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RESEARCH ARTICLE

SYNTHESIS AND CHARACTERISATION OF SILVER NANOPARTICLES FOR POTENTIAL USE AS AN ENDODONTIC DISINFECTANT

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ABSTRACT

Background: Disinfection of root canal system is paramount in endodontic success. Recently, nanoparticles of various metals have been employed to reach and combat resistant bacteria in intricacies of root canal system.
Aim: This study aimed at synthesis of silver nanoparticles bychemical reduction method and their characterisation them using spectrophotometry and nanoparticle tracking analysis.
Methodology: Silver nanoparticles were synthesised by reducing a solution of silver nitrate with Gallic acid.
Characterisation was done by two methods: spectrophotometer and nanoparticle tracking analysis
Results: The silver particles synthesized by the aforementioned method had spherical morphology and an average size of 32 nm and showed absorption peak at 425 nm.
Conclusion: Chemical synthesis of Silver nanoparticles is a simple and inexpensive process and the silver nanoparticles so produced can be used as endodontic irrigant for enhanced endodontic success rates.

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INTRODUCTION

In recent times, an ecological approach to endodontic infections has resulted in the understanding of Endodontic infection as a biofilm mediated disease (Neelakantan *et al.*, 2017). In view of the complex structure of Biofilms that renders the involved microbiota extremely resistant to treatment procedures, achieving complete root canal disinfection as a means of treating endodontic disease still remains elusive. Furthermore, It has been established that a great fraction of the root canal surface remains unaltered after instrumentation (Peters *et al.*, 2001). This has time and again emphasized the significance of using a chemical adjunct in order to achieve maximal disinfection of root canal system. This has led to the continuous search of an ideal or nearly ideal disinfecting solution for achieving complete sterility of root canal system. In this regard, a plethora of root canal irrigants have been introduced, each with its own set of whip hand and limitations.

Ideal requisites of an Endodontic irrigant include (Haapasalo *et al.*, 2010):

a. Flush out debris from the root canal system
b. Dissolution of Organic and Inorganic tissue
c. Smooth the way for root canal instruments during root canal shaping
d. Enable removal of infected dentin
e. Bactericidal
f. Should be safe to periapical tissues
g. Should not result in tooth weakening
h. Should be able to reach the internal anatomic structures within / intricacies of root canal system

Till date, there is no single solution that can attain all the aforesaid tasks. Nanotechnology has been explored in this regard (Shrestha and Kishen, 2016; Wu *et al.*, 2014; Muraleedaran and Mujeeb, 2015) and it has been found that nanoparticles can serve as highly potent antimicrobials due to high surface area and charge densities and consequently greater physical interaction with bacterial cell surface with resultant enhanced bacterial killing (Sawai J. Shoji *et al.*, 1998). A variety of nanoparticles including Zinc oxide, Silver and chitosan have been tried in the field of endodontic disinfection with varying success rates (Guerreiro-Tanomaru *et al.*, 2013; Samiei *et al.*, 2015; DaSilva *et al.*, 2013; Samiei *et al.*, 2016; Wu *et al.*, 2014). This paper presents a simple and inexpensive method for synthesis of silver nanoparticles and characterisesthem using spectrophotometry and nanoparticle tracking analysis.

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Methodology

Synthesis of Silver Nanoparticles

In order to prepare silver nanoparticles, a 100 ml of freshly prepared 0.01 M $AgNO_3$ solution was placed in the reaction pot. Following this, a second solution made of 0.1 g of gallic acid which functions as reducing agent and 0.1 M of deionised water was added to the first solution under magnetic stirring. 1.0 M NaOH was then added to adjust the pH of resulting solution to 11 and solution was continuously stirred for additional 20 minutes. (Figure 1)

Figure 1. Synthesis of Silver Nanoparticles

Nanoparticle tracking Analysis: A Nanosight-LM20 instrument was used to carry out NTA analysis. A disposable syringe was used to introduce 0.3 ml samples to the viewing unit under black background to increase visibility. Particles moved under Brownian motion and appeared as point scatterers (Figure 3).

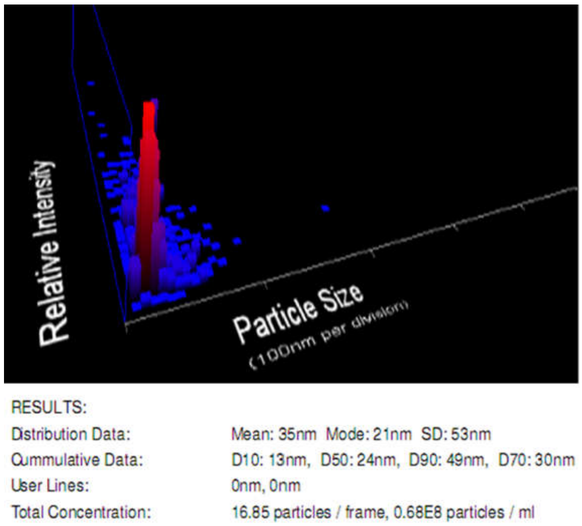

Figure 3. Nanoparticle tracking for characterization

RESULTS AND DISCUSSION

The silver particles synthesized by the aforementioned method had spherical morphology and an average size of 32 nm with a concentration of $10.4*10^{10}$ particles/ml. On a UV-Visible

