1° Encontro Brasileiro de Biocelulose

4 e 5 de junho

UNIARA - Araraquara - SP

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1° Encontro Brasileiro de Biocelulose
Universidade de Araraquara – UNIARA
04 e 05 de junho de 2018

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▹Biomaterials - Abstracts

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Monitoring of bacterial cellulose degradation under different conditions: SOIL, SEA, natural weathering and accelerated aging

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ARTICLE INFO

ABSTRACT

Bacterial Cellulose (BC) is a highly crystalline linear glucose polymer synthesized extracellularly in the form of nanofibers by a large number of organisms, but the most commonly used bacterium is *Komagataeibacter hanseni*. Although the BC has great potential for many applications, the development of new materials implies knowing the environmental impact that it can cause. Thus, this work aimed to evaluate the degradation of BC in different environmental conditions. BC membranes were synthesized by *K. hansenii*, later purified in sodium hydroxide solution and dried in an air circulation oven. The degradation of the membranes was evaluated at different times in the following environments: soil (SO), estuarine environment (SEA), natural weathering (NW), and accelerated aging chamber (AAC). The samples were characterized by visual analysis (VA), Fourier transform infrared spectroscopy (FTIR/ATR) and thermogravimetric analysis (TGA). In the visual analysis it was possible to evaluate the physical alterations, such as: roughness, cracks, and color change. The results showed that the membrane degradation kinetics occurred in the following order: SO>SEA>NW>AAC. It is believed that in SO and SEA the degradation was more intense due to the presence of microorganisms and humidity in these environments. The total degradation of these membranes occurred in 5 days and 15 days respectively. The samples submitted to NW despite being exposed to factors such as wind, rain and radiation extended their degradation to 90 days. The CB membranes exposed in AAC had a slower rate of degradation compared to other environments influencing the mass and morphological properties.

Nisin In Bacterial Nanocellulose: An Antimicrobial Activity Evaluation

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ARTICLE INFO

ABSTRACT

Nisin is an antimicrobial peptide, 3.4 kDa, produced by the microorganism Lactococcus lactis (ATCC 11454). This bacteriocin inhibit the development of Gram-positive bacteria and Gram-negative bacteria, in a presence of chelating agents. Bacterial nanocellulose (NcB) has been considered an ideal and high-quality material applied in food, medical and pharmaceutical supplies. Due to all these benefits presented it is important to know the behavior of the NcB system containing nisin. For this reason, NcB were placed in a 24-well plate and 1 mL of nisin solution (0.1g.mL-1 with activity in 5 log10 AU.mL-1) was added in each well. The plate was kept on a rotating shaker at 30 °C, 100 rpm for 4 h. The nisin amount loaded in NcB was analyzed through protein assay. The antimicrobial activity against the microorganisms Staphylococcus aureus, foodborne pathogen, and Lactobacillus sakei (nisin bioindicator) were analyzed during 180 days by agar diffusion assay in different temperatures (4 oC, 25 oC and 37 oC). The results indicated the nisin was loaded in NcB, around 700ug.mL-1 with 6 log10 AU.mL-1, antimicrobial activity increased 1 log10 AU / mL. The antimicrobial activity results showed the system NcB-nisin was capable to inhibit the both microorganisms' growth, up to 60 days. The system showed good efficacy and the NcB potentiated the antimicrobial action of nisin, acting as a selective barrier of other compounds present in the standard solution and, as protection to the different temperatures. Indicating that NcB may be an ideal system for nisin and other compounds.

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Clinical evalutation of the bacterial cellulose membrane to the surgical treatment of deep corneal ulcers in dogs and cats

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ARTICLE INFO

ABSTRACT

Introduction: Deep corneal ulcers in companion animals constitute ophthalmic emergencies and, almost always, require surgical treatment that, if not adopted, leads to eye loss and blindness. In this sense, the use of the bacterial cellulose membrane embedded by ciprofloxacin (BCMF) in animal's cornea healing with corneal ulcers was clinically evaluated in this work. Methodology: Five dogs and one cat that had deep corneal ulcers and feline ulcerative keratitis by corneal sequestrum were evaluated, respectively. All received BCMF under the usual technique of keratoplasty. All animals were prepared for prior anesthesia care and routine clinical treatment of ulcers. The BCMF were cut to the same dimensions of the lesion beds and applied using a suture pattern interrupted with 9-0 nylon suture wire. Routine postoperative clinical measures were adopted for up to 21 days. Results and discussion: For all animals, immediate improvement of the ocular pain sign was observed. There was corneal vascular exaltation at 15 th postoperative days and its gradual attenuation after 30 th postoperatively. In two patients (dogs), dryness of the membrane surface was observed and need to the trimmed in an additional surgical maneuver at 40 th postoperative day. It was observed the occurrence of cicatricial leukoma next to the grafting area, but no signs of extrusion were observed. The transparency of the córnea around leukoma was restored. Conclusion: The results allow to admit that MCBF may be a therapeutic alternative in the surgical treatment of ulcerative keratitis in animals, however, additional studies with a greater number of patients are necessary to corroborate this clinical observation.

Use of bacterial cellulose-based hydrogel for wound healing after diode laser exeresis of sarcoid face in equine – case report

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ABSTRACT

Introduction: Sarcoid is a cutaneous neoplasm in equines. The use of surgical diodo laser has indication in neoplasias for promoting immediate hemostasi. BC-based hydrogel consists on a formulation for wound repair that increases fibroblast proliferation. We report the case of an equine with sarcoids treated with diode laser exeresis associated topic use of BC-basec hydrogel. In addition, in postoperative period the wound healing process was evaluated using BC-based hydrogel. Methodology: An equine, Quarter Horse, male, castrated, 9-years-old, 460 kg, attended at the Veterinary Teaching Hospital of UNESP/FMVA, presenting multiple sarcoids, with a fibroblast sarcoid on the left side of face (9 cm 2), with exacerbated growth for 2 years. Treatment consisted in diode laser exeresis of 4400mW, 4J and continuous frequency. The postoperative period consisted of application of phenylbutazone (4.4 mg/Kg/IV/q24h) for 3 days, and enrofloxacin (5mg/Kg/IM/q24h) for 10 days. Daily dressings (q12h) were performed using topical iodopolividone and repellent application. However, after 24 days without favorable evolution of cicatrization, with necrosis, BC-based hydrogel was applied daily on the wound after cleaning with saline solution. Results and discussion: From the use of the BC-based hydrogel, healing progressed favorably, so that after 6 days the wound was completely covered by granulation tissue, with evident contraction and epithelization. After 40 days the wound was fully epithelialized. Conclusion: It was concluded that diode laser exeresis was effective in the treatment of this sarcoid and the association with BC- based hydrogel was effective in the granulation, contraction and epithelization phases characterizing the wound healing.

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Nexfill ® dressing for lower limb ulcer healing in diabetic patients

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ABSTRACT

Chronic wounds represent a public health problem due to the number of people affected and due to their chronic nature, they are responsible for the main cause of lower limb ulcers, resulting in a compromise in the quality of life of patients affected by these wounds. One of the ways of treating chronic wounds is to use bandages composed of bacterial cellulose. These dressings have biocompatibility in vivo and when applied in cutaneous wounds provide healing more effectively. This paper aimed to report a case study of a patient living in Shelter of Elderly Dona Helena Dornfeld, in São Carlos / SP, who received the treatment promoted by a multidisciplinary team composed by nurses, nutritionist and physiotherapist using the Nexfill® dressing. A 93-year-old female patient with a diagnosis of Alzheimer' s and Type II Diabetes, with a lower limb wound there are more than 6 months. The treatment consisted of cleaning the wound with physiological solution and then the initial application of Nexfill ® dressing, replacements every 5 days. Images were recorded every 30 days and the área medication was determined using ImageJ ® software. After the 60-day period, it was possible to observe that the Nexfill ® dressing made possible the complete healing of the wound. Acknowledgments: To the team of Shelter of Elderly Dona Helena Dornfeld.

Bacterial cellulose aerogels: influence of functionalization on mechanical and absorption properties

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ABSTRACT

Cellulose represents one of the most attractive classes of materials for innovative applications and has been used as a raw material in the elaboration of products, including nanostructured ones, such as nanocomposites and aerogels – which are solid materials that have high porosity, low density and large area surface – where its properties have encouraged the emergence of new high value applications. To expand the range of applications, some studies have investigated the functionalization of aerogels. In the present work, in order to study the impact of functionalization on aerogels properties, bacterial cellulose (BC) was carboxylated by TEMPO-mediated oxidation, nanofibrillated in blender, silanized with methyltrimethoxysilane, and the final suspension was frozen in N2 liquid and lyophilized. Oxidation and silanization were evidenced by FTIR. Aerogels were produced from this functionalised suspension (BCOXNS) and compared to other non-oxidized aerogels, namely BCN (nanofibrillated BC), BCNS (nanofibrillated and silanized BC) and BCOXN (oxidized and nanofibrillated BC). Silanized aerogel presented a morphology with an organized lamella structure formed by the microfibrilar network. BCOXNS aerogel presented lower liquid absorption capacity than BCN and BCNS, but higher mechanical properties, which allowed its use during seven absorption-drying cycles. BCOXNS aerogel presented the best set of properties and was used as a model for future studies with other raw materials.

