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Tragacanth gum/nano silver hydrogel on cotton fabric: *In-situ* synthesis and antibacterial properties

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ABSTRACT

This paper is mainly focused on introducing cotton fabric with hydrogel and antimicrobial properties using *Tragacanth gum* as a natural polymer with hydrogel properties, silver nitrate as silver precursor, citric acid as a cross-linking agent and sodium hypophosphite as catalyst. The water absorption behavior of the treated fabrics was investigated with moisture regain, water retention, drying time of wetted fabric at room condition and vertical wicking tests. Antibacterial properties of the samples were evaluated against *Escherichia coli* and *Staphylococcus aureus*. The SEM pictures confirmed formation of nano silver and hydrogel layer on the fabric surface and XRD performed the crystal and particle size of the nano silver. The chemical structure of the fabric samples was identified with FTIR spectra. The central composite design (CCD) was used for statistical modelling, evaluated effective parameters and created optimum conditions. The treated cotton fabrics showed good water absorption properties along with reasonable antibacterial effectiveness.

1. Introduction

The hydrogel composes of "hydro" (=water) and "gel" that means to aqueous (water-containing) gels. They are three-dimensional (3D) materials with the ability to absorb large amounts of water, expand and swell (Chi Lin & Metters, 2006). This is due to different functional groups such as hydroxyl, carboxylic, amide and sulphonic within the polymeric structure (Pal, Banthia, & Majumdar, 2009). The three-dimensional structure of hydrogels are linked together by physical (*e.g.* hydrogen bonding) or chemical bonds (*e.g.* covalent and ionic bonding) (Rithe et al., 2014). Hydrogels are in different physical forms of solid molded, pressed powder matrices, microparticles, coatings, membranes or sheets, encapsulated solids and liquids (Soni, Salhotra, & Suar, 2014). They can be classified based on the porosity to non-porous, micro-porous, macro-porous and super-porous, based on ionic charge to neutral, anionic, cationic and amphoteric, based on preparation method to homopolymers, copolymers, multi-polymer, interpenetrating and semi-interpenetrating network, based on the physical structure of the networks to amorphous, semi-crystalline, crystalline, hydrogen-bonded, super-molecular, hydro-colloidal aggregates structures and based on the electric or magnetic field responding to stimulate pH, temperature, pressure, light, ionic strength. They can also be classified as natural, synthetic and combination of natural and synthetic hydrogel (Ahmed, 2015; Das, 2013; Ganji & Vasheghani-Farahani, 2009; Ganji, Vasheghani Farahani, & Vasheghani-Farahani, 2010; Peppas, Bures, Leobandung, & Ichikawa, 2000; Qiu & Park, 2001; Sri, Ashok, & chatterjee, 2012). Natural hydrogels are based on proteins such as collagen or gelatin and polysaccharide such as alginate, chitin and dextran have many advantages such as low toxicity, good biocompatibility and biodegradability (Ahmadi, Oveisi, Mohammadi Samani, & Amoozgar, 2015).

Hydrogel materials have been used in many industrials such as textile, tissue engineering, pharmaceutical as drug delivery systems and agriculture. Removing dyes, metal ions and other impurities from wastewater is one of the applications of hydrogel in textile industry (Atta, Ismail, & Elsaaed, 2012; Bhattacharyya, Kumar Ray, & Mandal, 2013; Lučić et al., 2014). Furthermore, they can be used for boosting fabric characteristics. Montazer et al. prepared PVA-tragacanth/nano silver hydrogel for modification of polyester fabric to produce hydrophilic and anti-bacterial properties for disposable medical and sanitary textile (Montazer & Kahali, 2016). Staneva et al. used PVA and acrylamide hydrogel containing ZnO nanoparticles to modify cotton fabric (Staneva, Atanasova, Vasileva-Tonkova, Lukanova, & Grabchev, 2015). Nazari Pour et al. applied polyacry-

