# Encontro de Polímeros Naturais

## EPNAT

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# 1° Encontro I Encontro de Polímeros
# 05 e 06 de Agosto de 2019

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# VISIBLE AND INFRARED EMISSION FROM LUMINESCENT HYBRID FILMS BASED ON GELLAM GUM AND KARAYA CONTAINING $GbNbO_4:Er^{3+},Yb^{3+}$ PHOSPHOR

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Area: ( ) Food and Agriculture ( ) Medical and Pharmaceutical ( x ) Multifunctional Applications

**Abstract:** The study of hybrid materials has been driven by its versatility and potential application several areas. These compounds demonstrate distinct properties due to the inherent characteristics of the polymeric matrix, such as easy processability, flexibility, mechanical strength and the inorganic particles characteristics, which have adjustable luminescent properties, high photoluminescence, high quantum yield, physical–chemical stability, as well as resistance to photochemical and metabolic degradation. Thus, the resulting composites exhibit interesting properties than starting components. In this work, luminescent composites films were obtained by the incorporation of 1.0 and 3.0% in weight of $GdNbO_4:Er^{3+},Yb^{3+}$ (molar ratio of $Er^{3+}/Yb^{3+}$ = 1:4) particles in the Gellan gum and Karaya. The inorganic phosphor was prepared by the Non–Hydrolytic Sol Gel process and the composite films were obtained by the casting technique. The results reveal that after the incorporation in the polymers, the luminescent properties were preserved. Photoluminescence results showed emission bands at 1005 and 1535 nm assigned the transitions $^2F_{5/2} \rightarrow {}^2F_{7/2}$ and $^4I_{13/2} \rightarrow {}^4I_{15/2}$ of the ions $Yb^{3+}$ and $Er^{3+}$, respectively. The results of luminescence by upconversion energy showed emission bands in the visible region at 520, 550 and 655 nm, which were attributed to the electronic transitions of $Er^{3+}$ $^2H_{11/2} \rightarrow {}^4I_{15/2}$, $^4S_{3/2} \rightarrow {}^4I_{15/2}$ and $^4F_{9/2} \rightarrow {}^4I_{15/2}$, respectively, in addition to indicating a process by absorption of 2 photons. Finally, the increase in the concentration of the phosphors did not cause macroscopic changes in the hybrid materials, however, an increase of the emission intensity was observed for all of the materials.

**Keywords:** *Down– and upconversion; Sol–gel and casting.*


# EVALUATING THE EFFECT OF PROANTHOCYANIDINS AND GLUTARALDEHYDE IN THE PHYSIOMECHANICAL PROPERTIES OF DENSE LAMELLAR SCAFFOLD FOR REVERSE CARDIAC REMODELING

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**Abstract:** The regenerative medicine is an emerging field that aim is healing damaged tissue. Collagen type I is the main component of the extracellular matrix (ECM) and constitutes about 25% of the total protein in the body. The formation of natural cross–links in the biological tissues provides strength and makes it more resistant to degradation. Proanthocyanidins (PA) have the ability to crosslink collagen. The choice of crosslinking agent is one of the most important require for the development of 3D scaffolds devices. This study aimed to investigate the effects of proanthocyanidins (PA) and glutaraldehyde (GA) associated with plastic compression method on the properties of the dense lamellar scaffold with a stiffness above of the range of the heart muscle. The scaffolds are composed by collagen type I, silk fibroin, hyaluronic acid, and chitosan. The physiomechanical, antioxidant activity (by DPPH method), and viability and proliferation cellular (by MTT and imaging cytometer – H9c2 cells) were evaluated. The crosslinking agents modified the physiomechanical properties but did not modify the mucoadhesion properties. PA–scaffold and GA–scaffold showed, respectively, 44% and 17% of antioxidant activity. Both crosslinking agents did not influence the viability and proliferation of H9c2 cells. Considering the physiomechanical properties, cellular compatibility, and protective action against reactive oxygen species, this study may provide a way to improve the inverse remodulation of heart tissue, after infarct acute of the myocardium.

**Keywords:** Dense Lamellar Scaffold; Collagen; Proanthocyanidin; Glutaraldehyde; Plastic Compression.


# EXTRACTION AND YIELD OF DNA–BASED HYDROGEL EXTRACTED FROM ORANGE (*Citrus sinensis L.*)

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**Abstract:** Hydrogels are polymers that can be used in regenerative medicine as biomaterials to encapsulate and carry cells, aiming at tissue regeneration. The important challenge when developing materials for this purpose is to ensure that cells remain viable in their interior, must be biodegradable, non–toxic and biocompatible. However, existing materials do not have all these characteristics. Due to its properties, DNA based hydrogels have been gaining prominence. DNA–based hydrogels are able to maintain viable cells, carry them and release them to their sites of action. DNA extraction of the orange (*Citrus sinensis L.*) was carried out using the cationic hexadecyl trimethyl ammonium bromide detergent (CTAB) and determined the yield. Then, the structural characterization of the DNA was performed using the Fourier transform infrared spectroscopy (FTIR) method, the tests were performed on the Spectrum 100 (Perkin–Elmer) equipped with an attenuated total reflectance (ATR) accessory and spectra were obtained in the range of 4000–650 $cm^{-1}$, after 16 runs per spectrum, with a resolution of 4 $cm^{-1}$. The yield of the sample from DNA extraction was 0.1% wt. The structural characterization indicated the presence of bands typical of the clusters that make up the DNA. Thus, it is concluded that there is a perspective that the use of orange DNA for the preparation of hydrogels may be an alternative with potential for use in regenerative medicine. The research is still in progress.

**Keywords**: Biomaterial; Hydrogel; DNA.


# INTEGRATING CELLULOSE FIBERS FROM PALM INTO PHBV COMPOSITES AND APPLICATION IN 3D PRINTING

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**Abstract:** Tissue engineering requires new rapid solutions to replace synthetic materials in the production of prostheses for bone regeneration. Rapid prototyping through 3D printing is configured as one of the most efficient tools for producing scaffolds that function as a cell growth carrier. Thus, the objective of this work was to develop PHBV filaments reinforced with cellulose fibers from the Australian royal palm tree for 3D printing. The filaments were obtained in a mini–extruder in different proportions of cellulose fibers (1 to 10% wt / wt). The filaments were characterized by scanning electron microscopy (SEM), stereoscopic microscopy (MO) and thermogravimetry (TGA). The 3D–printed poly(3–hydroxybutyrate–co–3–hydroxyvalerate)/cellulose fibers (PHBV/cellulose) scaffolds were developed by using fused deposition modelling (FDM) technique. The results showed that the insertion of the cellulose fibers into the PHBV to obtain the filaments altered the coloration, increased surface roughness, opacity and increased thermal stability. From the SEM, fiber agglomerations were observed in the fracture region of the composites as the percentage of cellulose fiber increased. The developed filament was suitable for the production of three– dimensional structures using a 3D priting, which is promising for the development of biomaterials.

**Keywords:** Polymer–matrix composites (PMCs); Thermogravimetric analysis (TGA); Scanning electron microscopy (SEM); Additive manufacturing (Fused deposition modelling – 3D printing).


# MULTILAYER FILMS STRUCTURED WITH NATURAL POLYMERS AND ZEOLITES AS A NEW FERTILIZER DELIVERY VEHICLE

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**Abstract:** As a strategy to increase food production and reduce environmental damage, the scientific community has intensified studies on obtaining Enhanced Efficiency Fertilizers (EEFs). These are attractive because they decrease the release rate of nutrients compared to conventional fertilization. EEFs have mechanisms to release plant nutritional synchrony, in this way, promote nutrient reduction by leaching and volatilization. The objective of this work was to prepare and characterize EEFs based on zeolites (Ze) adsorbed with macro and micronutrients, carboxymethylcellulose (CMC) and chitosan (Ch). First we evaluated the sorption capacity of Ze in relation to the nutrients potassium ($KNO_3$), copper ($CuSO_4{\cdot}5H_2O$), manganese ($MnSO_4{\cdot}H_2O$), zinc ($ZnSO_4{\cdot}7H_2O$) and iron ($FeSO_4{\cdot}H_2O$). After the sorption process, Ze enriched by the nutrients was incorporated into the CMC solution to obtain mono and multielement films by casting. Additionally, multilayer films containing CMC–Ze–macro in the inner layer and Ch or CMC–Ze–micro in the outer layers were prepared. Ze presents higher selectivity for the $Cu^{2+}$ and $Zn^{2+}$ ions in detriment of the $Fe^{2+}$, $Mn^{2+}$ and $K^{+}$ ions corroborant with the physical–chemical properties of the ions. The films were evaluated for their ability to release nutrients in the water. Monoelemental films (CMC–Ze–nutrients) release slower than Ze–nutrients. In addition, multilayer films of CMC–Ze–macro/CMC–Ze– micro multielement significantly decreased the speed for all the nutrients used. Structural and morphological results showed that physical interactions occur between the constituents of the films. The material has the potential for commercial application due to the low cost, simplicity of production, environmentally friendly and high value–added contributing to more sustainable agricultural practices.

**Keywords:** Agriculture; Green Polymers; Sustainability.


# MICROSPHERES OF STARCH AS ENHANCED EFFICIENCY FERTILIZER MATERIALS

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**Abstract:** Encouraging the development of sustainable agriculture is very important to reduce the negative impacts of the overuse of land. The use of intelligent materials that release nutrients on a long–term basis, together with sustainable policies, can contribute to sustainable agriculture. To achieve this goal is important to use materials with interest properties like biodegradation, natural source, and abundance. Starch polymer fits all these characteristics. The aim of this work was developed microspheres of starch and micronutrients by spray drying technique. For this purpose, starch gelatinization and atomization conditions were evaluated to establish the best experimental parameters. For starch gelatinization, time (10, 15 e 30 min), concentration (3, 5, 6, and 7 %), and temperature (57 and 97 °C) were tested under oil bath and magnetic stirring. For starch atomization, temperature (130 and 185 °C), concentration (3 and 6 %), and aspiration rate (10, 20 and 30 %), were evaluated. The best conditions for starch gelatinization (30 min, 6 %, and 97 °C) were established by the maximum concentration of solids possible, keeping the viscosity and homogeneity of the solution ideals for atomization. The best atomization parameters (6 %, 130 °C, and the aspiration rate of 10 %) were chosen by yield (dry mass obtained). It was possible to establish the best experimental conditions to obtain a yield of 47 % of starch microspheres.

**Keywords:** Natural Polymer; Spray Drying; Starch.


# VIABILITY OF CARRAGEENAN AND ALGINATE TO OBTAIN POLYMER FILMS FOR AGRICULTURAL APPLICATION

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**Abstract:** The global technological development is linked to the needs of society and, given the exponential population increase, one factor becomes essential: supplying food demand. Designing materials with effective properties that aid agricultural development have gained prominence in the last decades mainly inputs destined for the quantified and prolonged release of nutrients used in the diverse cultures of Brazil. In view of this demand, films consisted of marine algae matrices, such as carrageenan and alginate, are attractive due to the environmentally favorable properties as biodegradability and vehicle for releasing the nutrients in a programmed way. We hypothesized the casting films can be an interesting vehicle to sustain the nutrients and prolonged their release. Therefore, we evaluated and optimized the concentration and homogeneity of the polymer dispersions to improve the mixture and drying of the films by casting prior to nutrient addition. In this way, the study of new materials with high added value from sustainable, renewable and abundant sources is strategic not only from the technological/economic point of view but also from the environmental, due to the decrease in the damages caused by the excessive use of fertilizers in the Brazilian crops.

**Keywords:** Polymers; Film Casting; Agriculture.


# SCREEN PRINTED FLEXIBLE DEVICES FOR SENSING AND BIOSENSING APPLICATION

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**Abstract:** Printing technologies are widely used in electronic industry and for manufacture chemical sensors and biosensors. The screen–printed technique occupies a privileged place, because is an efficient and robust method with which can be produce low cost devices, also is possible operate in large scale capacity with facile and friendly operation. With rapid progress in the nanomaterials sciences new materials have been developed, that can be used as components in the manufacture of conductive inks, substrates and biomolecule stabilizers. The manufacture of screen printed electrodes and electrodes array on flexible commercial substrates and bacterial cellulose membranes obtained from biotechnological processes are presented in this research. In addition is also shown the advances obtained in the development of conductive inks derived from renewable sources and recycled polymers. The developed devices have been used in the manufacture of wearable sensors for the determination of cystic fibrosis in sweat and as electrochemical platform for composites using electrochemically reduced graphene/carbon black nanoparticles and its subsequent application in the detection of neurotransmitters (epinephrine, dopamine) and drugs (paracetamol).

**Keywords:** Screen Printed; Sensor; Biosensor; Flexibles Devices; Wearable Devices.


# DEVELOPMENT OF LOW COST BIOPRINTER AND BIOINKS BASED ON GELLAN GUN – LAPONITE FOR BIOMEDICAL APPLICATIONS

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**Abstract:** Three–dimensional (3D) bioprinting is a fusion technology that has recently gained significant attention in the biomedical field. However, commercially available bioprinting platforms can be prohibitively expensive for small research facilities, especially in an academic setting. Microextrusion is a simple and relatively inexpensive technique that presents sufficient resolution and excellent viability potential to design the printing platform, learning space for polymers for biomedical application. Gellan Gum (GG) is a microbial polysaccharide generated from the bacterium Pseudomonas elodea where it has properties like biodegradability and biocompatibility, being the most used biopolymer with gelling properties, while Laponite (LAP) is a synthetic clay frequently used to improve performance and properties of the products as rheological modifiers. In the present work was to develop a new bioink with GG / LAP gum and an economical benchtop bioprinter using microextrusion technology, modeling of depository financing model (FDM) so that it can use the bioink, serving as results for its validation of the bioprinter. The projected bioprinter was able to print hydrogels with spatial precision along the X, Y and Z axes of 0.2 mm. Hydrogels were characterized by techniques such as Scanning Electron Microscopy (SEM), thermogravimetric analysis (TGA), Fourier Transform Infrared Spectroscopy (FTIR) and Rheology, were tested where they produced prototypes that could be applied as biomaterial in regenerative medicine. Our results demonstrated that both the projected bioprinter and the bioink compound of GG / LAP have excellent properties for applications in additive manufacturing and biomedical applications.

**Keywords:** Gellan Gum; Laponite, Bioprinting; Bioink.


# FUNCTIONAL BIONANOCOMPOSITES BASED ON NATURAL POLYMERS AND SEPIOLITE CLAY

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**Abstract:** The design of novel materials in biomedical science has experienced a rapid growth in the last decades. Within this field, nanocarriers based on hybrid materials for pharmaceutical nanotechnology purposes are becoming particularly attractive due to the possibility of manipulation of structures at the nanometer scale, providing unique properties, such as high interfacial area, efficient drug loading, and high biocompatibility and bioavailability, which can contribute to minimize the required dose of medicines. Silk fibroin (SF) is a natural polymer extracted from cocoons of the silkworm (Bombyx mori). This protein is biocompatible, biodegradable, it has amino acids that act as cell receptors and mediate important interac–tions between mammalian cells and extra cellular matrix (ECM) facilitating cell adhesion and growth and it presents antimicrobial activity. Sepiolite is a fibrous hydrated magnesium silicate which shows an alternation of blocks and tunnels that grow up in the fiber direction. In the biomedical area, current investigation has demonstrated this argilomineral do not affect the cell viability, and in some cases can show anti– inflammatory properties, which support their effective use in the health sector. In this perspective, sepiolite and silk fibroin films have been used to prepared new bionano–composites by casting process aiming the use of this material as a possible biomolecule carrier for application in biomedical area. The character–ization these materials has been done with Thermogravimetric Analysis (TG/DTA), Fourier–transform infrared spectroscopy (FTIR), X–ray Diffraction (DRX), Transmission Electron Microscopy (TEM), Mercury intrusion porosimetry (MIP) and Helium Pycnometry.

**Keywords:** Silk Fibroin; Sepiolite; Bionanocomposite.


# ORGANIC–INORGANIC NANOCOMPOSITES BASED ON BACTERIAL CELLULOSE NANOCRYSTALS MODIFIED WITH POLYSILOXANES

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**Abstract:** In recent years, natural biopolymers have increased researcher´s interest in using biomedical devices and materials, including drug delivery. Bacterial cellulose nanocrystals (BCN) stand out as biomedical material due to remarkable characteristics such as great crystalline structure, high stiffness and low density, as well as excellent biological properties such as biocompatibility, biodegradability and low toxicity. Polysiloxanes are elastomers which may be considered good modifying agents because of their interesting properties like very low surface energy, excellent gas and humidity permeability, good thermal stability, low temperature flexibility, biocompatibility and low toxicity. In this work, organic–inorganic nanocomposites of bacterial cellulose nanocrystals modified with polysiloxanes have been prepared, aimed at controlled drug release. The surfaces of bacterial cellulose nanocrystals have been modified via sol–gel process using aminopropyltriethoxysilane (APTS) and glycidyloxypropyltrimethoxysilane (GPTMS), which give impart different functionalities to the bacterial cellulose nanocrystals. The experimental results expected will be possible prototypes that will describe the structure–property relationship of modified bacterial cellulose nanocrystals and the evaluation in relation to the controlled release of drugs.