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Biosynthesis and characterization of bacterial cellulose by komagataeibacter from different culture conditions

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ABSTRACT

Bacterial Cellulose (BC) production is traditionally conducted from commercial culture media containing glucose as the source of carbon and other high-cost nutrients for the process. The use of carbon and nitrogen sources from agro-industrial waste is an alternative to lower costs in obtaining biotechnological products beyond to lessening the impacts on the environment caused by the inappropriate disposal of this material. In the present work, we evaluated the production and characterization of bacterial cellulose (BC) films obtained by *Komagataeibacter hansenii* ATCC 23769 culture using mannitol, glucose, fructose, lactose, glycerol, inulin and sucrose as alternative carbon sources, corn steep liquor (CSL) and Prodex Lac® as nitrogen sources. The gelatinous membrane formation of CB was monitored for 12 days, under static condition and temperature of 30 ºC. The membranes were purified by different methods, showing the same influence on the thermal and chemical properties of the obtained material. After purification the membranes were dried and characterized by scanning electron microscopy (SEM), thermogravimetric analysis (TG) and Fourier transform infrared spectroscopy with attenuated reflectance accessory (FTIR/ATR). The highest concentration of BC was found in culture medium containing Prodex Lac® as the nitrogen source. Among the sugars, lactose, fructose and mannitol presented the best results. TG analyzis indicate that all membranes have similar thermal behavior. FTIR results show that chemically all membrane samples (despite nitrogen or carbon source) are equivalent in structures. The micrographs have shown that the medium may influence the morphology of CB, but in general, all presented nanofibers, an important feature in the membrane.

Bacterial cellulose membranes for food active packaging

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ABSTRACT

The main function of food packaging is to preserve the maximum quality of the product, aiming to increase shelf life. Conventional packaging is slowly losing space for "active" and "smart" packaging that interact directly with the product. Thus, the objective of this work was to produce and characterize BC membranes incorporated with rosemary (20% and 100% -pure) and gorgonzola aromas, and silver nanoparticles (NpAg) for possible application as an active package to extend shelf life of various food products, improve their quality and intensify their sensorial characteristics. BC membranes were synthesized by Komagataeibacter hansenii bacteria in a static culture at 30ºC for 12 days, after purified, incorporated with the scents and NpAg through soaking and later dryed. After, the membranes were characterized by Fourier transform infrared spectroscopy with attenuated reflectance accessory (FTIR/ATR) and thermogravimetric analysis (TGA). The FTIR/ATR analysis indicated the NpAg, and the gorgonzola and rosemary20% scent was incorporated in the membrane, differently from what happened with the pure rosemary scent. In this case, the rosemary scent was probably not incorporated to the membranes, because of its oil nature. The thermal stability was reduced to 38.2 °C, 24.2 °C, 1 °C, and 13.4 °C for BC/NpAg, BC/gorgonzola, BC/rosemary100%, and BC/rosemary20%, respectively, according to the TGA analysis. The antimicrobial property was proven for the membranes incorporated with the rosemary (20% and 100%) scents and NpAg. As for the membrane incorporated with the gorgonzola scent, there was no growth also, but this result was attributed to other substances used as vehicles thereof.

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Evaluation of soy molasses as fermentation medium for bacterial cellulose production

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ARTICLE INFO

ABSTRACT

Bacterial cellulose (BC) is a biopolymer with application in several areas; however, its large-scaleproduction is limited due to the high cost of the process and the fermentation medium. The soy molasses (SM) byproduct canbe a promising substrate for BC production, since it can serve as carbon and nitrogensource required for microbial development. In order to determine the potential of soy molasses to produce bacterial cellulose, an aqueous solution containing 75 g/Lof SM hydrolyzed with 5% (v/v) 1M H2SO4was heated at 90 °C/10min (mediumSMH75). Aliquots of 50 mL of MSH75 and HS medium (reference medium) were distributed in culture flask and sterilized at 121 °C/15min. After sterilization, ethanol (0.0, 1.0, 1.5 and 2.0% v /v) was add to the mediaand inoculated with 10% (v/v) of *Komagataeibacterxylinus* ATCC 53582culture. The fermentation was conducted at 30 °C/10 days, under static condition. The obtained membranes were characterized by Fourier Transform Infrared spectroscopy (FTIR), thermal gravimetric analysis (TGA), and X-ray diffraction (XRD). The supplementation of MSH75 medium with 2.0% ethanol increased BC production in55%when comparedto the unsupplemented medium and lead to a similar production (7.0 g/L) totheHS medium. The membranes obtained in the MSH75 medium supplemented with 2.0% ethanol had typical bands of cellulose, thermal stability and crystallinity similar to those obtained in HS. Hydrolyzed soy molasses supplemented with ethanol presents great potential as a fermentation medium for BC production via static fermentation.

Functionalization of SCAFFOLDS of PLA printed in 3d structure for application in tissue engineering

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ARTICLE INFO

ABSTRACT

Multifunctional nanocomposites Regenerative medicine is an area of medicine aimed to upgrade organs and tissues regeneration process, though the creation of temporary substitutes that is able to guide and stimulate this process. In order to upgrade this process it is necessary the development of biocompatible materials that should work as supports (Scaffolds) interacting specifically with tissues that will be regenerate. The poly acid lactic (PLA) biopolymer is biocompatible and biodegradable, being the material that has come to stand out as an effective scaffold bone repair. The objective of this work is to evaluate the cellularization of the PLA printed in 3D structure, by the technique FDM in the laboratory of Biopolmat of the UNIARA. For this analysis, PLA will have its surface modified by CAP (Col atmospheric plasma) and DLW (Laser direct Writing), and will also be adsorbed to rhBMP-2 (recombinant human morphogenetic protein 2). Presterilized PLA scaffolds are used in a culture of MC3T3 cells (mouse myoblasts) and C2C12 (mouse myoblasts) in 48 well plates for 24 and 48 hours. After the cell adhesion, proliferation and cell adhesion period, it is evaluated by the MTT colorimetric method. The physical and rhBMP-2 induced differentiation at different concentrations and assessed by the perception of alkaline phosphatase activity. The expected results are the surface treatments of PLA with the action of rhBMP-2, improved adhesion, a proliferation and a difference for the use of PLA, which is effectively used in bone regenerative medicine.

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Variation of carbon sources for bacterial cellulose production to use as sustained drug release system

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ARTICLE INFO

ABSTRACT

Bacterial cellulose membranes (BC) has received special attention in recent years due to its notable characteristics such as high purity, mechanical strength, crystallinity, biodegradability and biocompatibility, which allows their use in medicine and pharmaceutic areas. Nevertheless, the low yield and the high production cost constitutes a limitation BC use in these areas. The objective of this work was to obtain a higher yield of BC by *Gluconacetobacter hansenii* (ATCC 23729), by varying the type and carbon source concentration (glucose, sucrose and fructose) of the culture media, to use as antibacterial drug release topic system. The BC obtained were characterized by Fourier transformed infra-red spectroscopy, scanning electron microscopy and X-ray diffraction. Disks of the different BC were impregnated with antibacterial drugs, rifampicin (BC-RFM), ceftriaxone (BC-CRO) and levofloxacin (BC-LVX) and tested by Franz cell permeation and disc diffusion. The results presented that BC-RFM showed greater retention capacity and lower velocity of RFM releasewhen compared to BC-LVX and BC-CRO. This result can be related with the fact that RFM molecule is rich in OH radicals promoting the interaction by hydrogen bonds with the OH radicals of CB.

Case study: curative biocellulose in abrasion

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ARTICLE INFO

ABSTRACT

Multifunctional nanocomposites It is a case study of an abrasion wound, motivated by a motorcycle accident, treated with a biocellulose curative with the intention of knowing the acceptance of the product by the user, the benefits and the differentials of this. In the healing process, the with reconstructive phase begins on the fourth day after the tissue discontinuity, coinciding the application of the biocellulose curative Nexfil® in this study were used the smooth and porous versions to treat lesions found in grade I, II and III in the following body extensions: right palmar region - 2 lesions, 5 x 4 cm and another 3.5 x 7 cm; left palmar region - 8 x 8 cm lesion; flank D: lesion 10 x 9 cm; and all digital pulps. The biocellulose film was installed without adequate technical equipment, at home where the patient living conditions did not allow an aseptic environment and that would allow the development of an infectious process. Immediately, the use of the biocellulose film, facilitated the visualization of all the stages of the cicatricial process; the porous version allows the exudate elimination also stands out the accentuated adhesion, supporting baths without detachment and the possibility of dispensing an additional coverage. There was a report by the patient of immediate analgesia after an initial sensation of local warmth perceived during the application of the biocellulose film and which made viable the resumption of patient movement it does not show adhesion in clothes and detaches in a synchronized manner to healing timing.

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Functionalization of SCAFFOLDS of PLA printed in 3d structure for application in tissue engineering

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ARTICLE INFO

ABSTRACT

Multifunctional nanocomposites Regenerative medicine is an area of medicine aimed to upgrade organs and tissues regeneration process, though the creation of temporary substitutes that is able to guide and stimulate this process. In order to upgrade this process it is necessary the development of biocompatible materials that should work as supports (Scaffolds) interacting specifically with tissues that will be regenerate. The poly acid lactic (PLA) biopolymer is biocompatible and biodegradable, being the material that has come to stand out as an effective scaffold bone repair. The objective of this work is to evaluate the cellularization of the PLA printed in 3D structure, by the technique FDM in the laboratory of Biopolmat of the UNIARA. For this analysis, PLA will have its surface modified by CAP (Col atmospheric plasma) and DLW (Laser direct Writing), and will also be adsorbed to rhBMP-2 (recombinant human morphogenetic protein 2). Presterilized PLA scaffolds are used in a culture of MC3T3 cells (mouse myoblasts) and C2C12 (mouse myoblasts) in 48 well plates for 24 and 48 hours. After the cell adhesion, proliferation and cell adhesion period, it is evaluated by the MTT colorimetric method. The physical and rhBMP-2 induced differentiation at different concentrations and assessed by the perception of alkaline phosphatase activity. The expected results are the surface treatments of PLA with the action of rhBMP-2, improved adhesion, a proliferation and a difference for the use of PLA, which is effectively used in bone regenerative medicine.