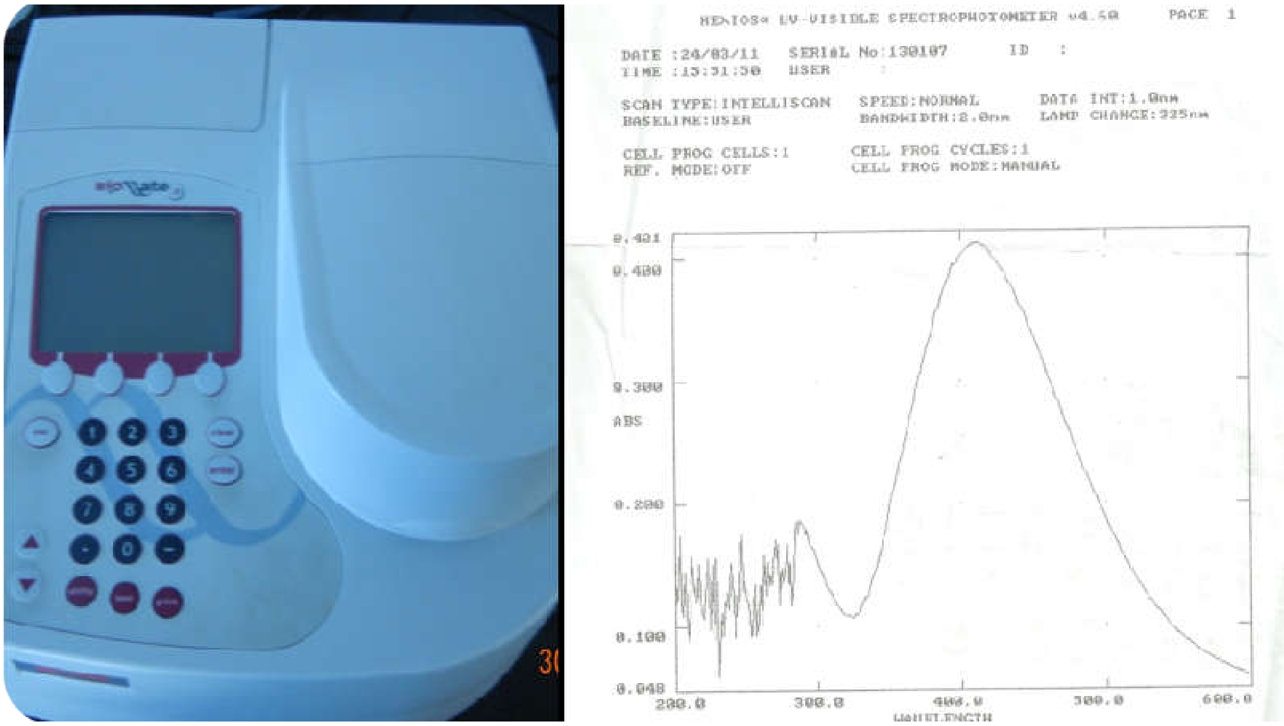

Figure 2. Spectrophotometer method for charecterization of nanoparticles

Characterisation of Silver Nanoparticles

Spectrophotometry: Thermo Biomate 3 UV-Visible spectrophotometer was used to monitor by Uv-vis spectra of the solution at a range of 300-600 nm which is a measure of bioreduction of silver ions in aqueous solution (Figure 2).

spectrophotometer, the prepared solution showed an absorbence peak at 425 nm. This is particular of silver nanoparticles because of their surface plasma resonance absorption band. Increasing antimicrobial resistance is a globally recognized problem in health care system and endodontics is no exception (Gretchen *et al*., 2011).

Conventional antimicrobial methods are incapable of combating the resistant microflora. Bacteria growing in a biofilm are highly resistant to conventional disinfection methods and are several times more resistant than the samebacteria in planktonic state. Standard disinfection protocols are often useless. A possible solution to this problem could be development and application of nanaoparticles to combat microbial infections. A plethora of metals have been used in medicine for such applications. Silver is one of the most commonly used antimicrobial since decades inspite of some concerns (Chopra, 2007). Mechanism of action of silver ions is proposed to be the electrostatic interaction between positively charged silver ions and negatively charged bacterial cell membrane (Dibrov *et al*., 2002). In nanopartculate form, their antimircobial action is further enhanced because of extremely small size of the particles, polyionic nature and high surface charge (Chen *et al*., 2010). Literature reveals that silver nanaoparticles are capable of quorum quenching and can prevent formation of resistant biofilms (Chaudhari *et al*., 2012). These properties make Silver nanoparticles, a potential irrigating solution for rootcanal disinfection

Conclusion

Use of nanoparticles for endodontic irrigation can be a significant tool as the mechanism of action of nanoparticles is such that it evades bacterial defence mechanisms. In addition, intrinsic antimicrobial activity of silver can enhance the overall effect of silver nanoparticles on root canal flora.

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