Production technology and characterization of alginate-based impregnated gauze

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INTRODUCTION: Traditional cotton wound dressings, like gauze and bandages, remain popular in wound care due to their affordability. However, they have drawbacks: adhering to wounds, risking tissue damage and low absorbance of secretions, requiring multiple layers, and causing discomfort. Modern alternatives, such as alginate hydrogel dressings, target these issues. Designed for moderate to intense exudate wounds, they enhance comfort and treatment effectiveness. Yet, their higher cost limits accessibility. Moreover, neither alginate nor cotton gauze offer bioactivity, while mechanical strength of alginate hydrogel may be inadequate. This work aims to develop enhanced gauzes to overcome these challenges, offering improved functionality at affordable costs and superior wound care.

EXPERIMENTAL: The impregnated gauzes were prepared by a three-step process: pretreatment, impregnation, and gelling. Pretreatment involved passing cotton gauzes through a $Ca(NO_3)_2$ solution (5-15 wt.%), while impregnation was carried out using solutions containing alginate and glycerol (mass ratio 4:10) with a dynamic viscosity of 0.3 Pa s measured at a shear rate of 10 s^{-1} and at 25 °C. Two different gelling solutions were used: one based on 2 wt.% $Ca(NO_3)_2$ and the second based on 2.3 wt.% $Zn(NO_3)_2$, both supplemented with glycerol (5-20 wt.%) and polyethylene glycol (10-30 wt.%). All produced gauzes were dried at 40 °C overnight and the best impregnated gauze candidates were further characterized. Dressings produced following the same procedure, just without gauze, served as controls.

RESULTS AND DISCUSSION: The impregnated gauzes were evaluated for the polymer layer thickness, sorption capacity, adhesion, mechanical properties and active component release. While polymer retention was consistent (87.6 ± 3.3 g/m^2) regardless of the gelling agent ($Ca(NO_3)_2$ or $Zn(NO_3)_2$), differences were noted in polymer thickness and sorption capacity. Under $Ca(NO_3)_2$ gelling, the polymer thickness was 42.6 ± 7.7 µm, with a sorption capacity of 770 %. In contrast, $Zn(NO_3)_2$ gelling resulted in a thickness of 77.1 ± 10.5 µm and a sorption capacity of 700%, indicating stronger hydrogel formation with Ca ions. Peel-off tests showed low adhesion force (1.91 ± 1.25 N), making the dressings painless upon removal. In mechanical tests, impregnated gauze exhibited superior strength compared to the control films, with nearly double the tearing force and higher elongation at breakage (approximately 23 %). Zn-alginate dressings achieved complete release of Zn ions after 72 h, with 70-80 % release after 24 h, which is suitable for dressing changes every 1-3 days.

CONCLUSIONS: The advantages of the enhanced dressings obtained as a result of this study include: *i*) high absorption capacity indicating capacity for moisture regulation and absorption of excess fluids in the wound, *ii*) expected painless removal of the dressing after the treatment, without leaving any residue of cotton threads in the wound, *iii*) the possibility of incorporating various active agents (*e.g.* antimicrobial, immune-stimulating, *etc*.) and their controlled release for faster and more efficient wound healing (as confirmed by the release of zinc ions from the developed enhanced dressings). During the process, a final formulation has been developed to ensure good flexibility and toughness of the impregnated dressings, making their cutting, and shaping according to the needs of the wound treatment very simple and efficient.

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