Procedure for obtaining individual kinetic parameters for bacterial cellulose

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ARTICLE INFO

ABSTRACT

One of the purposes of the study of kinetic processes in condensed phase is the determination of thermally stimulated reactions parameters. In general, the analysis methods involve the estimation of kinetic parameters based on the general equation given by:

$$\frac{d\alpha}{dT} = \frac{A}{\beta} e^{-\frac{E}{RT}} f(\alpha)$$

The equation above represents a simple non-isothermal process, involving a reaction governed by a single kinetic mechanism. Meantime, in the case of complex processes may be involved two or more overlapping reactions, being convenient to carry out the separation of the kinetic curves in individual cases. The separation (or deconvolution) of the kinetic "peaks" can be carried out by adjusting of symmetric functions such as the Gaussian function, Lorentzian, Weibull, or Suzuki-Fraser. Fraser-Suzuki (FS) function is a modification of the Gaussian function and has shown better results in describing the asymmetry characteristic of non-isothermal kinetic curves. This study aims to present a separation procedure of the "peaks" of the kinetic curves of processes involving cellulose thermal decomposition and determine the overall activation energy based on individual kinetic parameters E, A and f (α). Therefore, was possible to determine the kinetic parameters of individual reactions and describe the activation energy profile as a function of the degree of conversion of the global process. In logarithmic form, the terms of each individual kinetic equation is given by:

$$ln\left[\frac{FS_i}{f_i(\alpha)}\right] = ln\left[\frac{A_i}{\beta}\right] - \frac{E_i}{R}\frac{1}{T}$$

Given an experimental data set (α, dα/dT and T), deconvolution of the kinetic curve (dα/dT - T) provides the FSi (T) approximations. The kinetic parameters Ei and Ai are estimated from the slope and the linear coefficient of the curve of ln $\left[\frac{FS_i}{f_i(\alpha)}\right]$ vs 1/T.

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Reabsorbable bioactive membranes based on bacterial cellulose and strontium apatite

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ARTICLE INFO

ABSTRACT

Guided bone regeneration (GBR) is a procedure for periodontal regeneration therapy. Its principle is to prevent an invasion of non-functional scar tissues and also to stimulate bone growth. Conventional materials of GBR membranes are generally, non-degradable polymers, which require a second surgery to remove the membrane after new bone generation. Therefore, reabsorbable membranes based on bacterial cellulose (BC) and strontium apatite (ApSr) - strontium is known to inhibit bone resorption and induce bone formation - were produced and evaluated aiming a future application as GBR membrane. BC was obtained from the cultivation of Komagataeibacter hansenii in Hestrin-Schramm medium. After purification, the membrane was submitted to oxidation by NaIO4 and functionalized with ApSr. Degradability tests were performed in phosphate buffered saline (PBS) and in simulated body fluid (SBF) at 37 °C. BC degradation products were quantified by HPLC. The bioactivity was verified by scanning electron microscopy (SEM). The results obtained from the analysis of the supernatant showed glucose as degradation product for both materials after 90 days. However, the degradation was higher for BC/ApSr than BC. Also the results showed that the degradation in PBS was higher than in SBF, probably because when the samples are immersed in SBF is induced a chemical precipitation with formation of hydroxyapatite, which indicate the bioactivity of the materials, as it was confirmed by SEM analysis. Therefore, the BC/ApSr is expected to be capable of initiating a bone formation process at the same time that it will probably be susceptible to degradation at physiological conditions.

Large-scale production of bacterial cellulose – Nexfill®

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ARTICLE INFO

ABSTRACT

Bacterial cellulose is a non-toxic, biocompatible biopolymer that has a significant impact on the development of biotechnological products. These characteristics make it a promising biomaterial in the health area. The production of biocellulose occurs through the metabolism of the bacterium *Gluconacetobacter xylinus* in static culture with optimal availability of carbon and nitrogen sources, and under controlled conditions of temperature, humidity and pH. In addition, stringent control during the production process ensures the high quality and productivity of large-scale biocellulose. Seven Indústria de Produtos Biotecnológicos Ltda. (Nexfill®) - invests in continuous research and improvement of the strain, aiming at a high performance in the production of biocellulose. Furthermore, it controls its processes to ensure the excellent quality of Nexfill® dressings. In order to evaluate the quality of the biocellulose, its thickness, weight and appearance of the membranes are taken into account. The company's current production capacity amounts to 6.000 membranes / month, which corresponds to 1.2 million cm^2 of biocellulose, and it can be increased according to market demand. When it comes to dressings for skin wound treatment, smooth or porous versions, this number is reflected in a monthly production of 24 thousand dressings 16x21cm or 48 thousand dressings 10x16cm or 96 thousand dressings 8x10cm. In addition to dressings, Seven developed the biocellulose hydrogel and invests in research and development for continuous improvement. The production of high quality bacterial cellulose on a large scale is only possible due to all the quality standards mentioned and maintained by the company.

1º Encontro Brasileiro de Biocelulose
04 e 05 de junho de 2018

Nexfill® biocellulose hydrogel - an innovation for skin wound treatment

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ARTICLE INFO

ABSTRACT

Bacterial cellulose membranes have biocompatibility *in vivo* and provide rapid healing when applied to skin wounds. The company Seven Indústria de Produtos Biotecnológicos Ltda. works with biocellulose since 1997 and currently produces this product on an industrial scale, dressing that aims to temporarily cover moist cutaneous wounds without infection, protecting the wound and accelerating the healing process. The company's commitment to developing new biocellulose based products has led to the development of a hydrogel aimed at improving the therapeutic response of biocellulose and facilitating application in different types of skin wounds. This study consisted of characterizing hydrogel and analyzing *in vitro* its effectiveness in healing. Hydrogel was characterized by rheological measurements from the flow curve, surface morphology and *in vitro* study of cell migration. The rheological results of the flow curve show that hydrogel has thixotropic characteristics, thus facilitating its application to the skin, as they become more fluid during application, facilitating scattering and then recovering the initial viscosity, preventing the hydrogel from flowing. In addition, the thixotropic hydrogels, since they do not undergo change of viscosity during storage, have a longer shelf-life. Through microscopic analysis, it was verified that hydrogel has on its surface porous structures and nanofibers of biocellulose, besides providing an acceleration in wound healing as suggested in the cell migration test, indicating the promising and potential application of this product for skin wound treatment.

Use of bacterial cellulose-based hydrogel in experimental Wounds of equines – preliminary results

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ABSTRACT

Wounds in horses are common and are subject of exuberant granulation tissue. Bacterial cellulose is a tissue repair material and it has been successfully applied to skin healing The objective of this study was to evaluate the healing of experimental wounds, treated or not with bacterial cellulose-based hydrogel gel 1% (BC-based hydrogel). Two wounds in the lumbar region were made in three horses, after sedation and local anesthesia. The daily treatment consisted on the application of physiological solution and, in the cranial wounds, BC-based hydrogel enough to cover the wound bed. The evaluation of the wounds was performed after the surgical procedure, and at 3, 7, 14 and 21 postoperative days, observing the presence of hemorrhage, clots, crusts, granulation tissue, epithelization and exudate, as well as photographic documentation, calculation of wound area and rate of contraction. During the first 7 days, bleeding, clots, exudate and crusts were observed. Granulation tissue and epithelization was observed after 3 and 7 days after surgery, respectively. Wounds were not fully healed by day 21, however, epithelization was evident in both groups. Although the wounds of the treated group were superior in the clinical evaluation, the areas of wounds in D21 were similar between the control and treated groups (1.2 and 1.5 cm^2, respectively), as did the contraction rate (64 and 51%, respectively). The continuity of the research, with microscopic evaluations and a greater number of animals, is necessary to elucidate the contribution or not of the BC in the healing of cutaneous wounds in this species.

Thermography of experimental wounds treated with bacterial cellulose-based hydrogel in equines – Preliminary Results

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ARTICLE INFO

ABSTRACT

Introduction: Bacterial cellulose has been studied as a tissue repair material and its different variations have been successfully applied to skin healing. The objective of this study consist on evaluating the temperature kinetics during the cicatricial process of experimentally induced wounds, treated or not with BC-based hydrogel. Methodology: Three horses, adult and healthy, were used after sedation and local blockade. Two surgical wounds (4 cm^2) were made and skin and subcutaneous were removed, being a cranial (treatment) and caudal (control). Phenylbutazone (2.2 mg/Kg/IV/q24h) was administered for 3 days. Daily, the wounds were cleaned with physiological solution, and the cranial wounds were treated with BC-based hydrogel covering the wound bed. Thermographic images were obtained with Flir i60 camera, immediately after the surgical procedure (D0), and at 3 (D3), 7 (D7), 14 (D14) and 21 (D21) postoperative days. The temperatures of the center and the edges of the wounds were measured using the Flir Tools program. Results and discussion: Higher values of mean temperature of the center and edges were observed for treated wounds in D3 and D7relating to the control. Subsequently, a gradual decrease of the values was detected been the two groups similar in D14. Additionally, there was a temperature increase for both groups in D21, with similar values. Conclusion: Finally, the use of BC-based hydrogel in equine wounds is related to the increase of local perfusion and tissue metabolism, especially in the first 14 days of the healing process.

In vivo study of wound healing of biocurative from bacterial cellulose with chitosan associated with ciprofloxacin in mice

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ABSTRACT

In research for dressings with most cost effective, the biopolymers gain prominence, especially bacterial cellulose and chitosan, which have proven efficacy in the treatment of lesions. Bacterial cellulose has high tensile strength, flexibility, water retention capacity and is non-toxic. In addition, its porosity allows the introduction and release of antimicrobial agents, drugs and other biofunctional materials. Chitosan, a biopolymer produced from the deacetylation of chitin, contains antibacterial effectiveness, emulsifying, and non - toxic, biocompatible and biodegradable properties. The present study aims at analyzing the cytotoxic, mutagenic and cicatricle characteristics of a biocurative produced by bacterial cellulose (BC) and chitosan (QTS) associated with a ciprofloxacin (BC/QTS/CIP) and comparing it to pure BC. All samples showed no cytotoxicity or mutagenicity. Through the in vivo tests, it was possible to analyze the capacity of maintenance of moisture in the interface curative / injury, acting as barrier for microorganisms, toxicity and absence of any sign of irritability in the lesion for both analyzed biocuratives. Regarding the area of healing, until the 7th day, the percentage of reduction of the lesion area was higher for the BC/QTS/CIP biocurative, however, on the 14th day, reepithelization was superior for the animals treated with BC and with formation of more mature tissue. On the 21st day, 100% healing of the injured area it observed in both cases. Finally, it concluded that the biocurative of pure BC, obtained with little difference superior results regarding the reduction of the lesion area, and both did not demonstrate cytotoxicity and mutagenicity.