**Keywords:** Bacterial Cellulose; Nanocrystals; Polysiloxanes, Drug Delivery.


# ONION FILMS FOR USE IN EDIBLE PACKAGING

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Area: ( ) Food and Agriculture ( ) Medical and Pharmaceutical ( x ) Multifunctional Applications

**Abstract:** The great need for replacing the traditional food packaging for their sustainable and environmentally correct counterparts has been recommended due to severe damage caused to the environment. In this context, biodegradable films based on materials from renewable sources have been thoroughly searched around the world and those likely to be ingested feature strongly innovative character and high potential of industrialization. In the present work, are presented methods for getting and characterization of self–supporting films obtained by the casting process, from the processing of pulp of onion (*Allium cepa* L.). The films were obtained using three routes: a) from the raw onion pulp washed; b) hydrothermally treated pulp washed and, c) hydrothermally treated pulp not washed. The films were evaluated by Thermogravimetry (TG), Differential Scanning Calorimetry (DSC), Scanning Electron Microscopy (SEM), Contact Angle Measurements, High–Performance Liquid Chromatography (HPLC) and Fourier–transform infrared spectroscopy (FTIR). The TG/DTG curves for washed pulp films show higher thermal stability with two decomposition steps and one single decomposition step for non–washed. The DSC curves indicate glass transition (Tg) between 63°C and 81°C with higher temperature for the unwashed sample. By MEV the unwashed pulp films exhibit irregular surfaces, but continuous; the films of washings pulp have surfaced with layer and cracks. The Contact Angle Measurements suggest unwashed films are more hydrophilic that washed pulp films. The films of unwashed pulp present soluble carbohydrates and washed insoluble carbohydrates. By infrared, it is possible to indicate the chemical groups contained in films hydrothermally treated of pulp before and after washing. The washed and unwashed pulp films absorb 10% and 25% respectively of humidity in the climatic chamber. In this sense, were propose different protocols for the processing of onion pulp raw, and hydrothermally treated, aiming at obtaining the self– supporting films for application as edible packaging or medical applications.

**Keywords:** Package; Onion; Biodegradable; Biopolymer.


# BIO–CURATIVOS OF THE COMPLEXES CURCUMIN WITH BACTERIAL CELLULOSE: DEVELOPMENT AND CHARACTERIZATION

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**Abstract:** Bacterial cellulose was produced by Komagateibacter rhaeticus. Bacterial cellulose is an interesting material for using as a wound dressing. However, bacterial cellulose itself has no antimicrobial and leishmanicide activity to be used in treatment of different types of wound, such as cutaneous leishmaniasis. Curcumin is a natural compound which exhibits leishimanicidal and antimicrobial activity, but its low solubility makes it difficult to use in pharmaceutical formulations and preparing curcumin complexed with high amylose may increase its solubility in aqueous medium. Curcumin complexed were impregnated into bacterial cellulose by immersing bacterial cellulose in complexed curcumin solution. Several methodologies were tested for the incorporation of the curcumin complex in the bacterial cellulose and after selecting the most promising the morphology, thermal stability and curcumin content of the bio–curatives were examined by scanning electron microscope (SEM), differencial scanning calorimetry (DSC) and quantification by UV–Vis spectroscopy, respectively. The selected methodology resulted in the incorporation between 37.69% and 48.61% of complexed curcumin in bacterial cellulose. SEM results demonstrated the presence of the curcumin complexes on the surface and also covering the bacterial cellulose nanofibre , indicating the presence of the formulation incorporated by all extension of the bacterial cellulose membrane. In DSC analyses were observed a shift of the endothermic events of the complexes when associated with bacterial cellulose, indicating an increase in the thermal stability of complexed curcumin when associated bacterial cellulose membranes. Bio–curatives have shown promising results. Other tests will be performed to evaluate its effectiveness for wounds, especially in cases of cutaneous leishmaniasis

**Keywords:** Curcumin; Bacterial Cellulose; Bio–curatives.


# BACTERIAL CELLULOSE/ CHITOSAN/CIPROFLOXACIN BIOCURATIVES: IN VIVO STUDY ON THE CICATRICIAL PROCESS IN RATS

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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 bio–curative produced by bacterial cel–lulose (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 pristine BC membrane, obtained with little difference superior results regarding the reduction of the lesion area, and both did not demonstrate cytotoxicity and mutagenicity.

**Keywords:** Bacterial Cellulose; Biocurative, Biopolymer


## EVALUATION OF BACTERIAL CELLULOSE FORMULATIONS IN THE TREATMENT OF PRESSURE INJURIES: CLINICAL STUDY

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**Abstract:** Pressure interruptions (PL) occur due to tissue pressure and, consequently, pressure levels by the pathologies at the periphery of the site. They are characterized by necrotic areas that affect muscles, adipose tissue, bones and skin. The treatment of lesions with the use of bacterial cellulose (BC) is promising, since this material is non–toxic, biocompatible and stimulates tissue remodeling by maintaining energy levels and activating growth factors. Studies have shown that a. It was like a mechanical unit and adjuvant in the processing of ulcerative operations and surgical wounds. In addition, cellulose is one of the most abundant polymers, of low cost and of greater use worldwide. BC dressings are marketed by means of two formulations: the BC membrane contains silver and hydrogel with alginate. The objective of this study is to quantitatively evaluate the healing of PL with the use of bacterial cellulose– based formulations. The research will be carried out with a series of PL diagnoses, randomly distributed, in the Hospitalization Units, in the emergency department and in the Intensive Care Unit of the Santa Casa de Misericórdia Hospital of Araraquara. The patients are divided into 5 distinct groups, with 8 patients each, receiving formulations with different BC, such as: BC membrane, BC/silver nanoparticles membranes and a pristine group control. This study aims to accelerate the healing process, reduce the risk of patients, reduce the incidence of side effects, reduce treatment capacity and reduce the work of the multidisciplinary team.

**Keywords:** Pressure Lesions; Bacterial Cellulose; Polymers.


# INFLUENCE OF PROCESSING ON THE STABILITY OF BIOACTIVE COMPOUNDS PRESENT IN PROPOLIS: MICROENCAPSULATION X CASTING

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Area: ( ) Food and Agriculture ( ) Medical and Pharmaceutical (x) Multifunctional Applications

**Abstract:** Bioactive compounds have occupied a prominent place in the scientific environment, due to it antimicrobial and antioxidant functions. However, the difficulty of using such compounds is often linked to the unpleasant taste and its difficult solubilization. An alternative to these problems is their incorporation into oral disintegrating films (ODF) and their microencapsulation, which allows a "controlled" release system. Therefore, this study aimed to evaluate the influence of the process on the stability of the bioactive components present in the propolis by using two techniques: (1) the production of films by casting and (2) microencapsulation by spray–dryer. For this, a solution was produced using 10g macromolecule / 100g solution in three different formulations (gelatin:starch ratio 30:70, 50:50 and 70:30) and 20g sorbitol/ 100g of macromolecule. For the production of microparticles 200g of propolis ethanolic extract / 100g of macromolecule was used. The ODF were characterized in terms of water content, soluble matter, color, mechanical properties, morphology, infrared spectroscopy, and total phenolic and flavonoid content; and microcapsules in relation to water content, cold water solubility, color, wettability, particle size, morphology, infrared spectroscopy, and total phenolic and flavonoid content. The formulation with higher gelatin concentration produced ODF with better mechanical properties, as well as lower humidity. Similar, microcapsules with higher gelatin content, showed a distribution of unimodal particles, demonstrating a good encapsulation, homogeneous color parameters, low humidity and solubility in medium cold water, and a more spherical shape. Furthermore, ODF and microcapsules were stable, in relation to the total phenolic compounds, and flavonoids, for approximately nine months of storage at 25° C. Therefore, it could be concluded that the use of ODF and microcapsules, can represent an excellent alternative to transport the active compounds, mainly phenolic compounds, present in the propolis extract.

**Keywords:** Microparticles; Orally disintegrating films; Material.


# EFFECT OF ADDITION OF HYDROXYAPATITE AND POMEGRANATE PEEL EXTRACT ON COLLAGEN SCAFOLDS

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**Abstract:** Collagen type I (C), a bioabsorbable fibrous protein, hydroxyapatite (HA), a bioceramic that exhibits osteoinductive and osteoconductive properties and a pomegranate peel extract (R), abundant in flavonoids that have antioxidant and anti– inflammatory properties were used to obtain a biomaterial with possible use in reconstruction of bone tissue. Anionic collagen gel was obtained by alkaline hydrolysis of porcine serosa, and it was mixed with a suspension of synthetic hydroxyapatite and pomegranate peel extract solution to form scaffolds named as C, CHA (16.7% HA), CR (14, 4% R) and CHAR (14.6% HA and 12.2% R). These were characterized by differential scanning calorimetry (DSC), collagenase degradation assays and immersion porosity assays in ethanol. It was observed by DSC that the flavonoids present in the pomegranate extract act as a collagen crosslinking agent, and the denaturing temperature (Td) of the scaffolds without extract are 47.6°C (C) and 47.9°C (CHA) and for CR and CHAR scaffolds is 52.8°C. The collagenase degradation assay shows that in a period of 2h, C and CR degraded 6.3±2.9% and 4.4±1.7%, respectively, showing no significant difference, however the addition of HA to the scaffolds significantly increases the percentage of degradation, being 22.7±3.0% for CHA and 17.0±1.3% for CHAR. This may indicate that HA destabilizes the structure of the scaffold and the difference of 5.7% between CHA and CHAR may be due to the crosslinking of the collagen caused by the extract. Porosity tests show that there is no difference between the porosities of C, CR and CHA, being about 92%, however with the addition of extract and HA a reduction in porosity is observed (64.7±7.9%). It can be concluded that the addition of extract crosslinks collagen, the addition of HA increases the degradation and the addition of HA and extract reduces the porosity in approximately 30%.

**Keywords:** Collagen; Hydroxyapatite; Pomegranate Peel Extract.


# INFLUENCE OF SYNTHESIS METHODOLOGY ON THE PROPERTIES OF COLLAGEN:CHITOSAN:CALCIUM NANO PHOSPHATE SCAFFOLDS

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**Abstract:** Scaffolds of calcium nano–phosphate (CNP) and collagen have been developed aiming applications in the regeneration of bone tissue, due to properties as cellular adhesion, biocompatibility, porosity and capacity of drugs incorporation in the three–dimensional structure. However, one of the major challenges to be overcome is the heterogeneous distribution of calcium phosphate in the collagen matrix. This issue can be solved with the use of calcium phosphate crystals at the nanometer scale and the use of collagen associated with other biopolymers, such as chitosan. Thus, the aim of this work was to evaluate how different methodologies of CNP synthesis could affect the structural and thermal properties of collagen/chitosan scaffolds. The methodologies developed were: 1) CC–CNPM1: $H_3PO_4$ solution was added to a 1% chitosan gel and $Ca(OH)_2$ solution was dripped in the mixture. The mixture (pH 9.0) was homogenized in the collagen gel (1:1); 2) CC–CNPM2: CNP crystals were synthesized within a pectin matrix, precipitated, calcinated and incorporated to a 1% collagen gel; chitosan powder was then added to the mixture (1:1), which pH was also raised to 9.0. After, 5% (w/w) of ciprofloxacin was added in both methodologies. DSC thermal analysis revealed that the addition of CNP increased the collagen denaturation temperature in both cases. Photomicrographs by SEM revealed scaffolds with porous surfaces containing CNP crystals internally distributed. X–ray diffractograms confirmed the presence of CNP in the scaffolds. The CNP synthesis methodologies led to significant differences in scaffolds porosity, CC–CNPM1 being 30% most porous. Ciprofloxacin release increased rapidly in both cases and stabilized after 1 hour, CC–CNPM2 releasing about 33% less antibiotic than CC– CNPM1. Thus, it can be stated that both methodologies successfully generated CNP, better stabilizing the triple helix of the collagen and affecting the porosity of the scaffolds, as well as their drugs releasing capacity.

**Keywords:** Chitosan; Collagen; Calcium Nano–Phospate.


# DEVELOPMENT OF CHITOSAN–CELLULOSE FILM AS MATRICES FOR CONTROLLED RELEASE FERTILIZER

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**Abstract:** Controlled release fertilizers (CRF) are a technological alternative capable of avoiding the excessive application of fertilizers and, consequently, their harmful environmental and economic consequences. The use of polymer matrices composed of green and renewable source materials has been a widely exploited innovation for the development of new fertilizer materials. We developed a film based on chitosan/cellulose/fertilizer to use as an efficient CRF system. Cellulose fibers were extracted from sugarcane bagasse using an alkaline treatment (NaOH 4% m/v, 70 °C, 5 min, twice). A multielement solution with 10 mg $L^{-1}$ of N, P and K nutrients were sorption on fibers. Then, chitosan acid solutions (1% w / v) were prepared and 1 g of mixed NPK–type fertilizer (1: 1: 1) was added to the solutions. After obtaining a homogeneous mixture, 0.1, 0.5 and 1.0 g of sorbed fibers were added to the systems. The mixtures were oven dried at 30 °C for 24 h. The release property of the films was characterized by photometry by the quantification of the potassium ion. For the release tests, films with standardized mass were placed in tea bags and sequentially dipped in 50 mL of distilled water. At each pre–set time interval, the entire volume of water was exchanged, calculating the cumulative mass, in grams, of the available potassium ion in the medium. From preliminary results, it was found that polymer films composed of fibers are able to reduce the release of the potassium nutrient in water, indicating the feasibility of using these materials as fertilizer release systems.

**Keywords:** Sugarcane Bagasse; Npk; Film Casting.


# ORGANIC–INORGANIC NANOCOMPOSITES BASED ON *ALLIUM* CEPA BIOPOLYMER CONTAINING HYDROXYAPATITE / SIMVASTATIN FOR APPLICATION IN DENTISTRY

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**Abstract:** Bone regeneration has become a space of great interest in medical specialties, especially in the dental area. When teeth are extracted there is a concern on the part of the professional when it comes to the process of bone repair, since the regenerated bone can serve as a support for oral rehabilitation in that place. Thus, the bone volume in the alveolar region is essential for successful dental treatment. In view of the need for the bone regeneration procedure, many studies were conducted in this direction with the creation of biomaterials such as polymers and the formation of natural composites because these biopolymers have remarkable physical properties, special surface chemistry, sustainability, biosafety and excellent properties such as biocompatibility, biodegradability and low toxicity. In the present Project nanocomposite films will be obtained through the casting process from the onion pulp (Allium cepa L.) associated with hydroxyapatite and simvastatin. The pristine material, as well as all nanocomposites, will be evaluated for physico–chemical properties by means of thermogravimetric (TG), Vibrational Spectroscopy in the Infrared Region (FT–IR), X–ray Diffraction and Scanning Electron Microscopy), 3 specimens being analyzed for each
technique. In vitro assays for cell viability, cell adhesion and proliferation will also be conducted in addition to animal studies where mice from the laboratory of the University of Araraquara UNIARA will be used. At the end it is desired to obtain a material with properties for it to be used in guided bone regeneration in dentistry.

**Keywords:** Bone regeneration; Biomaterials; Membranes.


# CHITOSAN/RHAMNOLIPID NANOPARTICLES AS AN EFFICIENT ANTIMICROBIAL AGENT AGAINST Staphylococcus aureus

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**Abstract:** In recent years, the antimicrobial resistance has led to serious health and food problems. Nanomaterials have been identified as a new approach to deal with this problem because of their unique physical and chemical properties. In this study, the antimicrobial activity of chitosan solution (C), rhamnolipid nanoparticles (RL–NPs), chitosan nanoparticles (C–NPs) and chitosan/rhamnolipid nanoparticles (C/RL–NPs) was evaluated against Staphylococcus aureus ATCC 25923. Chitosan (MW $1.63 \pm 0.03 \times 10^3$ g $mol^{-1}$, degree of deacetylation 82.6%) was extracted from squid pens by deproteinization, deacetylation and depolymerization. A 0.5 mg $mL^{-1}$ chitosan solution was prepared in 0.5% acetic acid. RL–NPs were obtained by dissolution of 0.5 mg $mL^{-1}$ commercial rhamnolipid (25% Rhamnolipid Inc.) in water. C/RL–NPs were prepared by mixing chitosan and rhamnolipid at 1:1 (v/v) ratio with addition of sodium tripolyphosphate (TPP) aqueous solution (0.5 mg $mL^{-1}$) under constant stirring. The minimum inhibitory concentration (MIC) was determined using the microbroth dilution technique and minimum bactericidal concentration (MBC) was also evaluated. Chitosan solution inhibited bacterial growth showing a MIC of 14 µg $mL^{-1}$ and MBC of 116 µg $mL^{-1}$ whereas, the MIC and MBC values of RL–NPs were 37 µg $mL^{-1}$ and 75 µg $mL^{-1}$, respectively. The bacterium was resistant to C–NPs at the concentrations tested. C/RL–NPs showed a MIC of 7/9 µg $mL^{-1}$ and MBC of 29/37 µg $mL^{-1}$. In conclusion, the MIC and MBC values were lower than that obtained for isolated molecules, suggesting a synergistic effect and offering a promising strategy to design non–toxic functionalized NPs for applications in several areas.

