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Abstract

New Hydrogel Formulations Based on Natural and Synthetic Polymers for Skin Regeneration †

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Abstract: The skin, which represents about 16% of the total body mass, acts as a protective barrier against external microbial factors [1]. Therefore, damaged tissues, especially burns, require rapid local coverage to avoid infections and to ensure the protective barrier function of the skin [2]. The aim of this study was to design and characterize new hydrogel formulations based on natural and synthetic polymers and that were biodegradable and cytocompatible to serve as temporary dressings with regenerative properties for skin wound healing. The proposed experimental variants of the hydrogels are based on mixtures of gelatin (Gel), sodium alginate (Alg), polyvinyl alcohol (PVA), and methylcellulose (MC1500) in different weight ratios: Gel-Alg (1:0.75, g/g), Gel-Alg-PVA (1:0.27:0.18, g/g/g) and Gel-Alg-MC1500 (1:0.26:0.35, g/g/g). Physicochemical and biochemical characterizations were performed to determine the swelling degree, biodegradation in physiological conditions (pH 7.4, 37 °C) and in the presence of collagenase (mimicking the inflamed wounded milieu), viscosity, and syneresis, while their ultrastructure was investigated by SEM analysis [3]. The L929 murine fibroblast culture was used to assess the in vitro cytocompatibility of the hydrogels after 24 h and 48 h of cultivation using quantitative MTT and LDH assays [4]. Cell morphology was observed in treated cultures by light microscopy after Giemsa staining. The physicochemical and biochemical analyses indicated that the novel polymeric hydrogels variants had a good swelling capacity due to the presence of Alg, had an adjustable viscosity, and controlled biodegradation over time in both physiological and inflamed conditions. Two mixture variants were outlined: Gel-Alg-PVA with reduced porosity and low biodegradability over time and Gel-Alg-MC1500 with increased porosity and higher biodegradation over time, even in the physiological environment. The SEM morphology observations showed that the hydrogels had a dense and microporous structure, with pores of irregular shapes and sizes, which could ensure skin protection against external microbial agents while also maintaining the required degree of humidity and oxygen exchange with the external environment. In vitro quantitative tests indicated a high degree of cytocompatibility for all of the tested hydrogels, with cell viability percentages higher than 90%. The cell morphology observations revealed that in the presence of hydrogel samples, the L929 murine fibroblasts maintained their normal phenotype, and the cell density was similar to that of the negative control (untreated cells). Overall, our findings indicated that the hydrogels containing synthetic polymers (Gel-Alg-PVA, Gel-Alg-MC1500) had adequate physicochemical, biochemical, and biological properties that should be further tested to determine their role as biomaterials for skin tissue engineering applications.

Keywords: gelatin; methylcellulose; cytotoxicity; wound healing

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References

1. Wu, G.; Ma, X.; Fan, L.; Gao, Y.; Deng, H.; Wang, Y. Accelerating dermal wound healing and mitigating excessive scar formation using LBL modified nanofibrous mats. *Mater. Des.* **2020**, *185*, 108265. [CrossRef]
2. Baghersad, S.; Bahrami, S.H.; Mohammadi, M.R.; Mojtahedi, M.R.M.; Milan, P.B. Development of biodegradable electrospun gelatin/aloe-vera/poly(ε-caprolactone) hybrid nanofibrous scaffold for application as skin substitutes. *Mater. Sci. Eng. C* **2018**, *93*, 367–379. [CrossRef] [PubMed]
3. Kaberova, Z.; Karpushkin, E.; Nevoralová, M.; Vetrík, M.; Šlouf, M.; Dušková-Smrčková, M. Microscopic Structure of Swollen Hydrogels by Scanning Electron and Light Microscopies: Artifacts and Reality. *Polymers* **2020**, *12*, 578. [CrossRef] [PubMed]
4. Craciunescu, O.; Gaspar, A.; Trif, M.; Moisei, M.; Oancea, A.; Moldovan, L.; Zarnescu, O. Preparation and characterization of a collagen-liposome-chondroitin sulfate matrix with potential application for inflammatory disorders treatment. *J. Nanomater.* **2014**, *104*, 110. [CrossRef]