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Morphological and chemistry analysis of bacterial cellulose membranes after pressure process

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ABSTRACT

Bacterial cellulose (BC), is a biopolymer applied in several fields. It has high water retention capacity, purity and crystallinity, is biocompatible, has fibers of nanometric size and has no lignin, pectin and hemicellulose in its structure, such as plant cellulose. However, little is known about possible changes that pressing treatment can cause in the morphological and chemical properties of CB. Therefore, the aim of this work is a chemical and morphological analysis of CB produced by *Komagataeibacter rhaeticus* strain after pressing process. The membranes were produced, purified, pressed with a hydraulic press according to central composite planning, evaluating 2 variables: pressing time 10, 20 and 30 seconds and pressing force of 1, 2 and 3 tons. The samples were analyzed by scanning electron microscopy (SEM) using the JEOL T-300 microscope operating at 2 kV and by infrared vibration spectroscopy (FTIR) with BRUKER 70 spectrometer from Bruker. SEM images of the treated samples compared the untreated samples showed more compacted fibers, less porous and aligned in the same direction according to the time and pressing force. However, the samples obtained by spectroscopy did not show chemical changes, which the CB presented characteristic bands. The results show that the use of the press can vary the structure morphology of CB.

In-situ modification of biocellulose for drug delivery

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ABSTRACT

Bacterial cellulose (BC) has been intensively studied for many applications in the biomedical field including artificial blood vessels, tissue engineering, wound dressing, drug delivery, etc. However, plain BC films do not have biocidal activities neither are able to entrap, keep and control the release of antibiotics and proteins for therapeutic purposes. *In-situ* modification of BC scaffolds by adding exogenous molecules (*i.e.* polymers) to the culture media during BC synthesis allowed to drastically change the film properties. *In-situ* modification of BC with pectin allowed to efficiently encapsulate an antibiotic levofloxacin and human Serum Albumin. The Levo and HSA release profiles observed in the BC films in presence of HMP showed controlled and sustained molecular delivery along the time for 12 hours. Also, incorporation of alginate in BC network during bacterial growth showed a network able to entrap and properly doxorubicin. The release of the anticancer drug from BC-Alginate scaffold reduced the HT29 colon cancers cell growth in 67% after 48 h incubation. Structural analysis of the BC scaffolds modified with pectin and alginate by XRD, FTIR, DSC, and SEM demonstrated strong changes in the BC properties and interpenetrated matrices which allow to develop a class of BC films which displayed novel properties.

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Development of 3D-bioprinted pectin-biocellulose scaffolds for drug delivery

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ABSTRACT

The aim of the project is to develop personalized therapies using 3D-bioprinted dressing scaffolds for the treatment of ulcerated diabetic foot. The bioprinter developed in the Nanobiomaterials Laboratory (CINDEFI) is a 3D-cartesian printer commanded by an open source Arduino hardware and Marlin firmware. The 3D-bioprinter head was designed to extrude viscous materials using a syringe able to deposit 400 µm-strips over the plate with an air gap among filament of 750 µm. Hybrid pectins-cellulose biogels with different properties and compositions were assayed to be injected and making stable gel scaffolds on the printer plate. Biogels containing 20-25% (w/v) pectin plus 3-5% (w/v) nanocellulose were stable up 2.8 mm high using cylindrical and conical structural designs. The effect of amorphous (nanoparticles) and microcrystalline celluloses were compared in the film formation and stability. Biophysical analyses of scaffolds were performed by thermogravimetry (TGA), differential scanning calorimetry (DSC) and porosimetry.

Development and characterization of biocuratives of bacterial cellulose with curcumine

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ABSTRACT

Bacterial cellulose is an abundant biopolymer, synthetized by the bacterium Komagataeirbacter rhaeticus, which shows characteristics and properties desirable for its use as a bandage in topical treatment of wounds. The aim of this study is to prepare and standardize bacterial cellulose bio-curative for the future incorporation of actives, such as curcumin, which has several pharmacological properties, like as antioxidant, antiprotozoal, antimicrobial, antiinflammatory and its application in wounds has shown an improvement in epithelial regeneration besides improving fibroblast proliferation and vascular density. For this to occur, bacterial cellulose membranes with curcumin will be produced and standardized and will be characterized by MEV, DSC and TG techniques, in order to demonstrate modifications in membrane structures with theincorporation of the compoundof interest in their matrix, to be produced a funcional bio-curative.

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Biocellulose nanofibers: a new generation of materials for application in the release of drugs

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ABSTRACT

The use of excipients having bioavailability to control the release of drugs in the body has been the subject of research, as they are able to decrease the daily amount of administration of the drug and its side effects, encouraging patients to adhere to its use. It was used as an alternative for the production of microcapsules, Bacterial Cellulose (CB), which has a nanometric structure, high surface area and fibers so intensely entangled, joined by hydrogen bonds, which when dried through the process of Spray drying imprison the drug within the matrix, increasing the release time thereof. Methodology: The production and purification of CB, Grinder defibrillation and spray drying were performed; were analyzed by Scanning Electron Microscopy (MEV) and by Liquid Absorption (AL). Results and discussion: Purification of CBs was sufficient to remove residues from the culture medium as well as bacterial residues, as well as defibrillation employing micro grinding in grinder was more adequate for the desired need. The results of AL revealed a pH-dependent behavior, with lower acid absorption, which should contribute to better control of the release when in the gastric environment.

Development of filaments based on polymeric composites of phb (polyhydroxybutyrate) and bacterial cellulose obtained by addictive manufacturing for biomedical applications

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ARTICLE INFO

ABSTRACT

Additive manufacturing is an alternative method for producing new materials, and it has growned since the drop of the FDM (Fused Deposition Modeling) patent. FDM filaments are composed of thermoplastic polymers, but there is no a large variety of filaments available on the market. The main objective of this work has been the preparation and characterization of new filaments for 3D printing based on polymeric composites of PHB (polyhydroxybutyrate) and bacterial cellulose (BC). The composite filaments were produced using a simple screwthread extruder, varying the PHB-BC mass ratio. For the preparation of these composites, residues from the BC production were donated by Seven Biotecnologia Company. BC residue was powdered reduced using a Pulverizete until obtaining a micrometric powder that was mixed with PHB in different weight/weight proportions (1%; 0,7%; 0,5%; 0,3%; and 0,1%). The obtained filaments have been characterized by SEM images, infrared spectroscopy (FTIR), thermogravimetric (TG) analysis, and Differential Scanning Calorimetry (DSC), and in vitro tests. The average diameter of these new BC-PHB filaments were 1.75 mm and it could be a candidates for use in 3D printing in special for biomedical applicattions.

1º Encontro Brasileiro de Biocelulose 04 e 05 de junho de 2018

Development of filaments based on polymeric composites of phb (polyhydroxybutyrate) and bacterial cellulose obtained by addictive manufacturing for biomedical applications

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ARTICLE INFO

ABSTRACT

Additive manufacturing is an alternative method for producing new materials, and it has growned since the drop of the FDM (Fused Deposition Modeling) patent. FDM filaments are composed of thermoplastic polymers, but there is no a large variety of filaments available on the market. The main objective of this work has been the preparation and characterization of new filaments for 3D printing based on polymeric composites of PHB (polyhydroxybutyrate) and bacterial cellulose (BC). The composite filaments were produced using a simple screwthread extruder, varying the PHB-BC mass ratio. For the preparation of these composites, residues from the BC production were donated by Seven Biotecnologia Company. BC residue was powdered reduced using a Pulverizete until obtaining a micrometric powder that was mixed with PHB in different weight/weight proportions (1%; 0,7%; 0,5%; 0,3%; and 0,1%). The obtained filaments have been characterized by SEM images, infrared spectroscopy (FTIR), thermogravimetric (TG) analysis, and Differential Scanning Calorimetry (DSC), and in vitro tests. The average diameter of these new BC-PHB filaments were 1.75 mm and it could be a candidates for use in 3D printing in special for biomedical applicattions.

BNC-based platforms for tumor growth models

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ARTICLE INFO

ABSTRACT

Many commercial tumor matrix biomaterials have uncontrollable cues that make molecular fine- tuned analysis difficult or near to impossible. Animal protein residues are particularly harmful. Critical questions such as the influence of growth factors in tumor development depend on highly defined matrix composition so they can satisfactorily rely on the target variables. The challenge is to start with a very pure bacterial nanocellulose (BNC) and establish a 3D culture environment that mimics tumor behavior. In particular, the vascular mimicry mechanism has recently been paid attention to due to possible relation with tumoral angiogenic process being included as a cancer hallmark. This work presents a bacterial nanocellulose-based 3D model platform for tumor growth studies and therapeutic strategies development. BNC membranes were produced by Komagataeibacter hansenii ATCC 23769 during a 4-days culture in a mannitol-based medium. Membranes were subsequently purified using caustic solution and extensive washing, fibers where oxidized and vascular promoters were chemically immobilized. Results show that vascular mimicry processes can be reliably modeled and controlled by adjusting nanofiber network density and topology. Our platform has been tested for a melanoma cell line with successful mimicry under in vitro culture controlled conditions. SK-MEL-28 from animal origin grew and spread forming vascular structures, analyzed by fluorescent microscopy. Resulting vessel network was characterized and quantified by image analysis. The developed BNC-IKVAV 3D hydrogel platform can provide a valuable tool to improve our understanding of microenvironmental cues in melanoma cancer progression, and their role in the vasculogenic mimicry process.