**Keywords:** Nanoparticles; Chitosan; Rhamnolipid; Antimicrobial Activity.


# INCORPORATION OF DRIED CAMU–CAMU EXTRACT IN STARCH/GELATIN ORALLY DESINTEGRATING FILMS

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**Abstract:** Oral Desintegrating Films (ODF) is an efficient way to administration of several compounds by the oral mucosa. ODF have been highlighted by the incorporation of active compounds obtained from natural sources. The aim of this work was to development Starch/Gelatin ODF with the addition of camu–camu powder (CCP) obtained by spray dryer. ODF was produced by casting, without extract (control) and with the addition of CCP (4 g/100g of filmogenic solution), maintaining constant the concentration of macromolecules and polymer (2 g/100 g and 20 g/100g of filmogenic solution, respectively), varying the ratio of starch (S) and gelatin (G) (30S:70G; 50S:50G; 70S:30G). ODF were characterized in relation to thickness, contact angle, surface pH and disintegration time. All ODF, showed homogeneity, absence of insoluble particles and film forming capacity regardless of the formulation. ODF presented thickness between 0.068 and 0.074 nm, without significant difference. A reduction of the contact angle (~84.6 ° to ~62.3 °) and surface pH of ODF (~6.9 to ~5.1) was observed after incorporation CCP, possibly due to the presence of hydrophilic compounds and more acidic characteristics of the fruit. No significant differences were observed in relation to the increase of the starch concentration for the contact angle and surface pH for the ODF control and with addition of extract. All ODF presented disintegration time between 12–20 s. Formulations with the highest concentration of starch, with and without the addition of CCP, disintegrated faster. In this way, it can be concluded that the ODF of starch and gelatin with CCP incorporation presented a short disintegration time (<18 seconds) and surface pH near the buccal, confirming its potential as an innovative dosage form for the incorporation of extracts obtained from natural sources such as camu–camu powder.

**Keywords:** Natural extract; Active compounds; *Myrciaria dubia.*


## ACTIVE PACKAGING SYSTEM BASED ON CHITOSAN FILM CONTAINING LEMONGRASS ESSENTIAL OIL

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**Abstract:** New packaging materials that are economical and easily degraded have gained prominence. Active and biodegradable materials could maintain the quality, promoting safety and prolonging the shelf life of food. Chitosan is a natural polymer derived from chitin, found in the exoskeleton of insects and crustaceans. Chitosan films have advantages such as flexibility, oxygen barrier, biodegradability, antimicrobial property and low toxicity. The incorporation of natural antioxidants in chitosan film matrix forms an active packaging system, as an alternative for the application in food products susceptible to lipid oxidation. The objective of this work was to develop a new and sustainable active packaging material from chitosan films, incorporating essential oil of lemongrass. The formulation was defined from Factorial Design $2^2$ + central points, with the independent variables: concentration of chitosan ($C_{chi}$, 1.0, 1.5 and 2.0%, w/w) and concentration of lemon grass oil ($C_{oil}$, 0.5, 1.5 and 2.5%, v/w). The highest antioxidant capacity (DPPH and ABTS) was verified in formulation containing $C_{chi}$ = 1.0% and $C_{oil}$ = 2,5%, as well as the higher phenolic content (5.94 mgAGE / g). The variables $C_{chi}$ and $C_{oil}$ promoted positive and significative effect in color parameters a* and b*, tending to more yellowish films. Chitosan active films containing lemongrass present potential to apply as antioxidant material for food packaging.

**Keywords:** Chitosan; Antioxidant Film; Sustainable; Food Packaging.


## INFLUENCE OF STERILIZATION ON COLLAGEN, ELASTIN AND JATOBA RESIN SCAFFOLDS

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Area: ( ) Food and Agriculture ( X ) Medical and Pharmaceutical ( ) Multifunctional Applications

**Abstract:** In the field of tissue engineering, a common challenge is to identify a sterilization method for biopolymers scaffolds that does not affect the structural or biochemical properties of the material. Some methods used for the sterilization of biopolymers are ionizing irradiation, ultraviolet radiation and gas sterilization by ethylene oxide. The aim of this study was to evaluate the influence of different types of sterilization in collagen and collagen/elastin scaffolds with or without Jatoba resin. Collagen was extracted in acetic acid pH 3.5 from bovine tendons after an alkaline hydrolysis treatment (72 h at 25°C). Elastin was obtained from bovine auricular cartilage by alkaline hydrolysis (24 h at 45°C). The Jatoba resin was purified and solubilized in ethanolic solution in the proportion of 1:20 (w/w). Scaffolds of collagen (C), collagen/elastin (CE), collagen/resin (CJ) and collagen/elastin/resin (CEJ) were prepared and sterilized by: ethylene oxide (Sterilization Center Com. Ind. Ltda.), ultraviolet radiation (20 minutes with a 30 W UV lamp) and gamma radiation (15 and 25 kGy doses by $^{60}$Co source) in the Multipurpose Irradiator type compact, with a dose rate of 5 kGy/h at the Radiation Technology Center of the Nuclear and Energy Research Institute. SEM and DSC were made to analyze the scaffold morphology and integrity of collagen triple helix. Photomicrographs showed no changes in the morphology of the scaffolds after sterilization procedures. DSC curves showed that the sterilization procedures do not modify collagen triple helix, with the exception of gamma irradiation at the dose of 25 kGy. Gamma irradiation was introduced as the simplest and most efficient sterilization procedure without toxic residues. Doses between 5 and 25 kGy are currently reported as sufficient to sterilize collagen materials. Therefore, the 15 kGy gamma irradiation is the most indicated to sterilize the scaffolds obtained in this study.

**Keywords:** Collagen; Elastin; Gamma Irradiation.


# MECHANICAL PROPERTIES OF PVA/ANIONIC COLLAGEN MEMBRANES CONTAINING ANTIBIOTICS DESIGNED AS THERAPEUTIC CORNEAL DEVICES

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**Abstract:** Collagen has been used extensively as a biomaterial to enhance tissue regeneration. In ophthalmology, collagen–based devices such as corneal shields and keratoprostheses are used to stimulate corneal regeneration. Although frequently collagen has not the adequate mechanical properties to the required application and some strategies, such as crosslinking or blending, are necessary to enhance its performance. Blends of collagen and PVA are relative new biomaterials with excellent mechanical and film forming properties that have not been applicated in ophthalmology. In this study, the tensile properties of membranes of PVA/anionic collagen containing antibiotics were assessed to evaluate their affordability for ophthalmological application. The mechanical compatibility between the two polymers was verified in the dry membranes. In the swelling state, the tensile properties of the blends were superior to the tensile properties of the commercial soft contact lenses. The results indicated that the PVA/anionic collagen membranes are mechanically stable systems with potential use in corneal regenerative medicine.

**Keywords:** Collagen; PVA; Blending; Corneal Regeneration.


# INFLUENCE OF ZEOLITE ZK406H ON THE SWELLING AND STRUCTURAL PROPERTIES OF THE POLYSACCHARIDE NANO–COMPOSITE HYDROGELS

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**Abstract:** The new nanocomposite hydrogels based on methylcellulose (MC) supported in poly(methacrylic acid)–co–polyacrylamide (PMAA–co–PAAm) networks were developed with the goal to reduce the environment impact caused by the indiscriminate use of agrochemical. In this work, the hydrophilic and structural properties of these nanocomposites prepared from 0.5, 1.0 and 1.5% w/v of zeolite, was studied by swelling degree and X–ray diffraction (XDR) technique, respectively. The swelling degree results showed that the addition of zeolite into hydrogel matrix reduced its water absorption. This factor is probably related to physical crosslinking caused by interactions between the zeolite and the hydrophilic groups of the hydrogel chain. XRD nanocomposites diffractograms showed the zeolite crystalline peaks at 2θ= 9.77°, 22.30°, 26.53° and 29.93° with d = 0.91, 0.40, 0.34 and 0.30 nm, respectively. These results indicate an increase in the crystallinity of the polymeric chains, and it is corroborating with hydrophilic properties. In addition, both results confirmed that the zeolite remained into hydrogel after dialysis process. In this way, the presence of zeolite in the hydrogel matrix can improve other important properties such as sorption and desorption properties that may qualify these materials for future use in agriculture, such as carrier vehicles for controlled release of agricultural inputs.

**Keywords:** Hydrogel; Swelling; XRD; Zeolite And Agriculture.

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# BACTERIAL CELLULOSE–BASED PHOTOACTIVE MULTIFUCNTIONAL HYBRID MEMBRANES

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**Abstract:** Photoactive films with photocatalytic, self–cleaning and antibacterial properties formed on flexible and biocompatible substrates are important due to their potential application in the design of self– cleaning and antibacterial surfaces, filters and facemasks. In this research study, we report flexible and multifunctional organic–inorganic hybrid membranes (BC–$SiO_2$–$TiO_2$/Ag) based on bacterial cellulose (BC) that contain photoactive ($TiO_2$) and antibacterial (Ag) components, rendering them photocatalytic, self–cleaning and antibacterial properties. The $SiO_2$ and $TiO_2$ particles were obtained from the hydrolysis–polycondensation of the respective alkoxide precursors and the amorphous $TiO_2$ obtained after sol–gel coating was selectively crystallized in anatase phase using a soft hydrothermal treatment at 130 °C as confirmed by XRD and Raman spectroscopic analysis. The resulting hybrid membranes were characterized by SEM, EDX, XRF, XRD, dynamo mechanical analysis, FTIR spectroscopy, Raman spectroscopy and UV–visible spectroscopy. The $TiO_2$ coating exhibits a typical film–like smooth surface at low Ti/Si ratio but undergo morphological changes with the formation of a rougher surface consisting of $TiO_2$ nanoparticle of around 170±35 nm, as observed by SEM analysis. The prepared BC–$SiO_2$–$TiO_2$ membranes showed good photocatalytic and self–cleaning activity under UV irradiation which increases with increase in Ti/Si ratio or $TiO_2$ loading of the hybrid membranes, as evaluated by the photo–bleaching of a crystal violet over–layer deposited on the surface of the hybrid membranes. The hybrid membranes containing Ag were also tested for their antimicrobial activities against the selected bacterial strain and the samples showed good antibacterial activity in dark. The prepared membranes have the potential to be used in facemask which could be easily sterilized under UV irradiation and safely discarded after use.

**Keywords:** Bacterial Cellulose; $TiO_2$; Self–cleaning; Photocatalysis.


# DELIVERY SYSTEM OF CASHEW GUM LOADED WITH AN ANTIOXIDANT OIL

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**Abstract:** Nanoparticles technology is developed in order to minimize the side effects and keep acceptable the delivery system, improving the bioavailability of the compound. This system can be developed from synthetic and natural polymers. Cashew gum (CG) is a natural polymer, which can be an efficient alternative to encapsulate antioxidant oils, once that the oils have limited application due to their lipophilicity, oxygen and light sensibility, and bioavailability. Thus, the aim of this study is to develop a nanocapsule to protect the antioxidant oil in order to obtain a control delivery system. The samples were prepared by nanoprecipitation technique with antioxidant oil (10, 25 and 50 %, w/v). After developed, the mean particle diameter (Z– average), polydispersity index (PDI) and zeta potential were determined by dynamic light scattering (DLS). *In vitro* release study was performed in triplicates during 24 h and analyzed by UV–visible spectrophotometer at 292 nm. Particle size analysis showed diameters ranges 300 to 600 nm and PDI 0.1. The smallest size, 370.97 ± 55.80, was observed with the lowest concentration of antioxidant oil, what suggest which more oil concentration, bigger is the particle. Z–potential showed a negative charge for pure CG, –2.98mV, and the oil applied was already reported in the literature with a positive charge and the complex range –23.9 to –25.8, the opposite charges can suggest that the oil was coated by the gum and homogeneous solution and moderate stability. *In vitro* release study of CGNPs+10 was 16.2 % while the pure oil was 11.1 % after 24 hours. Therewith, besides protecting the oil oxidation the particles also present a higher oil release if compared with pure oil. Thus, these results reinforce the capacity of CG encapsulate an antioxidant oil and that can be used as a delivery system for different purposes.

**Keywords:** Cashew gum; nanocapsule; *In vitro* release.


# DEVELOPMENT AND CHARACTERIZATION OF MICROSPHERES OF SILK FIBROIN AND CARBOXYMETHILCELLULOSE

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Area: ( ) Food and Agriculture (x) Medical and Pharmaceutical ( ) Multifunctional Applications

**Abstract:** In the last few decades, the use of polymers in several areas had been increased exponentially due to their versatility and multiple applicability. When related to polymers, it is possible to found the natural and the synthetic polymers. Moreover, the biopolymers had a special highlight because the proprieties found in this biomaterial had a huge interest in health care, food and drug applications, and so on. The biopolymer carboxymethilcellulose is a hydro–soluble derivate from cellulose and it is found in huge amounts in the nature. Another biopolymer is the silk fibroin that is biopolymer of easy obtainment from silkworm's cocoon (*Bombyx mori)*. Both compounds had several reports about their applicability in health studies, especially related to obtainment of hydrogels. For this reason, our objective was to develop and to characterize microspheres of carboxymethilcellulose (CMC) and silk fibroin (SF) potentially applicable for medical sciences. The hydrogel SF+CMC was obtained using a solution of 1%SF with 2%CMC (w/w) in 25mL of ultrapure water. Then the hydrogel was submitted to a syringe pump to drip the hydrogel in a solution of aluminum chloride 5% (w/v) for reticulation. After, it was washed with ultrapure water for obtaining the microspheres cleared of reticulation agent. The characterization was made by swelling in water studies, thermogravimetry and differential scanning calorimetry, The results suggest that a silk fibroin and carboxymethilcellulose composite was obtained by physical reticulation with $Al^{3+}$ ions. Thus, the obtained microspheres will be used for a next step of applicability in drug release.

**Keywords:** Silk Fibroin; Carboxymethilcellulose; Microspheres.


# MODIFICATION OF SURGICAL SILK SUTURES WITH CHLORHEXIDINE AS ANTIMICROBIAL AGENT

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**Abstract:** Silk is a natural polymer fiber composed of an organic protein called fibroin. This polymer is derived from *Bombyx mori L* silkworm species. The silk suture is a sterile and non–absorbable surgical suture very used in Oral Surgery. It can induce infections by bacterial accumulation. For this reason some attempts have been made to develop sutures with antibacterial properties. Thus, the objective of this work was the incorporation of chlorhexidine gluconate (CHX), as antimicrobial agent, in surgical silk sutures. Chlorhexidine is a chemical antiseptic with fungicide, bactericidal and bacteriostatic action, inhibiting bacterial proliferation. It was incorporated by impregnation at ambient temperature by using 2% and 4% (v/v) water solutions. Sutures were characterized by Fourier Transform Infrared Spectroscopy (FTIR) and Thermogravimetric Analysis (TGA). Also, in vitro drug release studies were performed in water. The FTIR results revealed the CHX incorporation by drug characteristic bands presence. Thermal analysis showed an increase in the maximum decomposition temperatures of modified silk and CHX incorporation. The drug release was higher for sutures with 4% of CHX but a rapid burst release effect was obtained. Then, we can conclude that chlorhexidine was effective incorporated in these surgical silk sutures. Other modifications are being made to better control the chlorhexidine release and the antibacterial activity will be studied.

