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Coated chitosan onto gauze to efficient conditions for maintenance of the wound microenvironment

Jefferson Souza[a,b*], José Matos[a], Margarida Fernandes[b], Andrea Zille[b], Raul Fangueiro[b]

[a*] *Federal University of Piauí, Teresina – PI, 64049-550, Brazil*
[a,b] *2C2T, University of Minho, Guimarães, 4800-058 Portugal*

Abstract

The aim of this work was to evaluate the thermo-physiological comfort and moisture properties of surgical cotton gauze coated with chitosan (CH). Gauze was coated with CH at mass fractions of 0.5, 0.25, 0.125, 0.1, 0.063 wt%. Thermal, moisture management and morphological properties were evaluated. Results indicate that the functionalized medical gauze induces low capilarity, allowing a good degree of moisture and absorption capacity of wound exudates. This biofunctional medical gauze coated with CH0,125 wt% demonstrates to deliver an efficient coating and promote the best conditions for maintenance of the wound microenvironment.

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Keywords: Biofunctional; chitosan; wonund; moisture; capilarity

1. Introduction

The repair processes of damaged skin pass through of a series of complicated steps in order to provide a complete reestablishment of the tissue integrity with the restoration of the skin barrier [1]. The healing process, aside the needs of an efficient dressing, also include other important parameters such patient comfort and drainage control [2]. Wound healing includes an intricate sequence of cellular and molecular processes such as inflammation, cell migration, angiogenesis, provisional matrix synthesis, collagen deposition and re-epithelisation. To provide an

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effective wound dressing, some requirements and properties are necessary: (1) heat control of wound-dressing because it helps to keep a moist environment facilitating the healing process [3]; (2) an appropriate water vapor transmission rate (WVTR) which provide a moist environment on the wound beds, without risking dehydration or exudates accumulation; (3) enough gas permeability when applied to oxygen-requiring reparative processes; (4) an elevated level of fluid absorption capability to purge excessive exudates; (5) a helpful barrier against the penetration of contaminations, (6) antibacterial activity to eliminate bacteria development below the dressing; (7) the absence of cytotoxic effects [4].

In the last few years the field of advanced medical textiles has showed an outstanding growth due to the development of new intelligent textiles products such as implantable and medical devices, bandaging and pressure garments, infection control and barrier materials, controlled release materials, hygiene products [5]. These developments are determined by the excellent physical, geometrical and mechanical properties of developed new textiles showing improved strength, extensibility, flexibility, vapor and liquid permeability, dimensional structures, fibre diversity, fineness, cross-sectional shape and others.

Among the textile materials applied to healthcare and medical garments, cotton is one of the most important and widely used. However, cotton facilitates the growth of microorganisms due to its hydrophilic property retaining moisture, oxygen and nutrients [6]. To avoid this drawback, the application of chitosan, a polysaccharide, which have homeostatic and antimicrobial properties, has been largely referenced to provide wound infection control and at the same time retain the intrinsic textile characteristics [7]. The application of Chitosan has also showed other important effect such as the acceleration of the wound healing activating the immune cells through cytokine production, giant cell migration, and s type IV collagen synthesis stimulation [8, 9]. Moreover, chitosan has also showed biocompatibility [10, 11], antibiotic properties [12], haemostatic activity [13] and biodegradability properties [14].

The goal of this work was to obtain a simple and cost-effective cotton gauze with concomitant antimicrobial and comfort properties for an effective wound-healing process using a controlled concentration of chitosan impregnated in the fibres material in order to avoid the loss of dressing inherent textile characteristics. Essential factors such as thermal properties, water uptake, friction, morphological analysis and the amount of vertical wicking were determined for the chitosan-coated samples and compared with a simple cotton gauze.

2. Materials and Methods

2.1. Materials

Chitosan (DD 85%, ChitoClear hq95-43000, Mw = 350 kDa) was purchased from Primex (Iceland) and Gauze Cambric from Alvita 100% cotton, with a yarns density of 9 warps and 7 weft for cm^2. All the other materials were purchased from Sigma-Aldrich and used without further purification.

2.2. Preparation of Chitosan Coating

0.5, 0.25, 0.125, 0.1, 0.063 g of chitosan (CH) were dissolved in 100 ml of distilled water with 1% of acetic acid. The solutions were stirred at 300 rpm for 60 min at room. After chitosan was completely dissolved, the mixture was stirred until room temperature was reached. The coating CH solutions were applied to gauze fabrics by a simple dip coating method. Each fabric was dipped in the CH solution at room temperature for 5 minutes under stirring conditions. The excess coating was then removed by gently rinsing with distilled water and the gauze dried in an oven for 12 hours at 50 °C.

2.3. Scanning Electron Microscopic (SEM)

Morphological analyses of coated chitosan gauzes were carried out with an Ultra-high resolution Field Emission Gun Scanning Electron Microscopy (FEG-SEM), NOVA 200 Nano SEM, FEI Company. Secondary electron images were performed with an acceleration voltage at 5 kV. Backscattering Electron Images were realized with an