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In vitro study of osteo-1 on bacterial cellulose membrane surfaces modified using non-thermal plasma treatment

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ARTICLE INFO

ABSTRACT

Bacterial cellulose (BC), which has been used in a variety of medical applications, presents excellent malleability, hydrophilicity and biocompatibility. Due to these properties, this material is suitable for applications in tissue engineering as a temporary substitute for skin, as a support for drug interactions and for tissue growth. Success in using biodegradable polymers is determined by interactions between cells and the material employed, which are largely governed by the characteristics of the surface. The present work aims to evaluate the cellularization on a bacterial cellulose membrane (BCM) surface that has been modified using non-thermal plasma. OSTEO-1 will be cultivated in osteogenic differentiation medium in 48-well plates (5000 cells / mL) for 7, 14, and 21 days, in the absence and in the presence of BCM synthesized by *Acetobacter xylinum,* with or without modification of the membrane surface using non-thermal argon and oxygen plasma treatments. The culture medium will be exchanged every 72h, for alkaline phosphatase analysis. Cell adhesion and morphology will be analyzed by electron microscopy. Cell viability will be evaluated by the MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) reduction method, using absorbance at a wavelength of 570 nm. Mineralization will be quantified by the Alizarin Red method, with measurement of absorbance at 405 nm. Cell counting will be performed with a Bio-Rad TC20 cell counter. We intend to develop a biopolymer derived from BC that offers improved cell adhesion and proliferation performance, which can be used in regenerative medicine and biomedical devices.

Preparation of chemically modified cellulose hydrogel for bioprinting

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ARTICLE INFO

ABSTRACT
The tissue engineering study strategies for repairing and maintenance of alive tissues, and for such, the cells and the biomaterials are widely studied, once they form the systems responsible for the success of the tissue engineering. The behaviour of the cells depends on their interaction with the biomaterials for the formation of new tissues. Several technologies such as three dimensional printing and bioprinting have been arising for the development of new strategies to improve the repair and maintenance of tissues. The biomaterials used for these technologies are limited because they must show adequate properties for processing and also for keeping the cells viability. The cellulose chemically modified with TEMPO reagent is biocompatible and shows interesting properties for shaping by ionic complexation. In this vein, the proposal of this research project is the use of chemically modified cellulose hydrogel for incorporation of cells, followed by extrusion in form of fibers. The capability of fiber formation and maintenance of the cells viability will be the parameters to evaluate the efficiency of the material as a bionk for bioprinting application.

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Evaluation of the potential of cashew permeate as culture medium for bacterial cellulose production

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ARTICLE INFO

ABSTRACT
Bacterial cellulose(BC) is a biopolymer secreted by microorganisms that iscomposed by nanofibers with high crystallinity and purity,which provides a wide range of applications in several areas. In order to reduce the costrelated to BC production, agroindustrial sources rich in sugars and other nutrients have been widely studied as alternative culture media. This study evaluated the use of cashew permeate (CP), which is byproduct obtained in the process of extracting cashew pseudofruit fiber's aqueous extract rich in carotenoid, as a culture medium for BC synthesis. The fermentation was performed by static cultivation using three different CP concentrations (40, 50, and 100%; v/v) and a synthetic medium (Hestrinand Schramm; HS), for comparations purposes, using the *Komagataebacter xylinusATCC 53582*bacterial strain. The BCsproduced in HS and CP were characterized by thermogravimetry analysis(TGA), Fourier transforminfrared spectroscopy(FTIR) and X-ray diffraction(XRD). The characterizations results showed that BC from permeate presented typical behavior of bacterial cellulose, e.g. high purity and crystallinity and good mechanical properties.The BC'sproductionsin CP 40, 50 and 100% were 2.4, 2.8, and 3.50 g.L-1, respectively, which aregood production values.In fact,the BC'sproduction in CP, even at a lowerconcentration, was higher than the production reported by others fruit-based media.

Study of microwave-assisted bacterial cellulose oxidation

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ARTICLE INFO

ABSTRACT

Bacterial cellulose (BC) is a biopolymer that has unique properties, which make it a promising materialfor application in several areas. The modification of the cellulose opens the possibility to introduce new desired properties. The dialdehyde cellulose derivative (DAC) can be produced employing periodate as an oxidizing agent. Factors such as time, temperature and periodate concentration directly influence the rate of oxidation. Microwave dielectric heating allows reactions that are not possible using conventional heating, with improved reaction yields and reduced reaction times. In addition, microwave heating is environmentally friendly and reduces operating costs. It is worth noting the lack of studies on the microwave-assisted oxidation reaction of bacterial cellulose. Therefore, it was intended in this work to optimize the oxidation process of BCby microwave-assistedheating and to compare with the process by conventional heating. BCfilms were obtained after the static fermentation of *Komagataeibacter hansenii*. To obtain the DAC, after being purified, the films were immersed in KCl/HCl buffer solution (pH 1) for 24 hours and oxidized with 1.5 g NaIO4: 1 g BC, where the reaction time and temperature were evaluated in the oxidation process. The aldehyde content (%) was determined by potentiometric titration.The results showed thatby conventional heating, to reach a content of 50% a reaction time of 360 min was required. While through microwave heating it was possible to decrease the reaction time to 30 min and achieve an aldehydecontentof 76%.

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Ce3+-doped calcium phosphates grown on biocellulose template for bone tissue engineering

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ARTICLE INFO

ABSTRACT

Biocellulose is a natural biopolymer produced by a variety of microorganisms belonging to different genera, such as *Gluconacetobacter*. Due to its remarkable physicochemical properties, besides its excellent biocompatibility, it has been demonstrated that biocellulose may be used as a template for the formation of calcium phosphates (CPs), which are the main synthetic bone grafts used. In order to improve antibacterial activity of CPs and to potentiate the differentiation, proliferation and mineralization of osteoblasts, an alternative has been the addition of dopant ions such as cerium ions (Ce3+). According to previous studies, it has been verified that those materials are notably promisor to applications in bone tissue engineering. In this context, we propose in this research the synthesis of Ce3+-doped CPs (CPsCe) (% Ce3+ = 5.00% m / m) by alternate soaking of biocellulose membranes, followed by calcination for 10 h at 500° C. The materials were characterized by XRD and SEM. EDS analysis indicated the presence of the Ce3+ ions. XRD patterns showed the presence of two phases: chlorapatite, (Ca10(PO4)6Cl2) and buchwaldite (NaCaPO4), once the precursors presented Na+ and Cl- ions, which were not completely removed during the intervals between the soaking cycles. The SEM images showed regions with *3D* porous body, with nanowires that are interconnected forming a resistant structure and suggesting the formation of mineral scaffolds, by growing CPs on biocellulose template.

Proposal of new means of culture for production of bacterial cellulosis

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ARTICLE INFO

ABSTRACT

Due to its characteristics such as high purity, biocompatibility and biodegradability BC has been attracting the interest of researchers for its use in the medical and pharmaceutical area. However, because of the relative difficulty of obtaining on a large scale, this biopolymer it has been the subject of several researches, regarding the study of new methods and conditions of cultivation, mainly in relation to the carbon sources used. In this work were proposed two culture media with different carbon sources, synthetic medium 1, containing glucose and sucrose (MS1), synthetic medium 2 containing glucose, fructose and sucrose (MS2), to compare with the media described in the literature Zhou (Z), containing glucose, Yamanaka (Y) containing sucrose, Hestrin-Schramm (HS) containing glucose to BC produce. All media were inoculated with the bacterial strain *Gluconacetobacter hansenii* ATCC 23769 and maintained under static conditions for 7 days at 28 ° C. The experiment was carried in triplicate. After treatment to bacterial elimination and pH neutralization the BC were submitted to the complete dehydration to dry mass yield determination. Scanning Electron Microscopy analysis showed differences between the fibers the intertwining thickness and arrangement of fibers. The MS1 and MS2 dry mass yield presented higher values when compared with HS, Z, Y These results demonstrate an influence of the carbon sources present in the different culture media on the metabolic pathway for BC production.

1º Encontro Brasileiro de Biocelulose 04 e 05 de junho de 2018

Development and characterization of microparticles reticulated with al3+ ions based on gellan gum nanocomposites reinforced with cellulose nanofibers

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ABSTRACT

Microparticles are multiparticulate systems of size ranging from 1 to 1000 μm with defined shape that have been used in the design of controlled drug release systems, since they allow the compartmentalization of the drugs and their protection against degradation exerted by external and internal factors.These systems are advantageous in relation to conventional release systems, since they allow the temporal and / or spatial control of the release, contributing to the increase of the therapeutic effect and reduction of side effects and toxic. The aim of thiswork was the development of microparticles based on gellan gum and reinforced with cellulose nanofibers (NFC) (3, 5 and 7 % m/v) as a potential strategy for controlled drug release. The microparticles were obtained through the ionotropic gelation process using Al3+ ions as crosslinking. The morphological analysis was performed by Scanning Electron Microscopy (SEM). The liquid absorption profile was evaluated in an Enslin device. Interactions between gellan and NFC was evaluated by Fourier Transform Infrared Spectrocospy (FTIR). The inotropic gelling method using Al3+ was efficient since it allowed the formation of spherical particles with reduced size (1210, 1060, 878 and 1210 μm). The NFC influenced the obtaining of the microparticles being used as reinforcement and it is possible to customize the size / shape of the particles. In the swelling, the addition of 3% of NFC was responsible for the lower absorption of liquids, which should also have a great impact on the control of release rates. The interaction between continuous phase (GG) and reinforcement (NFC) was confirmed by FTIR and occurred through hydrogen bonds. Therefore, it is concluded that the development and characterization of Al3+ crosslinked microparticles based on gellan nanocomposites reinforced with cellulose nanofibers has been successful and can be used in the design of controlled drug release systems.