**Keywords:** Silk suture; Chlorhexidine; Drug Release.


# CHITOSAN – LEMONGRASS ESSENTIAL OIL FILM AS ANTIAGING FACIAL MASK

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Area: (X) Food and Agriculture ( ) Medical and Pharmaceutical ( ) Multifunctional Applications

**Abstract:** Chitosan films are characterized by biodegradability, low toxicity, flexibility, resistence and antimicrobial properties. Several researchs indicated the chitosan film application in cosmetic, food, biomedical and other products. The objective of this work was developed and characterized chitosan active films containing lemongrass essential oil (LO) with potential application as antiaging facial masks. Different concentrations of LO (0, 0.5, 1.0, 1.5%, w/w) were incorporated into chitosan filmogenic matrix (1.0%, w/w) forming the active chitosan films. The antioxidant properties of active chitosan films increased in function of LO concentration ($EC_{50}$ = 0.024 mg/µL for 1.5% of LO), measured by DPPH method. Similar results were observed to water vapor permeability and water solubility that increasing the LO concentrations, it was observed higher water vapour barrier and less water solubility. Chitosan active films containing 1.0 and 1.5% of LO presented a reduced celular viability (30%). Chitosan active films containing 0.5% of LO presented cellular viability over than 70%. In this way, the active chitosan films containing lemongrass essential oil (0.5%) has potential to apply as antiaging mask with antioxidant capacity, seletive permeability, integrity and safety (citoxicity).

**Keywords:** Chitosan; Films; Lemongrass Oil; Facial Mask.


# ANTIMICROBIAL WOUND DRESSING BASED ON BACTERIAL CELLULOSE MEMBRANES CONTAINING SILVER NANOPARTICLES FOR WOUND TREATMENT

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**Abstract:** Bacterial cellulose (BC) is a natural polymer synthesized by gram–negative bacteria such as *Komagataeibacter rhaeticus,* without impurities as lignin, pectin and hemicellulose usually present in vegetable cellulose. In addition to amazing physico–chemical properties, BC can be applied in biomedical field as drug excipient, nerve recovery, wound dressings, among others. Seven® industry has fabricated dressing based on BC that exhibits benefits such as healing and regenerating properties to treat chronic wounds. Specifically, porous BC wound dressings can promote healing been applied for moderate and high wound exudation. Despites good healing properties induced by BC, these kind of dressings do not show antimicrobial properties, which makes difficult to cure effectively wounds with high contamination degree by pathogens. To overcome this drawback, this work proposed to ally wound healing properties of BC with silver nanoparticles (AgNP) labeled BC@AgNP, since these biocomposites have proven efficacy against microorganisms. Methodology: Porous BC Nexfill® dressings were impregnated with distinct concentrations of AgNP as 500, 250, 125 and 62.5 ppm corresponding to the BC@AgNP1, BC@AgNP2, BC@AgNP3 and BC@AgNP4, respectively. AgNP distribution onto BC, cell viability and bactericidal and bacteriostatic effects were evaluated. Results and discussion: MEV results showed a homogeneous distribution of AgNPs onto BC nanofibers network. Cell viability assays displayed non–toxicity of BC@AgNP in healthy cells, with values above 70 % of viability for all biocomposites. Beyound that, commercial wound dressing was evaluated showing high toxicity (30 % of cell viability) regarding to our BC@AgNP samples. Antimicrobial assays using contact method exhibited no microbial growth by using BC@AgNP for ***E. coli*** and ***S. aureus*** bacteria. Death Curve assays demonstrated that the fabricated BC@AgNP can be used for more than 24 h being efficient in maintaining its bacteriostatic abilities. Conclusion: All results from BC@AgNP suggest these biocomposites as potential and effective dressings to avoid wound infections.

**Keywords:** Bacterial cellulose; Silver nanoparticles; Antimicrobial wound healing.


# BIODEGRADATION OF PROGRAMMABLE RELEASE FERTILIZER BASED ON PHB–TPS AND NANOCELLULOSE

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**Abstract:** The currently farming system uses a large amount of agrochemicals in the planted area. The loss of these essential components arises by different physical–chemical processes (leaching, volatilization, solubilization in the soil), but also contribute to environmental pollution. In order to reduce this waste and prevent pollution, programmable release fertilizer (PRF) has been a viable alternative. However, these are expensive and are usually formulated with materials that accumulate in the soil due to low natural degradation, causing damage to the environment. So some polymers, natural or synthetic, are alternatives to this problem because of their physical and microbial degradation characteristics. In this work the biodegradation profile of PRF based on cellulose, cellulose nanofibers, starch, thermoplastic starch and poly (hydroxybutyrate), PHB, according to NBR 14283 was obtained. It considers carbon dioxide a product of degradation and aerobic activity of microorganisms, making it possible to quantify biodegradation. Thus, the biodegradation profiles show that PHB, starch or TPS composites formulated with nanocellulose have a high biodegradation rate. And only the fertilizer in the matrix also accelerates this mechanism when compared to the profile of the matrices. Therefore, nanocellulose is an efficient factor for biodegradation, and may improve soil cultivation properties.

**Keywords:** Starch; Programmable release, PHB.


# CHARACTERIZATION OF COMPOSITE MICROSPHERES OF SILK FIBROIN AND SODIUM ALGINATE

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**Abstract:** In the nature is possible to found a diversify varieties of compounds. In these compounds are situated the high structured polymers, that are molecules made by the junction of small structures called "monomers". Furthermore, is also possible to found the biopolymers, which are attracting more attention lead these proprieties. Two examples of biopolymers are the sodium alginate (A) and the silk fibroin (SF), the sodium alginate are originated from the brown algae, while the silk fibroin is a compound present in the composition of cocoon of silkworm (*Bombyx mori*). The SF have high biocompatibility, mechanical properties and low toxicity, and the alginate had been applied in large scale in food industries. For this reason, our objective was to develop and to characterize microspheres of sodium alginate and silk fibroin potentially applicable for food and drug sciences. The hydrogel A+SF was obtained using a solution of 1%SF with 2%A (w/w) in 25mL of ultrapure water. Then the hydrogel was submitted to a syringe pump to drip the hydrogel in a solution of 5% calcium chloride for reticulation. After, it was washed with ultrapure water for obtaining the microspheres cleared of reticulation agent. The characterization was made by water permeability, thermogravimetry and differential scanning calorimetric, the results suggests that the composite obtained by silk fibroin and sodium alginate had molecular interactions after the preparation. Thus, the microspheres obtained were promissory for the next studies.

**Keywords:** Sodium Alginate; Silk Fibroin; Microspheres.


# OBTENTION OF CARBOXYMETHYLCELLULOSE MICROSPHERES: THE RETICULATION EFFECT WITH $CA^{2+}$ AND $AL^{3+}$ IONS

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**Abstract:** The carboxymethylcellulose (CMC) is a water–soluble derivative from cellulose, and cellulose is a natural polymer found abundantly in nature. The CMC has the capacity of deriving itself to gels, which possibility the obtainment of microspheres. The microspheres are solid particles or droplets obtained through a process of reticulation. Moreover, the reticulating agent causes a link by crossing bond between the polymers chain, allowing getting a network, resulting in differences in the materials properties. The reticulation process can be chemical or physical. The last one is reached by using multivalent ions solutions. Thus, the objectives of this work were to obtain CMC microspheres and to study the reticulation effect of $Ca^{2+}$ and $Al^{3+}$ ions. The microspheres were obtained by dripping a solution of 2% (w/v) CMC into the reticulating agent using a syringe pump, washed with ultrapure water and dried by lyophilization. After, they were characterized by visual analysis, swelling studies in water and thermogravimetric analysis (TG/DTG/DSC). The results showed that with the use of the $Al^{3+}$ ions was possible to obtain the microspheres, while with $Ca^{2+}$ the material was not spherical and showed a coalescence effect. Furthermore, the TG/DTG/DSC data showed variations in the thermal properties of the materials by the reticulation process. The swelling results showed that the $Al^{3+}$ reticulated microspheres showed twice the volume of absorbed water than the reticulated with $Ca^{2+}$. In conclusion, the CMC microspheres with the desired characteristics were obtained using $Al^{3+}$ ions as reticulating agent. These microspheres will be used for the encapsulation of entomopathogenic fungi in the next step of this work.

**Keywords:** Carboxymethylcellulose; Microspheres; Reticulation.

**Acknowledgments:** To The São Paulo Research Foundation (FAPESP), process No. 2017/50334–3.


# BIOINSECTICIDAL ACTIVE PACKAGING MATERIAL BASED ON CHITOSAN–LEMONGRASS OIL COATING CARDPAPER

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**Abstract:** Active packaging system is an excellent solution for a wide range of applications in the food industry. Flour and grain–based products are an important kind of food susceptible to microbiological and entomological infestation. The insects' infestation causes the reduced grain quality, which results in economic losses. The objective of this work was developed an active and sustainable grain–products packaging material with insecticidal action against *Sitophilus zeamais* insects. The active material consisted in chitosan coating cardpaper containing lemongrass essential oil (Cymbopogon citratus), as a botanical insecticide. A Factorial Design $2^3$ was developed to evaluate the effect of chitosan and lemongrass essential oil concentrations, and the number of coating layers, on the bio–based coating's properties. SEM images showed that active chitosan–oil coating filled the void spaces between the cellulosic network, improved the barrier, reducing water vapor permeability (WVP), increasing the grease resistance and maintaining a microbial impermeability. Increasing $C_{oil}$ from −1 (20%) to +1 (40%), reduced the WVP in the order to 0.24 $g.mm.h^{-1}.m^{-2}.KPa^{-1}$, indicating that the lipid presence increased the hydrophobicity of the chitosan coating matrix. The grease resistance was improved increasing the total solids ($g.m^{-2}$) on the cardpaper surface. The chitosan–lemongrass oil coating on cardpaper is an active and environmental friendly alternative to grain–products packaging material to reduce the insects infestations.

**Keywords:** Chitosan Coating; Botanical Insecticide; Active Packaging.


# DEVELOPMENT OF A NEW METHOD OF EXTRACTION OF HYALURONIC ACID (HA) FROM EGGSHELLS BY SONICATION FOR USE IN DENTISTRY

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**Abstract:** Differences in the rate of crosslinking of hyaluronic acid (HA) gels can alter their properties and compromise their biological performance and biodegradation. The objective of this study was to evaluate the efficiency of a new method of hyaluronic acid extraction from eggshells by son–ication. A controlled, parallel group, double blinding laboratory study was conducted to evaluate the efficiency of the sonication method to extract hyaluronic acid from eggshells. For sonication extraction 15 mg of crushed egg shells were mixed with 15 ml of sodium chloride.The ultrasound was applied for 10 and 20 minutes with amplitude of 20 hertz. The control group was defined as 15g of eggshell powder and 15mL of acetic acid (4M) were mixed and the solution was stirred (200 rpm) for 24 hours at 9 ° C and constant pH (~ 3.5). Subsequently, an equal volume of isopropanol was added and the solution centrifuged (18,000 x g, 20 min and 4 ° C). The hyaluronic acids extracted was precipitated gel was suspended in 1 L of 3% sodium acetate, 2% silica gel and activated charcoal and centrifuged (20,000 x g, 20 min and 4 ° C) to remove impurities. The purified hyaluronic acids was filtered (0.45 and 0.20mm) and lyophilized. The hyaluronic acid extracted by each method was characterized by UV–Vis chromatography (Carbozole reaction), infra red spectroscopy (FTIR), pH evaluation and rheometry. The results obtained were compared with scientific standard (sigma aldrich) and commercial Rennova Lift (Croma GmbH). The extraction process had a yield of 0.5%. The AH extracted from the eggshell is similar to the stan–dards and can be classified as medical grade and showing potential to be a more ecological alternative to obtain this biopolymer

**Keywords:** Biopolimer; Hyaluronic Acid; Crosslinking.


# ETHYLENE–ADSORBER/CHITOSAN–COATED KRAFT PAPER FOR ACTIVE PACKAGING APPLICATION

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**Abstract:** Ethylene ($C_2H_4$) is a plant hormone that strongly affects climacteric fruits and vegetables post harvest quality as it accelerates ripening. Therefore, maintaining ethylene on the lower level is essential for prolonging shelf–life of climacteric fruits. The present work aims to develop an active packaging system capable of adsorbing ethylene gas inside climacteric fruits packaging. The systems consist of Kraft paper coated with chitosan–ethylene adsorber. An experimental design $2^2$ + central points was formulated to understand the best coating condition. Dependent variables were chitosan and ethylene adsorber concentrations (w/w). Ethylene adsorber was dispersed in chitosan solution and applied as a coating on kraft paper with a film spreader equipment. Grammage (weight per area), thickness, and Taber stiffness (bending resistance) were measured. Despite the presence of a chitosan–adsorber coating, it was not observed higher grammage and thickness for any of the coated systems when compared to non–coated Kraft paper, possibly, due to low concentrations of both chitosan and adsorber chosen in this experiment. Taber stiffness of coated paper systems presented higher values when compared to non–coated paper. It indicates that even though the solids (chitosan+adsorber) on the coating were low enough not to affect grammage and thickness, they were sufficient to improve the mechanical property of bending resistance, especially in the fibers alignment direction. For further studies, it is required to evaluate other properties of the material. For example, barrier properties and especially its effectiveness on ethylene adsorbing and prolonging climacteric fruits shelf life. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001. This work is also supported by São Paulo Research Foundation (FAPESP; grant#2016/25120–7).

**Keywords:** Ethylene; Packaging; Kraft paper.


# EVALUATION OF CHITOSAN FILMS CONTAINING ALOE VERA EXTRACT AND/OR COPAIBA OIL IN HEALING TESTS WITH WISTAR RATS

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**Abstract:** Polymeric films have been used as wound dressings for burns. Healing, anti–inflammatory, and antibiotic properties can be potentiated with the incorporation of bioactives. Traditionally healing phytotherapics such as ***Aloe vera*** extract and copaiba oil were incorporated into chitosan films. In previous studies, the physical and biological properties of the films were evaluated and then some films were selected for the ***in vivo*** tests with Wistar rats. The animals were anesthetized and partially epilated on the back. The deep wound was obtained by total excision of the dorsum skin and removal of the fleshy pannicle with the aid of scalpel and surgical scissors, removing a fragment of skin and adding a dressing (film) in place. The animals were randomly distributed in seven groups of five animals: Group I – commercial dressing Membracel; Group II – chitosan film 2%; Group III – 2% chitosan film + silver sulfadiazine; Group IV – chitosan film 2% + Copaiba 0.5%; Group V – Chitosan film 2% + Aloe Vera 0.5%; Group VI– chitosan film 2% + Copaiba 0.5% + Aloe Vera 0.5%; Group VII – control group (dry gauze). After the surgery, visual follow–up was performed, the area of the wound was measured and the healing progress was documented. The monitoring was daily until the day after the wound closure. The results were compared at three different levels: wound closure rate; the macroscopic appearance of the healed wound and histological evaluation. It was concluded that the film containing 0.5% copaiba oil (Group IV) presented the best result in terms of skin regeneration rate, with complete wound closure in 11 days, that is, three days earlier than the control. The other films showed full wound closure at times equal to the control, although these presented a higher regeneration rate in the initial stages (Grant 2010/17721–4, São Paulo Research Foundation – FAPESP).

**Keywords:** Chitosan films; *In vivo* tests; phytotherapics.


# SWELLING AND RELEASE OF HERBICIDE IN SALINE MEDIUM FROM NANOCOMPOSITE HYDROGELS BASED ON CHITOSAN ANDZEOLITE

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**Abstract:** The conventional application of highly water–soluble agrochemicals, such the diquat herbicide, can provoke the contamination of water bodies destined to the supply of rural and urban populations. The controlled released of these compounds from biodegradable polymeric matrices can minimized the damage caused in the human health and the environment caused by these chemical products. The potential of nanocomposite hydrogels composed by chitosan and zeolite supported in poly (methacrylic acid)–co–polyacrylamide in agriculture was investigated by swelling and desorption analyses on different salt solutions. The swelling results showed that the water absorption by the hydrogel and their nanocomposite reduces with the increase in the concentration and valence of the ions presents in the swelling medium. In contrast, the desorption ratio and the diquat mass released by the nanocomposite significantly increased in the presence of bivalent and trivalent ions such the $Ca^{+2}$ and $Al^{+3}$. However, the nanocomposite released a smaller amount of diquat in all desorption test made in this studied, in comparison to the amount released by the pure hydrogel. Indicating that the zeolite insertion in these materials can produce a more controlled released of herbicides, and the desorption analysis also showed that diquat released was controlled by the ionic diffusion, proving that the nanocomposite can decrease the damages in the roots of plants caused by ions $Al^{+3}$, reducing costs of other processes such as liming.

