ACRYLIC COMPOSITE MATERIALS MODIFIED WITH BEE POLLEN FOR BIOMEDICAL APPLICATION

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Introduction

In recent years hydrogels, due to their biocompatibility, cell-controlled degradability, and intrinsic cellular interaction have become one of the most important class of materials used in medicine. Nowadays, hydrogels play an important role in dynamically developing field of tissue engineering where they are used as a three-dimensional porous scaffolds to guide the growth of new tissues, as an implantable devices, in cartilage wound healing, drug delivery systems, wound dress and bone regeneration. The structure and functions of those polymeric materials can be prepared in a precisely controlled way. To foster new tissue formation hydrogels must meet a number of criteria that include physical (e.g. degradation and mechanics) and biological (e.g. cell adhesion) guidelines [7]. Hydrogels are made from natural polymers (e.g. collagen, chitosan, keratin) as well as synthetic polymers (e.g. poly(vinyl alcohol), PVA, poly(ethylene glycol), PEG, poly(acrylic acid), PAA [1].

Poly(acrylic) acid (PAA) has been intensively examined by many scientist in the context of biomedical applications, due to its biocompatibility, pH-sensitivity, solubility in water and aqueous solutions of inorganic salts and simultaneous lack of solubility in most organic liquids. In neutral and alkaline solution acidic carboxyl groups of PAA are ionized and this leads to electrostatic repulsion of the polymer chains. Over recent years, various PAA-based materials for the use in tissue engineering have been proposed [2].

Nowadays, polymeric hydrogels are mainly combined with different type of nancompounds (e.g. graphene oxide, carbon nanotubes, gold–silica nanoshells, nano-hydroxyapatite, ultra-high-molecular-weight polyethylene nanofibres), biologically active proteins or peptides, and reinforced with inherently biocompatible particles (e.g. hydroxyapatite, HAp). HAp is the inorganic component of bones and teeth forming their hardness and strength. HAp due to its porosity, bioactivity, biocompatibility and ability to form a good connection with the living tissues is willingly used as a component of different types of biomaterials, especially in dental and orthopaedic surgery as a filled material for biocompatibility matrix [3].

In this research paper, we describe in detail the preparation, characterization and biocompatibility studies of three-dimensional hydrogel composite material prepared from acrylic acid, particles of HAp and agar (as a stabilizing agent), cross-linked by poly(ethylene glycol) diacrylate (PEGDA) under microwave irradiation and modified by different amounts of bee pollen.

Materials and Methods

The aim of this paper is to present the influence of bee pollen on the physicochemical and in vitro properties of poly(acrylic acid) hydrogel composites enriched with hydroxyapatite and modified with bee pollen as a prospective materials for biomedical application with beneficial features including good osseointegration and anti-inflammatory effect.

Results and Discussion

Phase and chemical composition of hydroxyapatite synthesized by wet-precipitation method was confirmed by means of XRD and FT-IR techniques. Proposed materials were investigated towards in vitro properties by immersion in incubation fluids including artificial saliva, Ringer's solution and distilled water and composites swelling ability was determined. Additionally, the chemical structure of the polymer matrix composites was confirmed by infrared spectroscopy with Fourier transformation. Moreover, to characterize composite degradation process in 21 days incubation FT-IR technique was employed. Hydrogel composite before incubation (a) and after 21 days immersion (b) are shown in FIG. 1. In order to describe bee pollen feature both scanning electron microscopy and X-ray fluorescence spectrometry were used. Presented research revealed that hydroxyapatite, as well as poly(acrylic acid) undergo biodegradation during in vitro test. Moreover, matrices degradation results in incubation fluids pH decrease associated with anionic nature of poly(acrylic acid), which is further enhanced by bee pollen release. The strongest pH drop effect was observed for Ringer's solution. Increase in conductivity of distilled water confirmed composites degradation process.

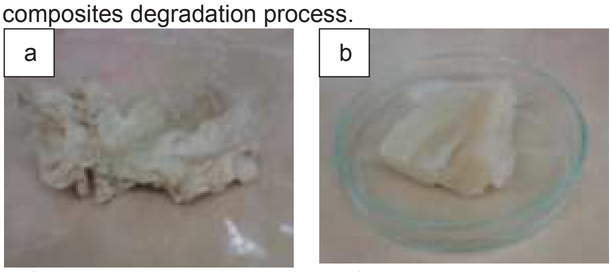

FIG. 1. Hydrogel composite before incubation (a) and after 21 days immersion (b).

Conclusions

Prepared composite materials present good sorption capacity against different fluids used in biomedical testing, such as Ringer's solution and artificial saliva. In vitro tests performed in this research proved that investigated materials are stable in body-simulated conditions during 21 days incubation. Given the fact that acrylic hydrogel materials are already applied as a wound dressing devices, further investigations should be focused on adoption this structure in the field of biomaterials supporting bone regeneration, which can be achieved by bioactive phosphates incorporation. It can be presumed that so-modified hydrogels would possess such beneficial properties and would support osseointegration.

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