Cellulose productionusing as cultura medium soybean hulls hydrolyzate

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ARTICLE INFO

ABSTRACT

Soybean hulls are an abundant and low-cost lignocellulosic residual material that could be used as feedstock to obtain high added-value products. Due to its relatively low recalcitrance, soybean hulls canbe enzymatic hydrolyzed into a sugar-rich medium, without the need of any pretreatment process. Here, soybean hulls hydrolysate was evaluated as a source of sugars to maximize the production by bacterial cellulose, a high-value nanomaterial with remarkable properties and applications in the medical, electronic and automotive sectors. For that, soybean hulls were hydrolyzed by different commercial enzymatic cocktails and the hydrolysate with higher glucose concentration was used for bacterial cellulose production by *Gluconacetobacter hansenii*in comparison to the conventional Hestrin & Schramm culture medium. The nanocellulose films were fully characterized using SEM, XRD, FT-IR and TGA analyses. The use of hydrolysate supplemented with glucose resulted in 5.3 mg of bacterial cellulose, a value around 20% higher than the one achieved using the conventional medium. The films produced were similar in terms of thermal degradation behavior, with Tonset of about 300°C, and crystallinity (75%). FT-IR data confirmedthat the cellulose films were pure and composed of type I cellulose, showing that soybean hulls hydrolysate can be used as a potential feedstock for bacterial cellulose production.

1º Encontro Brasileiro de Biocelulose 04 e 05 de junho de 2018

Cellulose productionusing as cultura medium soybean hulls hydrolyzate

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ABSTRACT

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Evaluation of stability of bacterial cellulose in pbs and artificial saliva

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ARTICLE INFO

ABSTRACT

Bacterial cellulose is a polysaccharide widely used as biomaterial, having a high water retention capacity, excellent mechanical properties and being biocompatible. The objective of this study was to evaluate the stability of bacterial cellulose in PBS and in artificial saliva, which are simulated bodily media, aiming its use as biomaterial. The samples were placed in containers containing a solution of phosphate buffer, PBS (pH = 7.0) and in an artificial saliva solution (pH = 6.4). They were maintained at 37 ° C until 180 days had elapsed. Samples were analyzed every 30 days until 180 days. The samples were morphologically characterized (SEM) before and after the degradation, thermally (DSC and TGA), chemically (IR), besides mass loss and pH analysis of PBS and saliva. The mass loss analysis showed that the material was stable, and that in contact with the PBS it had a 3.7% decrease in mass, while in contact with the saliva, it was 9.3% in 180 days, demonstrating that saliva is a more aggressive bodily medium compared to PBS. In the pH analysis there was no significant variation with both media. The morphological analysis of the bacterial cellulose in contact with the saliva showed a degradation in the fibers, which did not occur in contact in PBS. Bacterial cellulose is a stable material when exposed in PBS, but it undergoes degradation when in artificial saliva.

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Insertion of metal phosphates in bacterial cellulose matrix for biomedical applications

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ABSTRACT

Bacterial cellulose (CB) is one of the most promising biopolymers because of its good mechanical properties, crystallinity, water retention capacity, interconnected 3D porous nanostructure, and excellent biocompatibility. These characteristics are advantageous in guided bone regeneration (GBR) due to the possibility of processing them into three-dimensional structures, in regeneration of many organs of the body, such as skin, cartilage, and others. Hydroxyapatite (HAp) is the main constituent of the inorganic components in the natural bone and can be combined with the HAp properties (biocompatibility, bioactivity and osteoconductivity) to promote several benefits to the bone tissue. Studies have shown that biomaterials based on tricalcium phosphates (TCP) with trace bone elements (Sr^{2+}, Zn^{2+}, Mn^{2+} and Mg^{2+}) may increase osteogenesis and neovascularization. Thus, the objective of this work was to develop BC scaffolds functionalized with five different metal phosphates, termed BC/$Ca_3(PO_4)_2$, BC/$Sr_3(PO_4)_2$, BC/$CaSr(PO_4)_2$, BC/$Zn_3(PO_4)_2$ and BC/$ZnCa(PO_4)_2$, aiming to induce bone growth for GBR application. CB membranes were biosynthesized by *Kumagataeibacter hansenii* and purified. Scaffolds were prepared from BC membranes by dipping sequentially in solutions of calcium chloride, strontium or zinc followed by phosphate solution. After functionalization, the samples were lyophilized for thermogravimetric analysis (TGA), Fourier transform infrared spectroscopy with attenuated reflectance accessory (FTIR/ATR) and scanning electron microscopy (SEM) characterization. TGA analyses showed that the amount of the mineral phase was around 72.5 to 83.3% with a total weight, further confirming the formation of apatite on the BC membrane. XRD patterns and FTIR spectroscopy, strongly suggest the doping ions in trace amount (Ca, Sr and Zn) influence at BC, it is enriched the biocomposite properties, that are essential for bone cells life. SEM micrographs have shown the deposition of biological apatite crystals which were affected by the ions inserted. Our results indicate the apatite formation on the BC membranes and trace amount of metal elements involved in bone formation, suggesting that these are potential biomaterials for use in biomedical applications, especially for guided bone regeneration.

Combined use of cellulose biomembrane, photodynamic therapy and laser therapy in venous ulcer

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ABSTRACT

Venous ulcer is one of the most serious chronic venous diseases and is very common in the adult population, where 70-90% of cases are in the lower limbs, characterized by a discontinuous area of the epidermis and difficult to treat because of its complexity. METHODOLOGY: a randomized clinical study performed at the rehabilitation center of the Federal University of Triângulo Mineiro twice a week, by students of Physical Therapy and Physical Education. Among the techniques used, in the treatment of venous ulcers is photodynamic therapy (PDT) with blue LED and the administration of a topical photosensitizer (curcumin) in conjunction with laser treatment, celulose biomembrane application, ulcer hygiene, exercise and guidelines for home care. RESULTS: OAB participant, male, 74 years old, with ulcer in medial malleolus 3 years ago, initial area 13.91cm², current area 4.61cm². With respect to QV, improvement in the general health and vitality domains was observed, maintenance in the domains functional capacity, physical limitation and pain, and reduction of the mental health domain, which may be justified by the fact that the patient does not have a support network. DISCUSSION: the results showed na improvement in the healing process and pain improvement, which reflected the improvement of the results in the SF-36 questionnaire. CONCLUSION: it was observed that the proposed treatment presents promising results, bringing benefits to the health and quality of life of the participant.

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Bacterial Cellulose Membranes Modified with RGD Peptides for Skin Tissue Repair

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ARTICLE INFO

ABSTRACT

Bacterial cellulose (BC) is a biomaterial that has gained prominence in biomedical applications due to its structural and mechanical characteristics. Chemical modifications of BC have resulted in improvements in its characteristics without altering its main attributes, for example, in the mimetization of the local tissue environment and helping in the regeneration of tissues. The peptide sequence RGD is a main recognition site in several extracellular matrix protein that acts in the interaction between integrins and fibronectin promoting the cell adhesion. Therefore, immobilizing RGD peptides in BC can be attractive approach for new biomaterial development. Evaluate *in vitro* the potentiality of the use of membranes BC functionalized with peptides containing the RGD sequence for future applications in tissue regeneration processes. The modelled peptide (Acetil^{1521}WTGRGDSPA^{1529}NH$_2$) was synthesized by solid phase methodology, using a Rink BHA resin and Fmoc as protector of α-amino groups and t-Bu derivatives as side chains protectors of trifunctional amino acids. Hydrated BC was obtained from cultures of wild strains of *Gluconacetobacter xylinus*. The BC surfaces were characterized using Scanning electron microscopy (SEM) images obtained by a FEG JEOL 7500F microscope. X-Ray diffraction (XRD) patterns were performed on a Rigaku Rint 2000 Diffractometer (Rotating Anode). Fourier transform infrared (FTIR) spectra were obtained on a VERTEX70 BRUKER spectrometer using a diamond platinum ATR. SEM images showed that functionalized BC membranes showed no changes in surface morphology. XRD showed characteristic peaks of the cellulose. The FTIR spectrum of pure BC shows vibrating characteristics of cellulose. The functionalized membranes presented absorption bands of amide I and amide II, indicating the incorporation of the peptide in the membranes.

Bioactive bacterial cellulose wound dressing

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ARTICLE INFO

ABSTRACT

Bacterial cellulose (BC) is already applied as commercial wound dressing. More recently, many studies based on BC wound dressings had focused at conferring new functionalities to this material. Thus, immobilization of proteolytic enzymes, such as papain, could add to the BC the ability to actively act in the removal of necrotic tissue, thus improving the healing process. The immobilization of enzymes via covalent bonding on cellulose offers an advantage, for example, increase the stability of the enzyme. Therefore, the objective of this work was to evaluate the biocompatibility and hemocompatibility of BC dressings containing immobilized papain. The BC was obtained by static fermentation of bacterial Komagataeibacter hansenii (ATCC 53582) in synthetic culture medium. Then, the BC was purified (K2CO3 at 80 °C for 1h) and oxidized (NaIO4 at 55 °C for 6 h). The immobilization of enzymes on oxidized BC was performed by immersing the film in a 2% (w/v) papain solution prepared in citrate-phosphate buffer pH 7 at 45 °C for 24 h. The bioactive dressing was characterized by indirect cytotoxicity test on human fibroblasts, which showed a cell viability greater than 89%, suggesting that the biomaterial is non-cytotoxic. Human blood contact tests showed that the immobilization of papain in BC decreased its ability to promote coagulation. However, both pure BC and the papain-BC dressing did not presented hemolytic activity, showing to be hemocompatible. Therefore, the biomaterial proposed in this work have potential to be applied as wound dressing on skin wounds.