**Keywords:** Nanocomposite Hydrogel; Sweeling; Diquat; Zeolite; Desorption Properties.

**Acknowledgments:** UNESP, FAPESP and CNPq. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – "Finance Code 001"


# EVALUATION OF THE SWELLING RATE OF HYALURONIC ACID BASED FILLERS WITH DIFFERENT CROSSLINKS

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**Abstract**: Advances within Orofacial Harmonization in Dentistry have sought filling materials with better physico–chemical properties in orofacial procedures. Crosslinking of Hyaluronic Acid (HA), for example, which aims to crosslink the molecules of the gel, is intended to increase the product's durability and to modify it's elasticity and viscosity, providing a perfect clinical indication. Therefore, the crosslinking agent, the concentration, and the crosslinking method can modify the rate of fluid absorption in implanted tissue directly interfering with the treatment of patients. Thus, the purpose of this study was to evaluate the swelling rate and the crosslinking degree of HA with 2 differents crosslinking agents: I–polyethylene glycol diglycidyl ether (PEGDE) (150 uL and 300 uL) and II–butanediol diglycidyl ether (500 uL and 800uL). Fourier transform infrared (FTIR) and Swelling Test were performed to compare the products. Both tests were effective in qualifying the products for their crosslinking rate and fluid absorption. The results showed that the higher the crosslinking rate the lower the fluid uptake (BDDE 300uL> PEGDGE 800uL> BDDE 150uL > PEGDGE 500uL). The data obtained from the FTIR corroborated with those obtained by the Swelling test. It can be concluded that the concentration, the method and the different crosslinkers directly interfere with the absorption of fluids.

**Keywords:** Hydrogels; Hyaluronic Acid; Swelling Kinetics.


# DEVELOPMENT OF THE HPMC FILMS REINFORCED BY BIOCELLULOSE NANOFIBRILLATED

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**Abstract:** The disposal of the plastic materials has been caused an environmental problem. For this reason, research has been concentrating on development of the new materials "ecological friendly". The present work consists in the development of films based on a natural polymer to be used as packaging material. Films were produced by solvent casting method. Colloidal dispersion BCNC film–forming was obtained through the addiction of 78.5 g of the distilled water, 1.6 g of Hydroxypropyl methylcellulose (HPMC) and 0.08 g of Bacterial Cellulose Nanofribrillated (BCN) provided by BioPolMat–UNIARA. Films were analyzed by Tensile test through a Universal Mechanical Testing machine following ASTM 882/02 Method. HPMC film (control) exhibited tensile strength (MPa) of 60.81 ± 6.5 After BCN addition the values increased to 72.69 ± 6.2. The percent elongation at the break of the films change from 14.62± 2.3 to 12.78 ± 1.8 after BCN were added. The nanostructures addition contributed for increase of the film resistence due the interaction resultant between BCN and polymer matrice. This results is very important in this area and showed satisfactory properties of these films suggesting potential use as packaging material.

**Keywords:** Biopolymers; Biodegradable Pack; Renewable Resources.


# RIFAMPICIN SUSTAINED RELEASE USING BACTERIAL CELLULOSE SPHERES

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Area: ( ) Food and Agriculture ( x ) Medical and Pharmaceutical ( ) Multifunctional Applications

**Abstract:** Bacterial cellulose (BC) is a biopolymer of great interest for application in various industrial and medical areas due to its peculiar characteristics such as biocompatibility, hypoallergenicity, tensile strength, high water retention capacity, purity and crystallinity. In addition to nutrient sources, other factors such as methods of cultivation (static or agitated), oxygen availability, temperature, pH and the bacterial growth phase may influence BC production. The aims of this work were to obtain BC spheres, by *Komagataeibacter hansenii* ATCC 23769, in agitated culture, using media containing different carbon sources, to produce supports for sustained release of rifampicin (RFM). From a pre–inoculum in log phase of growth, BC spheres were produced in media containing different sources of carbon such as fructose (FRU), glucose and sucrose (MS1), sucrose (Y) and glucose (Z and HS) kept under stirring at 130 rpm for 24 hours. The spheres produced were processed in 0.5M NaOH solution at 65 ° C to remove the bacteria and residues from the culture media, washed in distilled water with periodic exchange, until the pH reached neutral, and after lyophilized. The dry mass yield and the swelling percentage were analyzed in addition to the characterization by scanning electron microscopy (SEM) and infrared spectroscopy (IR). The spheres produced were RFM impregnated and tested for sustained release ability of this drug. The BC spheres with the highest RFM release capacity were produced in the FRU and Z media and presented specific characteristics of composition and purity of BC (by IV) and high density and fiber interweaving (by SEM), when compared to those produced in the other means. These results demonstrated the great potential of these BC spheres to be used as a support for the sustained release of antibacterial agents, such as RFM.

**Keywords:** Bacterial Cellulose Spheres; Rifampicin Release; Different Culture Media; Agitated Cultivation.


# DEVELOPMENT OF STRATEGIES FOR ADMINISTRATION OF AN ANTIVIRULENCE COMPOUND TO AVOID CONTAMINATION IN FOOD BY *SALMONELLA* BACTERIA

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**Abstract:** In 2017, Brazil was the second–largest producer of poultry meat and the fourth–largest pork producer in the world market, according to the ABPA (Brazilian Animal Protein Association) and 33.1% of the production and 18.5% of pork were intended for export. The genus *Salmonella* consists of some species and numerous serovars that can be zoonotic, infecting humans and animals. Moreover, *Salmonella* can be carried through food resulting in a target of trade barriers. These bacteria are also involved in enteric disturbances in pigs and chickens influencing meat production due to low yield animal. Antibiotics are used in the animals' feed as the prevention of bacterial infections as well as AGPs (Antibiotic–Growth–Promoters). The intensive and indiscriminate use of antibiotics contribute to the emergence of multidrug–resistant bacteria increasingly frequent. The main objective is to enable the use of the molecule LED209 by developing an innovative controlled release system initially as a preventive agent to livestock in infections caused by pathogenic bacteria, especially *Salmonella.* One approach that has been highlighted is the use of compounds antivirulence disarms bacterial pathogens interrupting the disease progression, as the LED209, which has potential capability antivirulence, being capable of inhibiting the signaling cascade QseC. The virulence factors are regulated at many levels, one of the two–component systems such as QseBC responsible for regulating many virulence genes in more than 25 animal and plant pathogens. QseC functions as epinephrine/norepinephrine sensor and produced by the host autoinducer–3 chemical signaling between bacteria (quorum sensing), contributing to the transduction of signals from host stress and intraspecific and interspecific communication. Then as a vehicle to the LED will realized of a nanoemulsion followed by microencapsulation with polymers. LED209 blocks QseC, impairing its histidine kinase function by not transferring the phosphate to QseB that results in inhibition of the cascade regulation of various virulence genes.

**Keywords:** *Salmonella;* LED209; Antivirulence.

**Development Agency:** FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo) and BioSmart Nanotechnology Ltda.


# EVALUATION OF BIODEGRADATION OF EDIBLE ONION FILMS (*ALLIUM CEPA* L.)

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Area: ( x ) Food and Agriculture ( ) Medical and Pharmaceutical ( ) Multifunctional Applications

**Abstract:** There is an increase in demand for bioplastics from renewable sources, mainly in the areas of medicines, cosmetics, food films, among others. In this context, new biodegradable materials emerge, such as the film derived from the onion pulp. The biodegradation of the samples of Onion films, which were developed by UNESP/UNIARA and Vegetable Cellulose (reference), was performed in the soil column of the Carolina® brand, being removed every day until the 5th day and after the 10th day. The samples were cleaned and placed in a greenhouse for drying for 1 hour. They were characterized by the analysis of infrared spectroscopy and thermogravimetric analysis, in addition to visual analysis. The Onion films began degradation on the 1st day and degraded total on the 10th day. The vegetable pulp continued in the same size and thickness, however, as it is used as a reference pattern of degradation, it was already expected. All infrared spectra showed the chemical bands characteristic of the materials studied. The thermograms of the vegetable cellulose showed that they remained stable during the degradation time. The original Onion films had 3 stages of decomposition, being in 65 °c probably of the sample moisture and the remaining steps at 200 ° C and at 341 °c referring to the decomposition of the sample, but on the 4th day the Samples lost 1 step, leaving only the moisture and at 354 ° C its decomposition. The decomposition evaluation will be analyzed in 10 days for a better understanding of the thermal event.

**Keywords:** Biodegradation; Biopolymers; Soil.


# EVALUATION OF THE DEGRADATION OF THERMOPLASTIC STARCH COMPOSITES WITH PULP RESIDUES AND POST–CONSUMPTION PAPER IN THE INTEMPERISM

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Area: ( x ) Food and Agriculture ( ) Medical and Pharmaceutical ( ) Multifunctional Applications

**Abstract:** The intemperism is considered a destructive factor that can cause the deterioration of several materials by abiotic factors, being responsible for the physical and chemical modifications that alter the microscopic structure of the materials. In relation to the life cycle of renewable composites, it is not yet accurate to affirm the time of its durability. The aim of this study was to evaluate the abiotic intemperalism of thermoplastic starch composites with pulp and post–consumer paper residues. Thus, two formulations of thermoplastic starch composites developed by the casting technique were evaluated, containing 30% of cellulose residues and the other with 30% paper. Films with 100% of thermoplastic starch were also produced in order to compare them with the composites. As for the exposition in the natural environments of Feevale University (Brazil) and HAMK–Häme University of Applied Sciences (Finland) (ISO 877–1:2009 and ISO 9370:2009), the materials were subjected to intemperism for 42 days and, after that, were characterized SEM and IR. The results indicated that the intemperism in Feevale caused a more pronounced abiotic degradation compared to HAMK, but there were no chemical modifications in the materials. Possibly by the radical difference of solar radiation, climatic conditions and relative humidity of the air, which were incidents on the samples. In general, the samples that suffered the most degradation were those of TPS, since the pulp and paper composites presented similar results. These composites can be used as support films for plants or as disposable quick life cycle packaging.

**Keywords:** Thermoplastic starch; Weathering; Biodegradable polymers.


# EFFECTS OF SOLVENT ACIDITY ON RHEOLOGICAL PROPERTIES OF GELATIN SOLUTIONS

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**Abstract:** Gelatin is an animal protein produced by denaturation of collagen. These natural polymers are biocompatible, biodegradable, present healing activity and low antigenicity and toxicity. The low cost and the greater availability of gelatin stimulate its use in a wide range of applications, including the biomaterials development. Several methods can be used for production of scaffolds, such as freeze drying, casting or fiber production techniques such as electro–spinning or solution blow spinning. In these methods it is first necessary to produce a solution that will be further processed. Some processing methods are applicable only to solutions with certain rheological properties, properties affected by the concentration and acidity of the solvents used. Gelatin scaffolds are reported to be produced by aqueous or weak acid solutions, such as acetic acid. This study therefore aims to evaluate the effect of acidity on gelatin solutions on their rheological properties, in order to provide guidance for the preparation of feasible solutions for different processing methods. Gelatin solutions (5% w/w) were prepared by stirring in aqueous solutions of acetic acid at concentrations of 2.5, 5.0, 10, 30, 60 and 90% (w/w). The solutions were stored overnight (4°C) and analyzed in a stress–controlled Rheometer (AR–1000N). The increase in acidity resulted in changes on the rheological properties of the gelatin solutions, such as the conversion of gels to fluid solutions, indicated by the change of materials with G'>G'' to fluids with G''>G' and the suppression of the protein transition temperature above 10% of acetic acid. The samples with 30– 90% of acetic acid produced solutions suitable for fiber production. For applications that require gel samples, such as porous scaffolds production, concentration of acid in the range 2.5–5.0% is recommended in this polymer concentration. Solutions with acid concentration of 10% are indicated for production of films by casting.

**Keywords:** Gelatin; Rheological Properties; Biomaterials.


# CINETIC AND STRUCTURAL ANALYSIS OF PRODUCT BASED ON HYALURONIC ACID RETICULATED BY BDDE

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Area: ( ) Food and Agriculture (x) Medical and Pharmaceutical ( ) Multifunctional Applications

**Abstract:** Hyaluronic acid (HA) is an important compound for increasing the volume of the skin, because it is biocompatible, non–immunogenic, and can be stabilized by chemical crosslinking, making this product with water–insoluble viscoelastic characteristics less susceptible to enzymatic degradation. The objective of this work was to obtain gels crosslinked from hyaluronic acid (HA) by 1,4 butanediol dyglycidyl ether (BDDE) and to evaluate the kinetic characteristics present in the process of gels and the degree of crosslinking. As samples were prepared from differentcategories: degree of swelling (% Q), diffusional exponent (n), diffusion coefficient (D), mean mass between reticles (MMc), density of reticulation (q) number of chains actually elastic per unit volume (Ve).After the swelling kinetics measurements, the different gels samples with and without buffer solution (pH 7.0; NaCl), one can observe the increase of mass of the gels, which is of 5 to 9 times, in relation to its initial mass caused by the absorption of the solvent and / or the buffer solution. Thus, the presence of a mixed diffusion process with $0.45 < n < 1$ (Fikian + relaxation of the polymer chains) for gels with low degree of crosslinking, and predominantly Fikian behavior for gels with a high degree of crosslinking were evidenced.It is concluded that, due to swelling curves, the behavior of the gels presents specific parameters according to the% BDDE incorporated in the crosslinking sys–tem. It is concluded that, due to swelling curves, the behavior of the gels presents specific parameters according to the% BDDE incorporated in the crosslinking system. Thus, the structural characteristics related to the degree of crosslinking promoted in the gel express an important indication in increasing the resistance to enzymatic degradation.

**Keywords:** Hyaluronic acid; BDDE; Crosslinking.


# BACTERIAL CELLULOSE MEMBRANES INCORPORATEDWITH HERBAL EXTRACTS

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Area: ( ) Food and Agriculture ( X ) Medical and Pharmaceutical ( ) Multifunctional Applications

**Abstract:** Bacterial cellulose (BC) is a natural biopolymer known for its biocompatibility, non– toxicity and biodegradability. Such material is very attractive for medical and pharmaceutical aplications because it is free of contaminants and has superior mechanical properties due to its nano–fibrillar structure. Current studies have been conducted on the incorporation of substances, such as herbal extracts, that add specific properties to the BC. Marigold, propolis and witch hazel are examples of medicinal plants, whose extracts are promising in the treatment of wounds due to their antimicrobial and anti–inflammatory properties. The present work aimed to synthesize BC using *Komagataeibacter hansenii* and incorporate those herbal extracts on the membranes surface. For this study it was used aqueous (AEH) and glycolic extract (GEH) of witch hazel, hydroglicolic extract (HEM) and concentrated glycolic extract (GEM) of marigold and propolis extract (EP) in different concentrations. Dried samples were characterized by thermogravimetry (TGA), fourier transform infrared spectroscopy (FTIR) and antimicrobial activity. The incorporation of the extracts on the membranes was confirmed by the presence of chemical bonds from aromatic compounds, which were not found in the pure membrane structure. TGA analysis demonstrated a new degradation step, which was related to the degradation of the extracts. Besides, the incorporation reduced the thermal stability of the biocomposite in 21 °C for membranes with the witch hazel extracts, 45 °C for the marigold extracts and 56 °C for the propolis extracts. Anti–biogram revealed that the membranes incorporated with witch hazel extracts were not efficient against *S. aureus*, *E. coli* and *C. albicans*. Membranes with hydroglicolic extract (HEM) of marigold showed a 64% reduction in the colonization of *S. aureus*, while the glycolic extract (GEM) did not have an expressive antimicrobial activity. For the membranes incorporated with propolis extracts (EP), all the concentrations used were efficient against *E. coli* and *S. aureus*.

**Keywords:** Biocellulose; Herbal Extracts; Incorporation.


# DEVELOPMENT ALGINATE FILMS WITH COTTONSEED PROTEIN HYDROLYSATES FOR APPLICATION AS AN ACTIVE FOOD PACKAGING

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Area: (X) Food and Agriculture ( ) Medical and Pharmaceutical ( ) Multifunctional Applications

**Abstract:** The use of protein hydrolysates (PHs) obtained by the enzymatic hydrolysis of underutilized proteins as active ingredients may be a promising strategy in the development of bioactive packaging. The effects of the incorporation of hydrolysed cottonseed proteins into alginate films were investigated in terms of their physical, chemical, barrier, optical, antioxidant and antimicrobial properties and the release of peptides in two different alginate film food simulants. PH incorporation did not affect the moisture content, biodegradability, solubility or oil barrier properties of the films but did increase the thickness and water vapor permeability. The increase in the PH concentration increased the barrier properties to visible light, and the film colour became darker, reddish and yellowish. The total phenolic content and the antioxidant activity (as tested by the DPPH, FRAP and ABTS methods) also increased. The addition of PH modified the structural arrangement of the surface of the alginate films, which was modified from a continuous smooth surface with a more homogeneous structure (control film) a heterogeneous, rough and crystalline structure as the PH concentration increased in the films. The PH films showed an inhibitory effect against *Staphylococcus aureus, Colletotrichum gloeosporioides* and *Rhizopus oligosporus* but not against *Escherichia coli*. In migration tests in aqueous media, the active films released more than 60% of their peptides in 30 min. Meanwhile, there was a controlled and gradual diffusion of the compounds embedded in the film when fatty foods were simulated. The results showed that alginate films with PHs show promise as active packaging for the preservation of fatty foods.

