up to 95 nm in size (Figure 2). The drug-loaded AgNPs were obtained with controllable size due to carbohydrate assistance in the presence of [Ag(NH3)2]+. The carbohydrate coating also decreases the agglomeration rate and size.

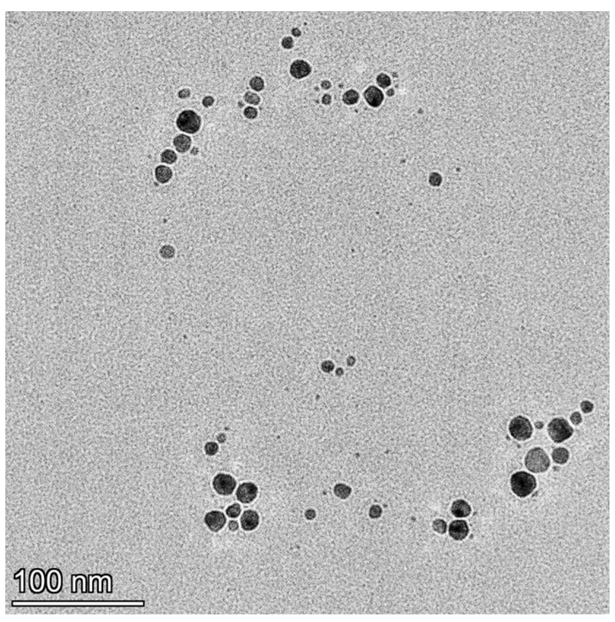
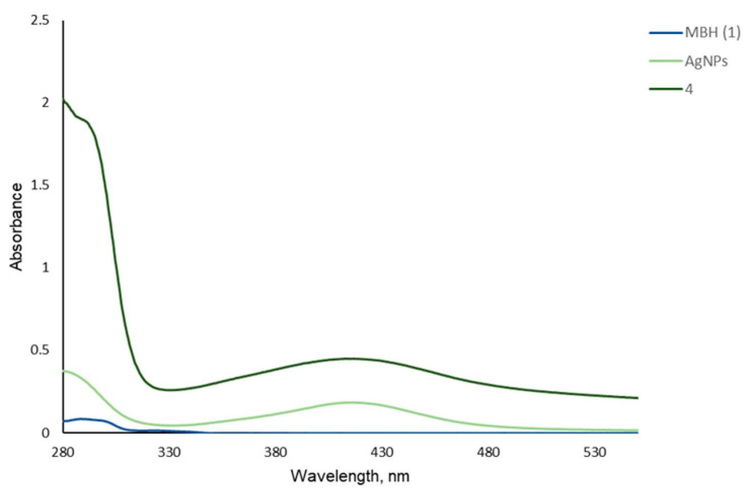


Figure 2. TEM visualization of drug-loaded silver nanoparticles with mebeverine.

The synthesis of the Ag NPs in an aqueous solution was monitored by recording the absorption spectra in the wavelength range of 190–600 nm. Figure 3 shows that the investigated compound have absorption maxima at 229 nm and 225 nm, respectively, and fructose has an absorption peak at 189 nm.



The indicator for the presence of AgNPs is the SPR characteristic band at 415 nm. The position of this band between 350 and 420 nm indicates the spherical shape of the particles. The peak is symmetrical, which indicates a low degree of aggregation of the NPs.

Figure 3. Absorption spectra: Mebeverine—blue; AgNPs —light green; AgNPs with Mebeverine—dark green

It is customary to examine medication concentration–response relationships utilizing in vitro and ex vivo models by isometrically quantifying concentration-dependent changes in spontaneous smooth-muscle contractions. In this investigation, we are using isolated rat stomach smooth muscle to examine the activating or inhibiting effects of mebeverine and its AgNP-loaded version. We looked at the cumulative dose-dependent responses after using ACh to confirm tissue viability. Mebeverine-loaded AgNPs elicited modest tonic relaxation and reduced the amplitude of spontaneous contractions by 50%, whereas neither formulation significantly changed contraction frequency (Figure 4).

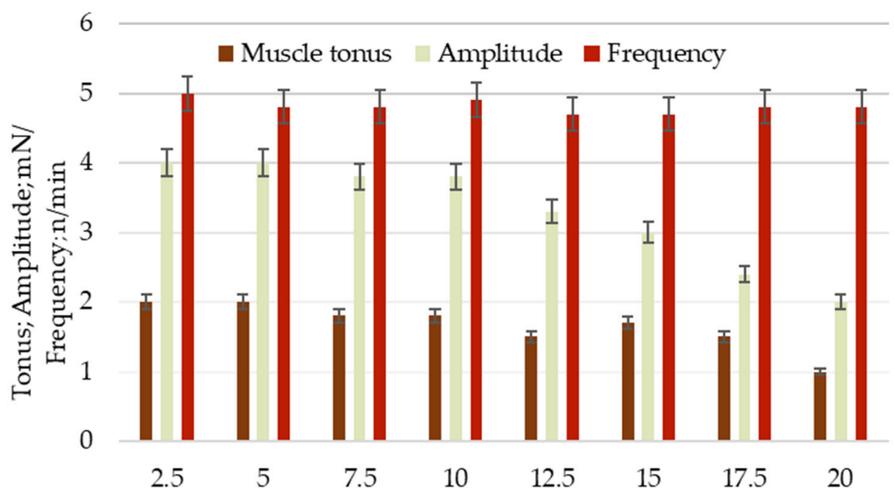


Figure 4. Changes in main parameters of spontaneous contractile activity under the influence of AgNPs with mebeverine.

CONCLUSION

Mebeverine-loaded AgNPs demonstrate distinct and enhanced biological effects compared to free mebeverine, including mild tonic relaxation and a significant reduction in smooth-muscle contractility, supported by receptor-modulation experiments that indicate involvement of both muscarinic and nicotinic pathways. In line with the reported controlled drug-release profile. In comparison to ordinary AgNPs, cytotoxicity and morphological evaluations showed mild, time-dependent cellular responses, indicating a favourable safety balance. Mebeverine-loaded AgNPs are a promising targeted antispasmodic and anti-inflammatory platform for gastrointestinal illnesses, according to the combined experimental and computational results, which call for more in vivo testing.

FUTURE WORK / REFERENCES

Acknowledgments:
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