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Bacterial cellulose paper-based cell culture platform for biomedical applications

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ARTICLE INFO

ABSTRACT

Introduction: A variety of commercially available papers are used to produce cell culture platforms, which can be used to cultivate several cell lines. The surface of this material, however, does not provide adequate cell adhesion. In order to overcome this problem, paper surface modification becomes an attractive alternative, allowing change on its chemical structure and immobilization of biomolecules to its surface. Since paper is mostly made of cellulose, bacterial cellulose (BC) is a promising biomaterial to be used in this context, as it presents high biocompatibility, exhibits 3D architecture similar to the extracellular matrix and superior physical and mechanical properties compared to plant-derived cellulose. In this sense, the present work aims to obtain new and highly effective BC-based cell culture platforms. Methodology: BC membranes synthesized by Komagataeibacter rhaeticus in HS culture have been modified with the functional groups -NH 2 , -SH, -C n H 2n+1 and -C 6 H 5 by the use of four distinct silanes in acetone medium. The modified membranes will be immobilized with rhBMP-2 via adsorption in DMSO solution. Results and Discussion: The modified membranes will be analyzed by FTIR, XRD, RMN, TGA and SEM. Cultures of human fibroblasts and keratinocytes are going to be used to evaluate the membranes cell adhesion and proliferation, which will be analyzed by SEM in combination with quantitative analysis. Cell viability will be evaluated by the MTT assay. Conclusion: We intend to develop a BC-based platform that offers significantly enhanced cell adhesion and proliferation, which could be used in several biomedical devices and regenerative medicine.

Development of multilayer biocomposite of bacterial cellulose and hyaluronic acid for therapeutic and cosmetic applications

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ARTICLE INFO

ABSTRACT

Bacterial cellulose (BC) and hyaluronic acid (HA) are biopolymers with excelente biological properties, but they present limitations in their physico-mechanics that limit their use in numerous clinical situations. The objective of this project is to develop and characterize multilayed biocomposite of BC / HA for therapeutic and cosmetic applications. For the production of hybrid membranes, sodium hyaluronate, MW = 1.1-1.7 × 106 Da, predispersed in water was added to the fermentation process at concentrations of 1, 5, 10 and 15%. After 10 days of fermentation the hybrid membrane floating on the surface of the culture medium was collected and immersed in an aqueous solution of 0.1 mol L-1 NaOH for one day for eliminate impurities such as bacteria and other interfering substances. In sequence the BC/HA multilayer pellicles were washed with deionized water several times to completely remove the alkali, and afterwards dried in stove at 40 C. The morphostructure of the hybrid membrane will be characterized by scanning electron microscopy (SEM). The confirmation of the incorporation of theHA will be evaluated by infrared spectroscopy with Fourier transform (FT-IR) and nuclear magnetic resonance spectroscopy (NMR). Termocalorimetry (TC) and surface energy evaluation will also be used to characterize the BC / HA multilayer biocomposite.

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Bacterial cellulose dressings containning silver nanoparticles loaded liquid crystals as potential strategy strategy for the treatment of complex wounds

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ABSTRACT

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▷Cosmetics - Abstracts

Peel-off facial mask containing propolis

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ARTICLE INFO

ABSTRACT
Peel-off facial masks are cosmetic products mainly obtained from film-forming vinyl resins, such as polyvinyl alcohol(PVOH). On the other hand, the associationof bacterial cellulose membranes(CB)with vinyl resins may improve the characteristics of regular peel-off marsksby conferringa net of nanometric channels. Propolis is a natural resin rich in phenolic compounds that have antioxidant, anti-inflammatory and antimicrobial activities. Therefore, the present work focused on the development and characterization of a facemaskrich in propolis bioactive compounds with peel-off technology. To obtain the facemask, CBfrom Nexfill Biotechnology wasprocessed(Turrax® Disperser)to obtain smaller particles. Next, CB was added with water, potassium sorbate and PVOH and allowed to stir until complete homogenization. Finally, the EPP-AF propolis extract was added and homogenized. Several compositionswere tested and the best formulationwas characterized byphysicochemical methodsand antimicrobial activity. As a result, a finely particulate sticky gel with burnt yellow colorcharacteristic, scatteringvalues of 42.80 cm^2/g(± 1,04), density 1.02 g/mL (± 0,02), pH 4.27 (± 0.03),flavonoidcontentof 0.30mg/g (± 0.01) and phenolic compounds of 1.59 mg/g (± 0.06) was obtained. The presence of Artepelin C, one of the main propolis compounds and related toseveral properties was determined.Additionally, animportant antimicrobial activity against different strains of *Staphylococcus aureus*(ATCC 25923 and 43300)and*Staphylococcus epidermidis* (ATCC 14990)was observed. Therefore,apeel-off facemask containing propolis bioactives and presenting antimicrobial activitywas successfully attained and could be employed in cosmetic facial treatments.

▷Food - Abstracts

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Nanofibrillated bacterial cellulose and gelatin hidrolysate as baseto antioxidant films

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ARTICLE INFO

ABSTRACT
Edible polymers, natural compounds and nanotechnology are commonly associated in the research of high performance bioactive films, an alternative for the preservation and improvement of food quality and safety. Among the natural polymer bases applicable in the formulation of films, bacterial cellulose has unique properties with high potential in the food industry. In the present work, the effect of the amount of hydrolysateand type of plasticizer on the antioxidant activity of films based on nanofibrillated bacterial cellulose (NFBC) and gelatin hydrolysate from Nile tilapia skin(GHT) was evaluated. NFBCwas obtained by mechanical deconstruction of bacterial cellulose (BC) previously submitted to TEMPO -mediated oxidation. The antioxidant hydrolysatewas obtained by enzymatic hydrolysis of gelatin.Different concentrations of GHT andplasticizers in the formulation were evaluated. NFBC-GHTfilms were obtained by casting. And the antioxidant activity of the obtained film was analyzed by the DPPH method.The antioxidant activity in the film increased with increasing amount ofGHT.All unplasticized films presented a brittle appearance. In order to add resistance to films, two types of plasticizers (sorbitol andglycerol) were evaluated as to their influence on the activity of the obtained film.The use of sorbitol in the formulation increased the antioxidant activity of the film since the glycerol reduced the activity. In this way, it is concluded that the use of plasticizer is essential to obtain a more resistant NFBC-GHT film, highlighting the sorbitol against glycerol for promotinga more active film.

Reinforcement of bacterial cellulose with recycled polystyrene for packaging applications

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ABSTRACT

Polystyrene (PS) is a synthetic polymer mainly produced in the expanded form (expanded polystyrene, EPS), commercially known as Styrofoam™, which is composed by only 2 wt% of PS. The mechanical and thermal recycling of EPS are not favored due to low density and release of toxic gases to the environment, respectively. The chemical recycling is an alternative approach for the EPS recycling because the dissolution in a solvent prevents the polymer degradation and there is no gas release into the environment. The use of d-limonene extracted from orange peel as a solvent is attractive since it comes from a renewable source and reduces about 95% of the original EPS volume. The resulting solution can be used for the production of self-cleaning and disposable papers, amphiphilic membranes and other applications as hydrophobic surfaces. In this way, different EPS solutions were prepared through the dissolution of EPS packages in d-limonene (10, 15 and 20 wt%), followed by the deposition onto bacterial cellulose (BC) surface using the airbrush technique. ATRFTIR indicated that the surface of BC was modified by the PS. The contact angle measurements showed an increase of the contact angle as the concentration of EPS solution increases, indicating na increase in the hydrophobicity of the samples due the presence of PS on the BC surface, as suggested by SEM results. Thermal analysis (TGA and DSC) indicated that there were no significantchanges in the thermal properties of bacterial cellulose.

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Edible films based on the combination of bacterial cellulose and pectin with fruit purees

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ARTICLE INFO

ABSTRACT

The industry primarily uses petroleum-derived materials as packaging, but this type of material accumulates in the environment. Thus, the development of packaging materials derived from natural sources is of great interest in the search for environmentally friendly products. Bacterial cellulose (BC) is a biopolymer synthesized by bacteria and presents interesting properties such as a nanostructured network, high crystallinity and high purity. Pectin, on the other hand, is one of the main components of plant cell walls, commonly used in the formation of cohesive and transparent films. The addition of fruit pulps to films is a way of providing them with color and flavor appeals. Moreover, fruits contain polysaccharides that contribute to film formation, as well as plasticizing sugars. In this study, films were prepared with different proportions of nanofibrillated BC (NFBC) and pectin, with or without fruit (mango or guava) purees, in order to evaluate the influence of the matrix composition and the presence of purees on film properties. The addition of purees increased the water vapor permeability (WVP), reduced tensile strength and modulus, and enhanced elongation. The replacement of pectin with NFBC made the films stronger, stiffer, more water resistant, and with decreased WVP. Pectin-based films may be applied as dissolving sachets, whereas cellulose-based films are the best choice for use as food wraps or coatings, which require better tensile properties and water resistance.

▷In situ and ex situ modifications - Abstracts

1º Encontro Brasileiro de Biocelulose
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Biocellulose gel with alginate on repair of excisional wounds in rats

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ABSTRACT

Wound healing is a natural biological response to tissue damage, which is knowed by a cascade of molecular events targeting tissue reconstruction. There are several therapies for wound healing. Bacterial cellulose membrane, commercially known as Nexfill® (Seven) have been shown as a promising biomaterial to treatment of wounds, providing a humid environment on the wound bed, improving scar formation and reducing pain on injured patients, as well it has a low cost and is easy to apply. In view of this, the relevant innovation is to evaluate the wound healing in rats with topical application of biocellulose gel with alginate. It was made two excisional wounds of 1.5 cm diameter on the dorsum of rats, which were divided into 4 groups: treated topically and 3x/week with Control gel, Nexfill, biocellulose gel with alginate (CB+AG) and Sham group (without treatment) to 0, 2, 7 and 14 days (n=5rats/follow-up days). The wounds were photographed on all follow-up days, the wound area was determinated by ImageJ software to calculate wound healing rate (WHR), which correspond to the formula [(initial area - final area) / initial area]. The Sham group showed superior WHR than Nexfill on the 2nd day. On the 7th day, Control gel was superior than Nexfill. On 14th day, all groups showed the wounds practically reepithelialized. Thus, Nexfill and CB+AG groups did not showed important reepithelialization by this macroscopic analysis. Other analysis will be carried out, however the results of these preliminary studies certainly relate to the texture/moisture of the gels.