**Keywords:** Lipid barrier property; Antioxidant activity; Visible light barrier.


# COLLAGEN MANGOSTEEN BIOMATERIALS. OBTAINMENT AND CHARACTERIZATION

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Area: ( ) Food and Agriculture (X ) Medical and Pharmaceutical ( ) Multifunctional Applications

**Abstract:** Collagen is an excellent biomaterial found in tissues of living organisms and widely used in the tissue engineering and medicine fields due to its properties such as biocompatibility, biodegradability and tissue regeneration ability. Due to ethnical, regulatory and contamination reasons, collagen sources such as fish skin are being currently used and studied. Among them tilapia (*Oreochromis niloticus)* is a cheap and abundant potential source. Polyvinyl alcohol (PVA) is known by its multiple applications in tissue engineering. Mangosteen extract (*Garcinia mangostana L)* has antioxidant, anti–inflammatory, antibacterial properties offering a great array of applications in medicinal areas. The present study aims to obtain gels and scaffolds of collagen, PVA, ethanol and mangosteen extract for the tissue engineering area. Type I anionic collagen was extract from tilapia skin, and was characterized by FT–IR and SDS–PAGE, showing characteristic collagen bands and a $\alpha 1 \alpha 2$. To prepare the gels collagen (3%) was solubilized in lactic acid (0.5%) and the other components were added in proportion to the collagen dry mass, PVA (0 and 5%), extract (0 and 10%) ethanol (0 and 10%) and characterized by rheology. Scaffolds were made from the same gels by lyophilization and characterized by SEM. Rheology analysis show a pseudoplastic behavior and a lower viscosity at higher shear rates when ethanol or mangosteen were added. Oscillatory analysis determined the viscoelastic region and show a lower tan $\delta$ when extract was added, reinforcing the elastic behavior. Scaffolds photomicrographs show a reduced pore size with ethanol and mangosteen addition. DSC analysis show two denaturation temperatures for the treated tilapia skin, the first corresponding to triple–helix denaturation and the second one to the peptide chains break, and rheology temperature analysis showed a small increase in denaturation temperature when mangosteen was added. PVA addition did not interfere in morphological characteristics or rheological properties.
CAPES

**Keywords:** Collagen; Mangosteen; Biomaterial.


# PREPARATION AND CHARACTERIZATION OF POLYURETHANE/TIO$_2$ NANOCOMPOSITES

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Area: ( ) Food and Agriculture ( x ) Medical and Pharmaceutical ( ) Multifunctional Applications

**Abstract:** The research of new materials has always occupied a prominent position in the scientific environment. A noteworthy area of research is the application of materials for medical and biological purposes. Such materials are called biomaterials. There are studies on biomaterials composites that aim to combine properties of several materials into one. Following this concept, in this work, we synthesized a composite with the combination of polyurethane of vegetal origin (PU) and nanoparticles of titanium oxide ($TiO_2$) for use in bone implants. The synthesis of PU and $TiO_2$ specimens was performed by adding 0%, 25% and 50% $TiO_2$ (by weight) to a certain amount of vegetable polyol. The mixture was allowed to stir until it reached its complete homogeneity. To this mixture, we added diisocyanate in the ratio 1:1 to the polyol and the stirring system. The mixture was then placed in molds which were placed for 48hrs in a vacuum. The materials were characterized using Thermo–Gravimetric Analysis (TGA), Scanning Electron Microscopy (SEM) and Mechanical Analysis (MA). TGA analyzes showed that the thermal resistance increased relative to the amount of added $TiO_2$. SEM images showed that the doped samples formed some foci of $TiO_2$ agglomeration. These sites can be considered as fragility points of the mate–rial that were proved by the results of stress–strain tests. Materials doped with $TiO_2$ presented lower tension values for the same deformation when compared to the pure material by increasing the load/load interaction and not the PU/load interaction, thus making the material very fragile. Based on the results, we concluded that the biomaterials analyzed presented superior thermal properties and inferior mechanical properties compared to the pure polymer.

**Keywords:** Biomaterials; Polyurethane; Titanium Oxide.


# POMEGRANATE PEEL EXTRACT CROSSLINKING EFFECT ON COLLAGEN SCAFFOLDS

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**Abstract:** Collagen is the most abundant protein of the extracellular matrix and is used as a component of scaffolds. For the preparation of collagen the use of pepsin removes the telopeptides, leading to a slower fibrillogenesis and generating collagen micro and nanofibrils. Furthermore, mechanical and thermal stability can be enhanced with the addition of crosslinking agents. Pomegranate peel extract contains vegetal polyphenols capable of interacting with amino acids and also has some antioxidant and antibacterial activities. The aim of this study was to study the crosslinking effect of pomegranate peel extract on collagen. Bovine tendon was used to prepare pepsinized collagen (7.5% in pepsin mass). Gels were prepared in acetic acid pH 4.2 (0.5% collagen). Extract was added to one gel (1.3 mg extract/g gel). From the gels, scaffolds and thin films were prepared. The materials were named C0E and C13E, for collagen without and with extract respectively. Scanning electron microscopy (SEM), differential scanning calorimetry (DSC), ***in vitro*** biological stability tests using collagenase and FTIR were used to study the effect of extract addition. The addition of extract generated matrices with higher denaturation temperature (Td), being 47.3°C (C0E) and 50.1°C (C13E). Biological stability increased with extract addition since C0E had a degradation of 70.5%, while C13E was only 37.1%. The increase in both thermal and biological stability is an indicative of the interaction between the hydroxyl groups of the pomegranate peel extract and the amino acid chains of the collagen. Besides that, the SEM showed that the matrices had porous surface with irregular pore sizes. Extract addition increased pore size and irregularity. FTIR spectra showed an enlargement in the O–H stretch bands, which represents the extract incorporation. Thus, it was possible to conclude that the extract acted as a crosslinking agent, improving the collagen stability. FAPESP

**Keywords:** Collagen; Pepsin; Pomegranate Peel Extract.


# CONFECTION AND PHYSICAL–CHEMICAL CHARACTERIAZATION OF HYDROGELS BASED ON BACTERIAL CELLULOSE CONTAINING EPP–AF®

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Area: (x ) Food and Agriculture ( ) Medical and Pharmaceutical ( ) Multifunctional Applications

**Abstract:** Exposure of ultravioleta (UV) rays to the skin can cause severe damage to the skin's structure, such as burns and even lead to the development of cancer. It is known that bacterial cellulose (BC), a natural polymer extremely pure and biocompatible, acts as a barrier against UV rays from the sun. For its advantages, it is already marketed in the form of wound dressing and as cosmetics masks. Propolis, in turn, is a resin produced by bees from pollen and plant residues, which has excellent biological activities, such as antimicrobial, antioxidant, anti–inflammatory, besides presenting an important role in protection against UV rays. For these reasons, it was thought to aggregate the properties of BC and propolis throught the production of a hydrogel with the function of sunscreen. Therefore, the BC membranes were grinded resulting in a pulp containing cellulose particles and, under mechanical shaking, emulsifiers and surfactants were added to it and also the standardized propolis extract obtained from the company Apis Flora (EPP–AF, from Portuguese "Extrato Padronizado de Própolis da Apis Flora"), creating the hydrogels. They were characterized by Fourier–Transform Infrared Spectroscopy (FTIR), Thermogravimetric Analysis (TGA) and Differential Scanning Calorimetry (DSC). Through the bands generated by FTIR, it was possible to observe characteristic vibrations of both BC and propolis, thus confirming the formation of the composite BC/propolis. Thermal Analysis shows that the BC/propolis hydrogel remained thermally stable, with thermal behavior similar to the pure BC. These informations prove the viability in the production of hydrogels of BC containing propolis, which present potential photoprotective action, but that still need to undergo tests to validate this activity.


# BIOPOLYMERIC SYSTEMS BASED ON ALGINATE AND CELLULOSE NANOFIBER AS POTENTIAL PLATFORM FOR DRUG DELIVERY

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Area: ( ) Food and Agriculture ( X ) Medical and Pharmaceutical ( ) Multifunctional Applications

**Abstract:** Recently, polymers from natural origin had been applied in several innovative technologies from alimentary to pharmaceutical uses due to its biodegradability, biocompatibility, renewability and sustainable nature. Cellulose is the most abundant biopolymer on earth, therefore a great example of this class of material. This polymer is present in various natural sources like wood, cotton and vegetable biomass and for mechanical disintegration of its fiber is possible to obtained cellulose nanofiber (CNF). Besides the biological properties mentioned, CNF exhibit low density, excellent mechanical and barrier properties. When associate with other polymers in drug delivery systems (DDS), CNF had shown improvement in encapsulation efficiency and promising sustained release profile of the drugs. Regarding this application, alginate (ALG) based biocomposites are widely applied in DDS due to its non–toxicity, biodegradability, biocompatibility and unique gel–forming characteristics. Nevertheless, macroporous structure, poor mechanical and weak water resistance properties results in low retention efficiency and sudden release of drugs. Thus, the present study aims to investigate the effect of CNF in alginate matrix for future drug delivery applications. For this purpose, alginate 2% (w/v) was processed as beads by dropping its dispersion in $CaCl_2$ 5% (w/v) crosslinking solution. To obtain ALG–CNF systems, different amounts of CNF were incorporated in alginate dispersion, resulting in final materials with CNF ratios of 0.25, 0.50, 0.75 and 1.0%. The beads were freeze dried for 24 h and then their surface groups and thermal behavior were investigated by FT–IR and TG–DSC techniques. In the FT–IR spectra, some differences were observed after CNF addition into alginate matrix. An increase of intensity related to –O–H bond were noticed, especially in ALG–CNF 0,25%, suggesting hydrogen bonding interactions between ALG and CNF. Regarding to TG–DSC analysis, ALG–NFC systems exhibited a much more complex degradation process than pristine polymers, which can also suggest interactions between ALG and NFC.

**Keywords:** Alginate; Nanofiber Cellulose; Biomedical Applications.


## OKARA AND OKARA FLOUR AS SOURCE OF FIBER IN FOOD PROCESSING

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Area: (X) Food and Agriculture ( ) Medical and Pharmaceutical ( ) Multifunctional Applications

**Abstract:** Introduction: The processing of the soybean water extract produces, as a by–product, okara, an inert mass of high nutritional value. In order to evaluate the potential of the by–product as a source of fiber in food formulations, okara and its flour were characterized in relation to dietary fiber content. Food fiber consists of carbohydrate polymers that are not hydrolyzed by the endogenous enzymes in the small intestine.
Methodology: Drying of forced air circulation, followed by grinding and sieving to obtain okara flour and enzymatic–gravimetric method for the determination of total, soluble and insoluble dietary fiber samples. Results: Okara in natura presented values of 3.66% of insoluble dietary fiber and 0.04% of soluble fiber and okara flour had values of 16.58% and 0.17% for soluble and soluble dietary fibers, respectively. Discussion: Large quantities of Okara produced in Brazil are destined to feed animals and could be used to fight hunger. Researches were carried out using okara as a substitute ingredient in several foods as an alternative to reuse this product, in morning cereal, chicken burger, biscuits and breads. The fiber content of the soybean helps in the reduction of cholesterol and triglycerides, besides having mechanical activity in the formation of the fecal cake, property related to the insoluble fraction. Conclusion: The results suggest that the use of okara and flour are adequate as a source of fiber in the preparation of food and that the use of flour has advantages in relation to the use of okara in natura because it presents concentrated fiber contents. In addition, dehydration increases shelf life of the product, promotes volume reduction, facilitates storage and transportation, and enables storage at room temperature.

**Keywords**: Okara; Okara Flour; Dietary Fiber.


## EFFECT OF YEAST EXTRACT ON THE PROPERTIES OF SCHIZOPHYLLAN

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**Abstract**: Schizophyllan (SPG) is an extracellular polysaccharide produced by the basidiomycete ***Schizophyllum commune***. SPG is able to form a gel when aqueous solutions are cooled below 6 °C and SPG solutions show two highly cooperative conformational transitions on heating, one at 6 °C and the other at 135 °C. SPG shows antitumor and immunobiological activities. The aim of this study was to analyze the effect of the yeast extract on the composition of the final polysaccharide because it may contain water–soluble polysaccharides that interfere with the final analysis. Mycelia suspension was prepared by suspending mycelia discs from culture plates. Discs from culture plates was used to inoculate 200 mL sterile culture (0.2% de peptone, 2% de glucose, 0.05% de $MgSO_4.7H_2O$, 0.05% de $KH_2PO_4$ and 0.1% de $K_2HPO_4$) that was incubated at 30 °C and 100 rpm for 21 days in a shaker incubator. After 21 days, to increase the contact surface of the mycelium with medium, the broth was homogenized and a total of 10 mL of the mycelia suspension was added to 100 mL medium (18 g/L yeast extract, 10 g/L malt extract, 38 g/L glucose, 1 g/L $KH_2PO_4$, 1 g/L $K_2HPO_4$, 0.6 g/L $MgSO_4.7H_2O$ and 2 g/L $(NH_4)_2SO_4$). The culture was incubated at 30 °C, pH 6.5 in an incubator shaker at 150 rpm for 7 days. The culture broth was then filtered and reduced. After that, alcohol was added, and the culture broth was centrifuged. The SPG produced was characterized using Fourier transform infrared spectroscopy with attenuated total reflectance (FTIR/ATR), thermogravimetric (TGA) and Differential Scanning Calorimetry (DSC) analysis. Both spectra of SPG showed peaks that confirmed that the polysaccharide is schizophyllan. TGA analysis showed that the decomposition profile is similar. However, there are various stages of degradation that may suggest impurities in the medium.

**Keywords:** *Schizophyllum commune*; Schizophyllan; Biopolymer.


# CHARACTERIZATION AND CYTOTOXIC ACTIVITY OF THE CASHEW, ANGICO, LEMON AND SERIGUELA GUM

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**Abstract:** Polysaccharides are biopolymers of complex structures, which may be formed by one or more carbohydrate units. Structural characteristics and physicochemical properties that polysaccharides have, including water solubility, molecular weight, monomer composition, types of glycosidic bonds of the main chain and branching, may contribute to good biological activity. With this, the objective of this work is to analyze the influence of properties of cashew (CG), angico (AG), lemon (LG) and seriguela gum (SG) in front of its cytotoxic profile. The gum was isolated and characterized, where its composition of carbon, hydrogen and nitrogen was determined through elemental analysis besides determination of the surface charge of the gums, molar mass and composition of monosaccharide. The cytotoxic profile of gums by the method of 3–(4,5–dimethyl–2–thiazole)–2,5– diphenyl–2–H–tetrazolium bromide (MTT) salt against normal and cancerous lineage of cells. The polymers analyzed had relatively negative zeta profiles, a certain difference in the percentage of carbon, hydrogen and nitrogen, where the SG and LG gums had a higher percentage, concomitant to the molar mass. About the cytotoxic effect against cancer cell lines, CG and LG have been shown to be more effective for leukemic, melanoma and colorectal lines. When related to cytotoxicity in normal cells, CG presented lower values of inhibition. Demonstrating great for biomedical applications.

**Keywords:** Natural polymers; Antitumor activity; Biocompatibility.


## *IN VITRO* ANTITUMOR POTENTIAL OF QUATERNIZED ANGULARGUM

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**Abstract:** The angico gum (AG) obtained from the red angico exudate (Anadenanthera colubrina var. Cebil (Griseb) Altschul) shows heteropoly–saccharides composed of arabinose, galactose, rhamnose and glucuronic acid, exhibiting great potential for biotechnological applications. In this approach, the objective of the present work was to investigate the cytotoxic profile of the modified red angico gum with the CHPTAC etherifying agent. For this, the gum was isolated, quaternized (QAG) and characterized, where its composition of carbon, hydrogen and nitrogen was deter–mined through elemental analysis besides determination of the surface charge of the gums. The cytotoxic profile of AG and QAG by the method of 3–(4,5–dimethyl–2–thiazole)–2,5–diphenyl–2–H–tetrazolium bromide (MTT) salt against normal and cancerous lineage of cells. From the charac–terization data, it was possible to observe that the polymer that passed through the quaternization process presented an increase in the percentage of carbon, hydrogen and nitrogen, concomitant to the increase of the surface charge due to the inserted group. Both gums presented cytotoxicity to normal cells at concentrations higher than those that showed activity against tumor cell. Therefore, the results demonstrate that the QAG presented in this study is a very promising biomaterial for biotechnological applications.