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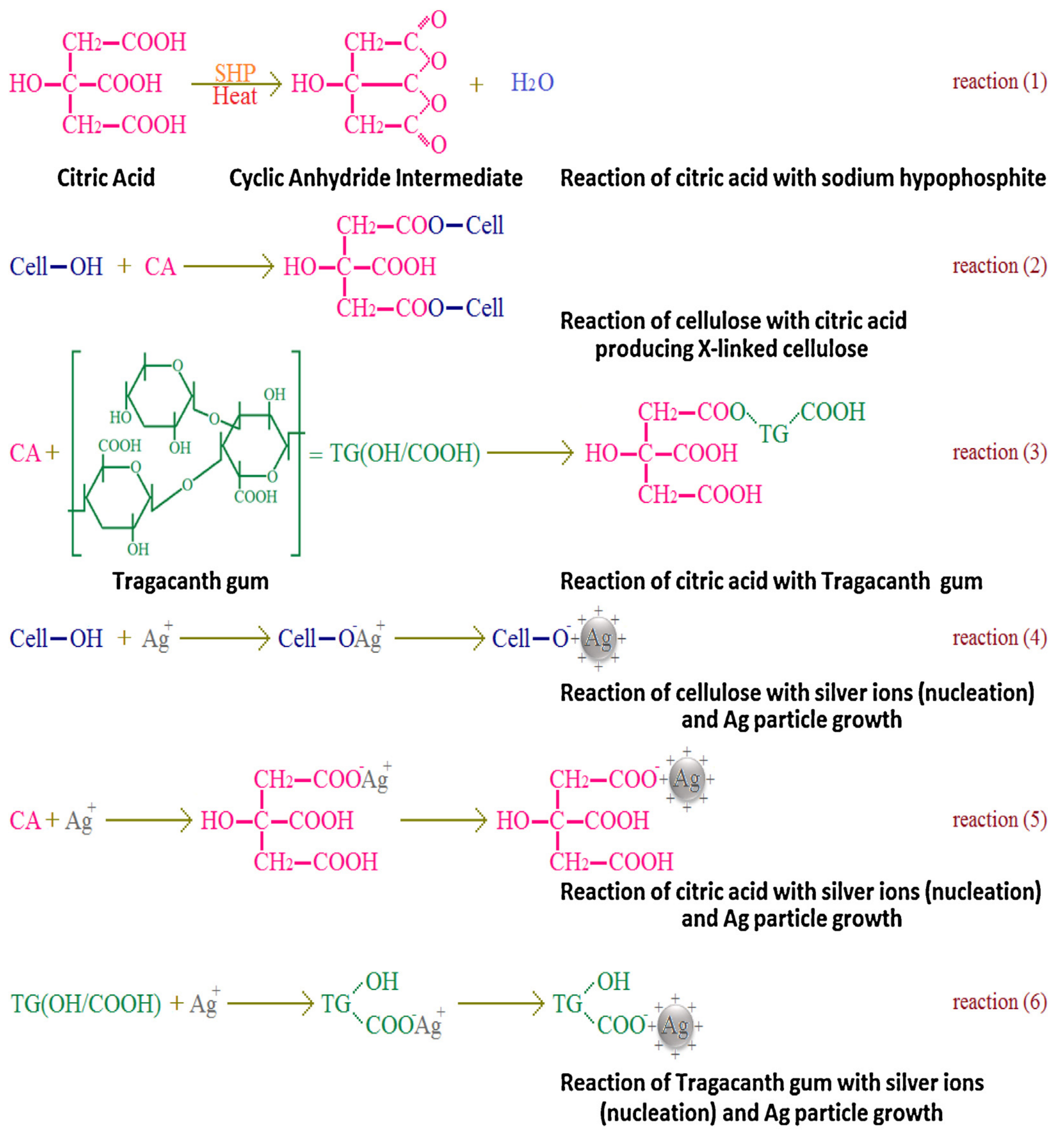
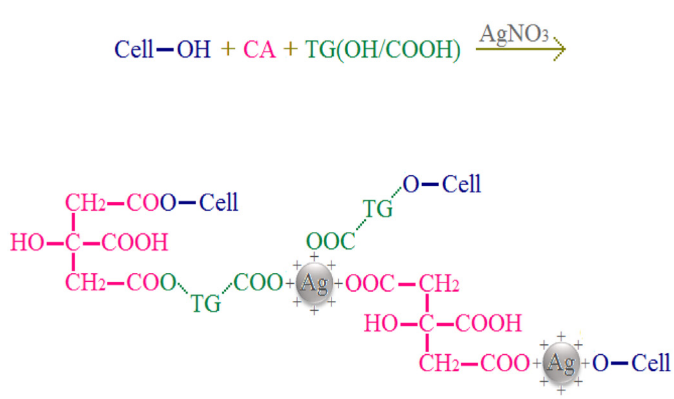


(a)



(b)

Fig. 1. (a) Reaction between cellulose chains of cotton, TG, CA and $AgNO_3$. (b) Synthesis of *Tragacanth gum*/nano silver hydrogel on the cotton fabric.