Komagataeibacter rhaeticus grown in sugarcane molasses-supplemented culture medium as a strategy for enhancing bacterial cellulose production

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ABSTRACT

Introduction: Although bacterial cellulose (BC) can be produced by a number of gram-negative bacteria, its production in standard culture medium in commercial quantities and economically competitive have been a challenge. In this sense, sugarcane molasses (SCM) has been proposed as a by-product from Brazilian fermentation industry that promotes costs reduction of culture media besides increase BC production. Herein, we evaluated BC production by *K. rhaeticus* in supplemented HS culture medium by adding SCM as alternative and cheaper carbon source (totally or partially). **Methodology:** BC membranes were prepared using seven distinct culture media and labeled F0 (standard HS medium), F1 (50 g/L of glucose), F2 (40 g/L of glucose plus 10 g/L of SCM), F3 (30 g/L of glucose plus 20 g/L of SCM), F4 (20 g/L of glucose plus 30 g/L of SCM), F5 (10 g/L of glucose plus 40 g/L of SCM) and F6 (50 g/L of SCM). **Results and discussion:** From FTIR, XRD and TGA results, great similarity among all membranes produced by distinct culture media were obtained. FEG-SEM analysis showed as higher SCM concentrations on culture media higher dense nanofibers network could be prepared. PeakForce (QNM-AFM) results displayed smoother and more flexible BC membranes as a function of the increasing of the SCM concentrations. **Conclusion:** The culture medium modification with an important by-product from Brazilian agroindustry appears as a viable alternative to reduce cost of BC production (of up to 20.06 %) besides increase the possibilities of industrial scale BC preparation.

▷ MULTIFUNCTIONAL NANOCOMPOSITES - ABSTRACTS

Bacterial cellulosemembrane with easy-cleaning properties

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ABSTRACT

Over the last decades, the design of high performance functional substrates with enhanced properties (eg. Easy-cleaning and Self-cleaning), has been the subject of intense research, offering promising improvements in a plethora of scientific and technological areas. The silica nanoparticles is promising nanomaterial for functional substrates owing to their remarkable properties and tunable surface chemistry. The ability to incorporate specific organic functional group onto their surface is another key parameter to engineer their properties in route to the target applications. Bacterial cellulose (BC) is secreted by a few strains of bacteria and consists of a cellulose nanofiber network with unique characteristics. Because of its excellent mechanical properties, outstanding biocompatibilities, and abilities to form porous structures, BC has been studied for a variety of applications in different fields, including the use as a biomaterial for scaffolds in tissue engineering. To extend itsapplications, BC is normally modified to enhance its properties. This work reports the preparation of Bacterial Cellulose Membrane (BCM) with Easy-Cleaning properties. Initially, sílica nanoparticles (SiO2) were prepared and functionalized with alkoxysilanes by co-condensation of TEOS (TetraEthOxySilane) with long alkyl chain and with a fluoroalkoxysilane. Subsequently, these nanoparticles were incorporated into BCM, following two different methodology: in situ and post-grafting. In situ functionalization of BCM, the culture medium composition was changed with the nanocomposites. On the other hand, in post-grafting functionalization, the BCM was modified after the BCM has been formed in culture.

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Production and characterization of all-cellulose films from bacterial cellulose

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ABSTRACT

Bacterial cellulose (BC) is a biomaterial with special properties and high technological potential to be exploited. In this sense, new routes that take advantage of BCproperties have been explored. All-cellulose composites are materials in which the matrix as well as the reinforcing agentare cellulose. These biocomposites could overcome the obstacle of a weak charge-matrix adhesion, usually foundin composites where matrix and reinforcement havedifferent nature. The objective of this work was to produce all-cellulose films from the deconstruction of BC, using nanofibrillatedBC (NFBC) as matrix and cellulose nanocrystals (BCNC) as reinforcement.The films were produced by the casting technique containingdifferent levels of BCNC (0-7.5% by weight),10g of cellulose NFBC, 5g of glycerol and distilled water (a solids content of 1g / 100ml). The suspensions werehomogenized in a high-speed blender (24,000 rpm, 15 min) andultrasonicated (60 Hz / 2 min). Then, the suspensionsweredeposited on a stainless-steel tray (20x30cm)witha final thickness of 0.100 mm and dried in an oven (50 °C / 48h).The films were characterized by thermogravimetric analysis, scanning electron microscopy, water vapor permeability (WVP) and percentage ofinsoluble matter. The films presented thermal profile characteristic of BCwith degradation peak around 350 °C. The microscopic images showed a homogeneous surface. The best WVPresult (2.2 g. Pa-1.h-1.m-1) was from the film containing5% of BCNCs. The percentage of insoluble matter was around 90% for all films, indicating high resistance to moisture. As conclusion,it is possible to produce all-cellulose films with good thermal stability, homogeneityand water vapor permeability.

Bacterial cellulose nanofibers as reinforcement in the paper sheets formation

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ABSTRACT

Bacterial cellulose (BC) is a biopolymer that has a three-dimensional structure of nanometric fibers, giving it a large surface area, high absorption capacity, high water retention, elasticity and excellent mechanical strength. Suspensions of biocellulose fibers have been used as reinforcement in paper formation, since the amount of filler used can greatly interfere with the final properties of the composite. Thus, this study proposed to evaluate the influence of the presence of suspensions of bacterial cellulose fibers on the properties of paper sheets formed in laboratory with bleached eucalyptus pulp industrial pulp. The BC blankets were obtained by culturing the G.hansenii bacterium (ATCC 23769) in static culture medium, Hestrin Schramm (HS), with subsequent processing using the Ultraturrax and Grinder equipments, obtaining two suspensions called: bacterial nanofibers cellulose-Ultraturrax and nanofibers bacterial cellulose-grinder, characterized by the morphological pattern. The formation paper sheets with and without the addition of the suspensions of biocellulose, were obtained according to ABNT ISO 5269-1: 2006, using concentrations of 0,5%, 1,5% and 3% of fibers with subsequent determination of the physical properties of the leaves formed. The results demonstrated the presence of networks of intertwined microfibrils, without significant differences between them. With the results obtained in the physical tests performed on the leaves, it was possible to observe a decrease in the air permeability and capillary rise properties with the increase of the NBC concentration employed, together with a slight increase in the water absorption capacity, since the polymer has a highly porous system.

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Functional bionanomaterials based on bacterial cellulose

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ABSTRACT

Bacterial cellulose has been extensively used as an attractive environmentally friendly material for the preparation of multifunctional bionanomaterials. The biosynthesis of bacterial cellulose at the laboratory scale from bacterial cultures is an interesting and attractive biomimetic access to obtain cellulose with outstanding properties. This kind of cellulose is a natural nanomaterial with a high surface-to-volume ratio combined with good biocompatibility, high mechanical properties, and high crystallinity makes bacterial cellulose a potential material for applications in different fields. This work is a fruit of strong collaboration between UNESP, UNIARA and UPV/EHU. The aim of this work was the fabrication of hybrid inorganic/organic bionanomaterials based on laboratory made bacterial cellulose. This kind of materials linked together excellent properties of bacterial cellulose with the properties of inorganic nanoparticles such as optical, magnetic and electrical properties as well as chemical or biochemical activity. In addition, the functionalization of cellulose with inorganic materials opens new pathways for the fabrication of novel functional hybrid bionanomaterials with promising properties for a wide range of applications in different sectors. In this work, different pathways for fabrication of functional hybrid bionanomaterials with tunable properties based on bacterial cellulose modified with amphiphilic poly(ethylene oxide-b-propylene oxide-b-ethylene oxide) (EPE) block copolymer, sol-gel synthesized nanoparticles (titanium, vanadium and a mixture of both oxides) and functionalized iron oxide nanoparticles will be presented.

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Multifunctional flexible nanocomposites based on magnetic cobalt hexacyanoferrate nanoparticles immobilized on biocellulose nanofibers

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ABSTRACT

Introduction: Natural polymers templates capable to maneuver the growth and spatial distribution of functional nanoparticles have been pushing forward the development of a new generation of sustainable and versatile materials. Pure cellulose nanofibrils biosynthesized by bacteria naturally deliver a 3D interconnected network, lightweight, foldable and sustainable paper substrates or "nanopapers". Cellulose nanopaper is an exceptional biodegradable and biocompatible and high mechanical strength substrate with a native fibrous structure that can be easily applied as structure-directing host to produce nanosized materials with optical, electrical or magnetic properties. In this work, we investigated the preparation of magnetic nanopapers by using bacterial cellulose nanofibers to control the growth of molecule-based magnetic nanoparticles such as Prussian Blue analogues. **Methodology:** Magnetic Cobalt-Prussian Blue (CoHCEFe) nanoparticles were synthesized in situ by hydrothermal method through a diffusion-limited precipitation process onto bacterial cellulose nanofiber network labeled BC/CoHCEFe01, BC/CoHCEFe03 and BC/CoHCEFe05 nanocomposites. **Results and discussion:** Scanning Electron Microscopy and Atomic Force Microscopy clearly unveiled a homogeneous distribution of immobilized COHCEFe crystalline nanoparticles whose size decreases (from 94 to 70 nm) as a function of nanoparticle content (up 28 wt%). Magnetic Force Microscopy showed that these nanometric in size COHCEFe crystalline nanoparticles well-dispersed in BC fibers network respond on the magnetic field applied to the Magnetic Force Field-tip. **Conclusion:** This nano/nano association approach can provide functional flexible biocomposites for application in catalysis, adsorption of radionuclides, energy generation, data storage, biosensing, optical and magnetic nanopapers devices.