**Keywords:** Angico red; cytotoxicity; biocompatible.


# SHELF LIFE, REOLOGY AND MORPHOLOGICAL CARACTERIZATION OF BACTERIAL CELLULOSE/ALGINATE HYDROGELS

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**Abstract:** The number of people affected by hard–to–heal wounds (chronic wounds) has been increasing in recent years, and the most affected group are the diabetics and hypertensives. One of the natural biomaterials used in the treatment of these wounds is the bacterial cellulose (BC), a product excreted by gram–negative bacteria, due to its properties such as biocompatibility, non–toxicity and the nanometric size of its fibers, which mimic natural collagen fibers, favoring the healing process. Alginate obtained from the extraction of brown algae is also a non–toxic and biocompat–ible material. When alginate is in contact with a wound, it causes an ion exchange between the sodium present in wound and the calcium from the alginate, forming a gel with exudative activities, aiding the electrolytic debridement. Due to the these biomaterials properties, bacterial–cellulose/al–ginate hydrogels were prepared. Their morphological structures were analyzed by Scanning Electron Microscopy (SEM). In addition, rheology assays has been performed in order to evaluate the viscosity as well as the scatterability of the hydrogels. Aiming the final product, the shelf life experiments are being carried out in order to evaluate the rheological behavior of the hydrogels.

**Keywords:** Bacterial Cellulose Hydrogel; Wound Healing; Shelf Life.


# PHYSICOCHEMICAL PROPERTIES OF PECTIN AND KONJAC GLUCOMANNAN FILMS ADDED WITH SUGARCANE VINASSE

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**Abstract:** The use of plastics in agriculture allowed significant improvements on productivity and quality. However, environmental concerns about the excessive use and disposal of synthetic polymers have boosted the interest for biodegradable polymers to produce alternative materials. Biodegradable materials can be integrated directly into the soil where are converted by microorganisms into carbon dioxide or methane, water, mineral and biomass, with no negative environmental impact or ecotoxicity. Vinasse, the main wastewater from ethanol industry, is rich in nutrients and usually applied in sugarcane crops through fertigation. However, its use is limited to the areas near the processing units and when indiscriminately applied can lead to soil salinization and groundwater contamination. The present study proposes the use of vinasse as the solvent for pectin (PEC) and konjac glucomannan (KGM) composite films. Vinasse had its pH lowered and then biopolymers were added in different proportions of PEC:KGM (100:0, 75:25, 50:50, 25:75 and 0:100). The solutions were casted into molds and dried at 40°C/18h. After drying, films were crosslinked by immersion in ethanolic 2% calcium chloride solution for 30 min. Films were characterized by their thickness, moisture content, water vapor permeability (WVP) and mechanical properties. All films were homogeneous and easy to handle. Non crosslinked films were completely water soluble and shower higher WVP and elongation compared to calcium crosslinked films. Moisture content, WVP and elongation decreased by increasing pectin concentration. Pectin/KGM films added with vinasse exhibit suitable functional attributes with good perspectives for agriculture applications.

**Keywords:** Pectin; Konjac Glucomannan; Vinasse.


## CHARACTERIZATION OF CHITOSAN PARTICLES ADDED WITH VINASSE INTENDED FOR SOIL FERTILIZATION

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**Abstract:** Technologies aiming to control or hinder the release of nutrients from fertilizers have been studied in order to improve agricultural systems efficiency with minimum environmental impact. In this context, biopolymers, such as chitosan, can be used to develop slow/controlled release systems with a focus on agriculture. Sugarcane vinasse is the wastewater from ethanol industry (about 12 L per liter ethanol) being mainly applied as fertigation in sugarcane crops. However, this disposal practice has been questioned due to potential effects on the soil and on groundwaters caused by nutrient lixiviation such as potassium. So, the use of vinasse as a solvent to produce chitosan particles was proposed. This study evaluated the properties of chitosan and vinasse particles (Chi–V) intended for soil fertilization applications. Particles were obtained by dripping the biopolymeric solution (3% in vinasse) into a crosslinking solution (sodium tripolyphosphate 5%) followed by drying. Chi–V particles were characterized according to average diameter, bulk density, pH, moisture content, water solubility, swelling degree, chemical composition and morphology. Results indicate that vinasse nutrients were properly incorporated into the chitosan matrix. Particles showed spherical shape with an average diameter of 2 mm, bulk density of 846 kg $m^{-3}$, pH 5.8, 13% moisture content, 46% water solubility and equilibrium swelling degree of 8 g $H_2O$/g. According to the Brazilian legislation Chi–V particles could be classified as organomineral fertilizer class A, added with Ca, S, Cu, Fe, Mn and Zn. Particles showed potential to be applied as fertilizer in agriculture, allowing the recycling of nutrients from vinasse to the soil and, above all, represent a novel alternative for the use of this expressive wastewater from the sugar and alcohol industry.

**Keywords:** Chitosan; Vinasse; Slow Release Fertilizer.


# SURFACE CHARGE OF COLLOIDAL SOLUTIONS OF GELATIN AND/OR CHITOSAN AT DIFFERENT PH

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**Abstract:** In recent years there has been an increase in research using natural polymers due to their peculiar properties that make them suitable for the most diverse applications, extending from the food to the pharmaceutical industry. In this study, characterization and rheological properties of pure components and blend of two biopolymers at different pH were investigated. The solutions were prepared separately, first pig gelatin type A (4%) was hydrated for 30 minutes and then was stirred for 30 minutes at 55 ° C in a thermostatic bath. Chitosan (2%) was diluted with acetic acid (2%) and kept under stirring for 12 hours at 40 ° C using a magnetic stirrer. Then, the solutions with 50:50 ratios were mixed for 2 hours at 50 ° C with constant stirred. The pH was adjusted (3,5 until 6,0) with 0.05M NaOH or 0.05M of acetic acid for further rheological analysis in steady state and dynamic tests (strain, frequency and temperature using a rheometer (AR2000 Advanced Rheometer; TA Instruments, New Castle, DE, EUA)). The determination of zeta potential NanoBrook Zeta Plus Zeta Potential Analyzer, BTI, USA) was done with pure solutions and blends separately, pH was adjusted aft er diluting solutions in the ratio of 1:10. The results indicated that for 4% of pure gelatin solution, zeta potential showed a decreasing of positive charges, the isoelectric point was 9.0; for pure chitosan (2%) two peaks of positive charges were obtained due to its cationic nature, showing some instability, and for the blend negative charges were close to 50. Due to the work being in its initial phase there are still many results that will come later.

**Keywords:** Biopolymers; Isoelectric Point; Zeta Potential.


# DEVELOPMENT AND CHARACTERIZATION OF FILMS BASED ON CELLULOSE NANOFIBERS AND QUATERNIZED ANGICO GUM FOR BIOLOGICAL APPLICATION

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**Abstract:** Several studies have been carried out on materials that can replace the existing dressings in the market, for example, some biopolymers, such as chitosan, gelatine, collagen and bacterial cellulose, which have excellent biological properties for tissue regeneration. The chemical modifications in the structure of the polysaccharides, such as quaternization, involve the introduction of functional groups allowing the production of new biomaterials with new properties and applications. The objective of this work is the development of a new product for the development of films functionalized with bacterial cellulose nanofibers (BC) and quaternized angico gum (QAG) for future biological applications. The films were produced following the casting technique, which has the principle of evaporation of the solvent, using the biopolymers. The films were characterized by: Infrared absorption spectroscopy with Fourier transform (FTIR), thickness, measured with MED25 digital external micrometer and atomic force microscopy (AFM). Of the films developed, two were chosen to be functionalized with BC and QAG, both with polymer matrix composed of agar to 3% and 1% respectively. The thickness of the developed films presented a variation of 0.0225 mm to 1.2 mm, being characterized as ultrafine films. For the FTIR, the spectra of the films presented some of the main characteristic bands of BC and QAG, with some displacements and changes of intensity, evidencing that there was chemical modification in the polymer. In the analysis of the films by AFM, the BC presents a greater roughness compared to QAG and the characteristic nanofibers of BC are very evident. In addition, the QAG film was more homogeneous and with less irregularities. It was concluded that the developed films have potential for the application as new biomaterial, for example, possible substitute for traditional dressing and further studies will be done to test the antibacterial activity of film with QAG.

**Keywords:** Biopolymers; Quaternization; Biomaterials.


# PHYSICOCHEMICAL PROPERTIES OF BILAYER FILMS BASED ON GELATIN WITH NATAMYCIN

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**Abstract:** Traditionally, packaging had a passive role. Nowadays, packaging can have an active role protecting foods and contributing to the reduction of synthetic additives added into foodstuff, with active agents are into packaging material, such as biopolymer–based films, incorporated with natural antimicrobials. The aim of this project was the development of antimicrobial double layer films, loaded with natamycin, and the evaluation of their physicochemical properties. To produce these films, gelatin was hydrated for 30 min at room temperature and solubilized in thermostatic bath (60 °C/15 min). Glycerol was used as plasticizer, at a concentration of 30 g/100g of gelatin, and the natamycin was added at the concentration of 0 and 0.5 g/g of gelatin. The film–forming solution was poured in a plate and dried in a forced–air circulation oven at 30 °C/24 h. The first layer of film was composed only by gelatin and glycerol, while the second one, a little thinner, was composed by gelatin, glycerol and natamycin. Both layers were produced by casting, and after being dried, films were conditioned into desiccators containing saturated solutions of NaBr (RH = 58% at 25 °C) for seven days. Films were characterized for moisture content and solubility, optical and mechanical properties, water vapor permeability (WVP), and water contact angle (WCA). The addition of natamycin did not affect the moisture of the films, remaining around 14%, but increased the film solubility from 38 to 46%. Regarding the mechanical properties, the natamycin increased the tensile strength and Young's modulus, and significantly decreased the elongation. Still, the natamycin also had high influence on the optical parameters, decreasing the values of $\Delta E^*$ and film opacity. Natamycin also increased, although not significantly, the WVP of the films, and decreased the values of WCA. The addition of natamycin can promote an antimicrobial activity to films, without affect their main physical properties.

**Keywords:** Natural Compounds; Moulds; Active Films; Physicochemical Properties.


# TRATMENT AND MANAGEMENT OF PRESSURE LESION WITH BIOCURATIVES OS BIOCELLULOSE CONTAINING PROPOLIS EXTRACT EEP–AF

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**Abstract:** Hospital–acquired Pressure Injuries (HAPI) develops by compressing soft tissue to rigid surface such as bone prominence. These are classified into four stages ranging from intact skin with dermal discoloration to necrotic tissue that may expose subepithelial muscles and structures. Care for the treatment of this lesion includes necrotic tissue debridement and dressing with Silver sulfadiazine 1% or other formulas, such as: 10% sulfanamide acetate and 02% nitrofurazone and 0.1% Gentamicin creams, among others. However, these treatments have adverse reactions, such as: leucopenia, allergic processes due to the oxidation of the components, and discomfort for the patient, who need to have their dressings changed daily, which makes the healing process slow and painful. In order to improve the treatment and management of HAPI, the evaluation will be quantitative in character descriptive, using the bacterial cellulose membrane containing propolis in the treatment and management of these lesions, evaluating the cicatricial process, using as a method of evaluation of effectiveness of membrane use or ImageJ software (version 1.48v). The research site will be the Santa Lydia Hospital located in the city of Ribeirão Preto, São Paulo and the subjects of the research will be the patients of the institution that accept to participate in the research signing the Term of Free and Clarified Compromise. The project is being evaluated by the Research Ethics Committee of the University Center Estácio of Ribeirão Preto. The membrane of biocellulose containing EEP propolis extract will be supplied by the company APIS FLORALTDA. It is intended to obtain a sample of 30 LPP patients in stage one and two, according to the National Pressure Ulcer Advisory Panel (NPUAP),objectifying with a positive evolution of the cicatricial process with reduced healing time compared to the therapeutic measures already implemented in the health services.

**Keywords**: Pressure lesions; Membrane; Propolis; Bacteral cellulose membrane.


# NATURAL LATEX MADE WITH SILVER SULPHADIAZINE FOR THE TREATMENT OF BURNS

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**Abstract:** Every year millions of people are treated by burns, with children and low–income people being the most affected. As burns achieve the first protective barrier of the human body, the epidermis, they increase the risk of infection and the number of fatal victims. The use of antibiotics assists in the fight against infection, but not in tissue healing, making the patient's organism susceptible to microorganisms. The objective of this study is to associate the cicatricial and angiogenic characteristics of natural latex with silver sulfadiazine (SFZ), an antibiotic commonly used in the treatment of burns. The adhesives were molded by mixing 4 mL of natural latex with 4 mL of SFZ solution (1 mg / mL) to complete polymerization. The material was characterized by using MEV, FTIR, mechanical resistance and the antibiotic release through the polymeric matrix was monitored by spectrophotometer (UV–Vis) at $\lambda$ = 241nm for 196 hours. Through the FTIR technique, it was possible to observe that the incorporation of SFZ in the latex did not present the appearance of new bands or covalent bonds, which would result in the entrapment of the drug or the appearance of toxic compounds. By using MEV, it was observed that the drug was uniformly distributed in the membrane. The strain–strain tests showed that there was an increase of 22% in the maximum deformation of the material after the incorporation of SFZ and an increase in the elasticity of the material. Optical spectroscopy revealed that 23.7% of the sulfadiazine was released by the latex membrane in 196 hours, where the kinetics followed a biexponential equation, with a faster release in 24 hours, in which 18.8% of the antibiotic was released. The latex membrane incorporated into silver sulfadiazine has shown to be a good release matrix and it can be used in places of great body movement.

**Keywords:** Natural Rubber Latex; Silver sulfadiazine; Burn.


# GELAN GUM MICROPARTICLES REINFORCED WITH VEGETAL CELLULOSE NANOFIBERS AS A DRUG DELIVERY STRATEGY

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**Abstract:** Microparticles are multiparticulate systems of size between 1 and 1000 μm and defined shape that have been used successfully in the design of controlled drug release systems Such systems are advantageous over conventional release systems, since they allow temporal and/or spatial release control, effectively contributing to the increase of the therapeutic effect and reduction of side and toxic effects. The physico–chemical, structural, thermal, mechanical and control properties of microparticle release can also be optimized through reinforcement using cellulose nanofibers, which have unique properties such as high mechanical strength and stiffness. Morin is a flavonoids that has been identified in a large number of medicinal herbs, is well known for its highly potent anti–hyperuricemic, anti–inflammatory and anti–cancer activities, In view of the above, the objective of this work was to obtain and characterize gellan gum microparticles by the ionotropic gelation method and to evaluate the effect of reinforcement with cellulose nanofibers on the fundamental properties and performance of the microparticles in the encapsulation and release of morin. Partial results: Scanning Electron Microscopy, revealed that the microparticles have roughly spherical structure and rough surface. The increased addition of NFC showed a significant reduction of the particle diameter in relation to the control sample, for the introduction of 3 and 5% NFC, respectively. On the other hand, the same behavior was not observed for the highest concentration of 7%, which presented a similar size to the control sample. The swelling results of the microparticles were analyzed at different concentrations of NFC. Sample control,swelling of 25% and 90% after 2 min and 90 min of assay. In the sample containing 3% NFC, swelling of 24% and 55% was observed after 2 min and 60 min. A distinct behavior was observed in the other samples. In those with 5% NFC they suffered a swelling of 85 and 88% after 60and 90 min, contributing to the increase of their speed of absorption. This behavior can be corroborated by the liquid absorption profile of the microparticles containing the highest NFC load (7%), which reached 110% swelling in 90 min.

**Keywords:** Microparticles; Gellan Gum; Cellulose Nanofibers; Controlled Drug Release Systems; Morin.


# FABRICATION, CHARACTERIZATION AND IN VITRO CELL STUDY OF SCAFFOLDS OBTAINED FROM NATURAL POLYMERS FOR SOFT TISSUE ENGINEERING

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**Abstract:** Over the past two decades, numerous biomaterials, including polymers, ceramics, and metals have been actively investigated for tissue engineering (TE) applications. TE aims to create medical devices that can repair or regenerate tissues impaired by disease or injury, those structures are typically fabricated by seeding scaffolds with cells. Scaffolds provide the necessary support as artificial extracellular matrices to serving as tem–plates in guiding the development of new tissue. Gelatin (G), a soluble protein obtained by hydrolysis of collagen, it´s suitable as a biomaterial for TE, has low cost, adequate biocompatibility and biodegradability. This protein can be blended with Chitosan (CH) to improve its biological activity since it contains an Arg–Gly–Asp (RGD)–like sequence, which promotes cell adhesion, migration, and forms a polyelectrolyte complex. In this study we have chosen G and CH, incorporated with bioactive components of natural origin like Aloe vera (A) and snail mucus (S). For production of porous scaffolds, first, scaffold forming suspensions (SFS) of (G) 2% w/w and (CH) 1% w/w were prepared separately with constant stirred for 2 h at 50°C in thermostatic bath, then were mixed with 50:50 ratio. Later (A), (S) and both (A+S) were added at 0.15% w/w. SFS were frozen at –80°C for 2 h, prior to freeze–drying at –58°C for 18h. The resulting sponge–like material was crosslinked and freeze–dried again. Fibroblasts and mesenchymal stem cells were used to study the adhesion capacity to scaffolds and morphological changes during 28 days of incubation. Scaffolds showed to be a highly porous sponge displaying interconnected porosity and homogeneous pore diameters, as well as pore wall thickness. Important microstructural changes were observed in the scaffolds as a function of additives. SEM revealed that the cells appeared to attach and spread well in all scaffolds, forming multiple protrusions and cellular aggregates that gradually increased in size.

**Keywords:** Scaffolds; biomedical applications; mesenchymal stem cells.

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# CHARACTERIZATION OF THE BIODEGRADABILITY OF PLASTICS USING *GALLERIA MELLONELLA* LARVAE

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Area: ( ) Food and Agriculture ( ) Medical and Pharmaceutical (x) Multifunctional Applications

**Abstract:** The intense consumption of plastic materials, characterized by its high durability, summed up to the fast and undue waste, results in the accumulation of debris and consequently a pollution that has reached the most remote areas of the planet. In 2017, however, it was observed that moth larvae of *Galleria mellonella* are able to digest polyethylene (PE), a type of plastic produced by the chemical industry, turning it into ethylene glycol, which can be used in the automotive industry. Given that Brazil is considered the fourth largest producer of plastic waste in the world and one of the countries that recycles the least, the ability of *G. mellonella* larvae to biodegrade materials made from various types of plastics such as PE and polystyrene (PS) proves to be extremely important, justifying the urgency of its study. Thus, the present proposal aims to evaluate the biodegradability of these larvae in bags, trays and bottles, analyzing the loss of mass, wettability and composition of the material, before and after contact with the animals. To perform the experiment, each group of larvae composed by ten subjects was placed in contact with approximately 2g of a type of plastic, which were: high density polyethylene (HDPE), low density polyethylene (LDPE) and PS. After two weeks, loss of mass was observed for LDPE and PS, while larvae did not appear to interact with HDPE. In this way, it can be observed that the density of the material is directly related to its biodegradability.

**Keywords:** *Galleria Mellonella;* Biodegradation; Plastics.


# PRODUCTION OF BIOFILMS FROM KALE PUREE AND SODIUM ALGINATE FOR USE AS WRAPS

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**Abstract:** The objective of this work was to produce edible films based on kale *(Brassica oleracea L. var. Acephala)* and sodium alginate that have satisfactory properties and market potential. The kale leaves were sanitized and blanched. A puree was made from kale and water for incorporation into sodium alginate and glycerol (plasticizer), and the mixture was homogenized in mechanical stirrer for 3 hours at 1000 rpm, degassed for 20 minutes in vacuum pump, cast on Mylar substrates, and left to dry at 25 ° C for 30h forming the non–crosslinked film. After drying, the film was immersed still attached to the Mylar surface and soaked on a 2% calcium chloride solution, used as a crosslinking agent, and the film was dried again at 25 ° C for 2h, forming the crosslinked film. The films have been analyzed for: thickness, swelling in water and contact angle. While the non–crosslinked film completely solubilized after 5 minutes in water, releasing pigments to the water, the crosslinked film got low degree of swelling in water (<50% of the initial mass). The crosslinked films presented a reduction in the water absorption and increase the contact angle in relation to the water, indicating a significant decrease in the hydrophilic nature of the films. The absorption time found for the crosslinked film treated samples was 1 min and the contact angle were 63°. The results showed that the developed films present characteristics similar to fresh kale as characteristic color and thickness, in addition to presenting hydrophobic properties, making them interesting for applications in the food sector.

**Keywords:** Films; Kale puree; *Brassica oleracea L*; var. *acephala.*

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# DEVELOPMENT OF LATEX MEMBRANE WITH *ALOE VERA* GEL EXTRACT AS AN ADDITIONAL PSORIASIS TREATMENT

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**Abstract:** *Aloe vera* brings in its composition active principles that have healing properties and its application for the treatment of dermal wounds is excellent. In view of this, this work aims to develop latex membranes with *Aloe vera* gel extract, for complementary treatment to psoriasis, a disease that affects 2–5% of the world population, causing injuries to the patient's skin and compromising his emotional stability, professional life and social. Latex from *Hevea brasiliensis* was processed and centrifuged. The *Aloe vera* gel extract was withdrawn from the in natura leaves of the plant, centrifuged at 2000 rpm for 15 minutes, the supernatant was discarded and the pellet lyophilized. In Petri dishes, 4 ml of latex and 2 ml of the aqueous solution containing the lyophilized gel (10 mg/mL) were added. The chemical interaction between gel and natural latex was evaluated by a Fourier transform infrared spectrometer (FTIR, Bruker Tensor 27) with an attenuated total reflectance (ATR) accessory. The liberation of the vegetal extract was evaluated for 96 hours in 50 mL of water and quantified from the spectrofluorescence, λem = 528 nm. With the FTIR technique it was possible to observe that there was no molecular interaction, demonstrating that the pharmacological properties of the extract were preserved. In the release kinetics there was release for 72 hours, showing that the membrane can be changed every 3 days. Approximately 85% of the total extract was released, and in only 24 hours it had been released 40%, confirming the effect of burst release, where the extract present on the membrane surfaces are released faster in the first hours and slower release. The total concentration released is satisfactory because it already induces healing activities. It is concluded that the bioproduct may have a great potential for complementary treatment of psoriasis.

**Keywords:** Natural Rubber Latex; Psoriasis; *Aloe vera*.


# INFLUENCE OF POWDERED CAMU–CAMU (*Myrciaria dubia*) BY– PRODUCT IN STARCH–BASED FILMS

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**Abstract:** Processing of camu–camu generates a large volume of by–products, which can be used for active films development. The aim of this work was the development of films with antioxidant activity based on starch and camu–camu by–product (CCBP). Initially, by–product was dried (70°C/5 h), ground and granulometry was standardized (100 mesh). Films were prepared by tape–casting technique with sorbitol (40 g/100g starch) and pre–gelatinized starch (5 g/100 g solution). The CCBP was incorporated into the concentrations of 0 (control film), 1 (CC1) and 2 (CC2) g CCBP/100 g of filmogenic solution). The films were characterized in relation to: water solubility, contact angle, mechanical properties and antioxidant activity (was measured by ORAC). The water solubility was not affected by the addition of CCBP. The contact angle increased from 63 ± 9° (control film) to 84 ± 8° (CC1) and 85 ± 3° (CC2), indicating films with hydrophobic surfaces. Tensile strength increased from 8.4 ± 0.6 MPa (control films) to 12.7 ± 1.2 MPa (CC1) and 15.3 ±1.5 MPa (CC2). Young's modulus increased from 347.1 ± 36.5 MPa (control film) to 639 ± 51 MPa (CC1) and 861.2 ± 67.5 MPa (CC2), while elongation at break decreased. CCBP addition acted as reinforcing agent of the starch film, increasing its resistance. The films with CCBP incorporation presented antioxidant activity, it was observed an increase from 0.47 ± 0.22 (control film) to 50.27 ± 7.02 (CC1) and 68.63 ± 5.40 (CC2) µMol Trolox Equivalent/g of dry matter. Thus, the addition of CCBP improved mechanical properties of the starch–based films, besides promoted antioxidant activity. These films have potential to be used as active films for food packaging.

**Keywords:** Active films; waste; antioxidant activity.


# EFFECT OF DIFFERENT RELATIVE HUMIDITY CONDITIONS ON DRYING PROCESS OF GELATIN FILMS PLASTICIZED WITH TRIBUTYL CITRATE

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**Abstact:** A limiting problem in biodegradable films based on natural macromolecules is their susceptibility to ambient humidity, since both, macromolecules and plasticizers, normally used in these materials production are hydrophilic. The aim of this study was to produce biodegradable gelatin–based film using hydrophobic tributyl citrate plasticizer (TBC) and evaluate the drying conditions effect (T=30°C and RH=45, 60 75%) on its properties. Films were produced by casting technique using 2g gelatin/100g of film–forming solution (FFS), 50g TBC/100g gelatin, 60g lecithin/100g plasticizer and 20g ethanol/100g FFS. Films were dried for 24 hours at 30°C and 45, 60 and 75% RH, using a climatic chamber with temperature and humidity control. Films were conditioned in desiccators with NaBr (58% RH) for 7 days and submitted to the following characterizations: mechanical properties, moisture content and solubility. The increase of drying relative humidity caused a decrease in films moisture content, from 10.9±0.2 to 9.3±0.6 g$H_2O$/100g FFS, being the drying time for the films of 8 hours for 45% of relative humidity (RH), 10 hours for 60% RH and 12 hours for 75% RH. There was no significant difference in films solubility (8.5g/100g FFS). For mechanical properties, the increase of drying relative humidity caused a decrease in tensile strength (from 44.9±4.1 MPa to 40.8±2.8 MPa) and Young's modulus (from 1359±115 MPa to 1208±83MPa), and did not provide significant differences in elongation (7.9±1.3%).Thus, although the use of different relative humidity in drying process of films caused some differences, it is possible to affirm that they have a reduced impact on its properties, forming concise films and with possibility of application as packaging in food industry.

**Keywords:** Hydrophobic Plasticizer; Drying Conditions; Mechanical Properties.


# EFFICACY OF HEALING IN DIABETIC FOOT ULCERS USING NATURAL RUBBER LATEX MEMBRANE

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**Abstract:** Cutaneous ulcers are those that compromise the integrity of the tissue regardless of its extent, reaching the subcutaneous region and underlying tissues. Several factors and diseases can influence the healing process leading to chronic wonds, such as Diabetes Mellitus, leading to diabetic foot ulcers. These chronic injuries require a high financial investment and are difficult to heal. Natural rubber latex is widely used in biological applications because of its good mechanical strength, flexibility and elasticity. It also has angiogenic capacity, which accelerates the healing process. The aim of this study was to evaluate the efficiency of the treatment of diabetic foot ulcers using the natural rubber latex membrane. We selected 10 participants with diabetic foot ulcer to compose the study. The natural rubber latex membrane was made by the casting method with a final thickness of 1millimeter. Of the 10 participants selected, only 8 followed with treatment. The wounds ranged from 45 days to 20 years of existence and were completely reepithelialized in 75% of the participants, with the shortest treatment time being 9 days and the longest treatment time was 139 days. The shorter the duration of the lesion, the faster the healing. The same applies with respect to its extent. The dressing was efficient in the healing process, with angiogenic properties, debridement capacity and consequently, the appearance of the granulation tissue, aiding and effecting the chronic wound healing.

**Keywords:** Natural Rubber Latex; Membrane; Diabetic Foot Ulcers.


# MORPHOLOGICAL CHARACTERIZATION OF HYALURONIC ACIDS AND THEIR CLINICAL INDICATIONS

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**Abstract:** The versatility of Hyaluronic Acid (HA) as a skin filler makes it a product with diverse characteristics depending on the manufacturer, type of crosslinking, and product concentration. These differences are important in clinical practice because they will determine the correct indication of each product, its local stability, and its durability. The objective of this study was to compare the superficial and internal morphology of lyophilized samples from four different commercial HA presentations, associating their characteristics with the perfect clinical indication. Rennova Ultra® 24 mg / mL (1), Rennova® Ultra® 20 mg / mL (2), Rennova Deep® 20 mg / mL (3) and Rennova Ultra® Deep® 20 mg / mL (4) were freeze–dried at –80 ° C for 2 days and subsequently lyophilized for 2 days using L101 equipment (Liotop, São Carlos – Brazil). Samples were fixed in stubs and metalized with carbon for SEM analysis. Photomicrographs with magnification of 40X, 100X and 500X and 1,500X were obtained using the FEG–MEV scanning electron microscope JSM–7500F (Jeol Ltda, Tokyo – Japan) from the Advanced Microscopy Laboratory (LMA) of the Chemistry Institute of Araraquara – UNESP. Gel 1 presented pores or chambers with larger diameter compared to the other gels, thus showing a looser structure and with less capacity to withstand tensions. The second showed a slightly dense structure compared to 1. The more homogeneous structure was presented in gels 3 and 4, which suggests a higher crosslinking rate indicating greater collectivity, as well as dermal volumizing capacity, supporting higher tensions. It is ob–served that, due to their morphological characteristics, gels 2, 3 and 4 are more suitable to correct greater loss of volume while gel 1 is more suitable for surface filling, since it has a structure with more pores and consequently supports less stress your clinical indication may be the lip contour and small loss of collagen.

**Keywords:** Hyaluronic acid; SEM; reticulation


# PRODUCTION OF NANO/MICROFIBERS OF NATURAL RUBBER CONTAINING REDUCED GRAPHENE OXIDE BY ELECTRO–SPINNING

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**ABSTRACT:** THE ELECTROSPINNING SYSTEM IS CAPABLE OF PRODUCING NANO/MICRO POLYMER FIBERS WITH INTERESTING FEATURES THAT CAN BE APPLIED TO SENSORS, CONTROLLED RELEASE AND TISSUE ENGINEERING. SEVERAL POLYMERS CAN BE USED FOR SUCH APPLICATIONS, BUT NATURAL RUBBER OBTAINED FROM LATEX EXTRACTED FROM THE RUBBER TREE *HEVEA BRASILIENSIS* IS OF LARGE INTEREST FOR THE PREPARATION OF BIOMATERIALS DUE TO ITS MECHANICAL PROPERTIES, STIMULUS TO ANGIOGENESIS, AND THE POTENTIAL APPLICABILITY AS A VEHICLE FOR DRUG RELEASE. IN ADDITION TO ITS EXCELLENT PROPERTIES, LATEX ALLOWS FOR THE POSSIBILITY OF ***IN–SITU*** REACTIONS SUCH AS THE REDUCTION OF GRAPHENE OXIDE. REDUCED GRAPHENE OXIDE (RGO) HAS NUMEROUS PROPERTIES THAT CAN BE ADDED TO NATURAL RUBBER AS THE IMPROVEMENT IN ELECTRICAL, THERMAL AND MECHANICAL PROPERTIES, ALLOWING THE USE OF THIS NATURAL POLYMER IN SENSORS. GRAPHENE OXIDE WAS REDUCED ***IN–SITU*** IN THE LATEX WITH THE USE OF CITRIC ACID, WHICH ADDS A CHARACTER OF "GREEN SYN–THESIS" TO THE REACTION. AFTER THE REDUCTION REACTION, THE LATEX WAS DRIED AT 60 ° C FOR 10 HOURS. AFTER DRYING, THE OBTAINED MATERIAL WAS SOLUBILIZED IN CHLOROFORM, FORMIC ACID AND DMF WITH THE POLYMER SOLUTION CONCENTRATION OF 3% FOR NANO/MICROFIBER PRODUCTION. THE MORPHOLOGICAL ANALYSES OF THE ELECTROSPUN FIBERS PRODUCED WERE CARRIED OUT BY SCANNING ELECTRON MICROSCOPY, WHERE HOMOGENEOUS FIBERS WITH NO BEADS AND AVERAGE DIAMETER OF 2,2 µM WERE OBTAINED. ADDITIONALLY, THE PRESENCE OF RGO ON THE SURFACE OF NANOFIBERS COULD ALSO BE OBSERVED. OUR PRELIMINARY RESULTS INDICATE THAT WITH THE USE OF THE ELECTROSPINNING SYSTEM IT IS POSSIBLE TO PRODUCE NANO/MICROFIBRES OF NATURAL RUBBER WITH RRO, WHICH WILL BE FURTHER APPLIED IN SENSORS AND DEVICES.

**KEYWORDS:** NATURAL RUBBER; OXIDE GRAPHENE; ELECTROSPINNING.


# USE OF POLYSACCHARIDE FROM MACROALGA *GRACILARIA* SP. FOR THE DEVELOPMENT OF POLYMER NANOPARTICLES

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**Abstract:** The red macroalgae consist of a class of aquatic organisms in which polysaccharides with recognized pharmacological activities can be extracted besides presenting characteristics such as availability, biocompatibility and versatility. In their structure they present hydroxyl groups and sulphates which favors the chemical modifications, which means the insertion of new chemical groups in its structure, allowing its use in obtaining new materials. The present work aimed to promote the modification of the polysaccharide isolated from Gracilaria sp., With phthalic anhydride, at the polysaccharide: anhydride ratios of 1: 2 and 1: 5, to obtain a hydrophobic material. The derivative obtained was characterized by FTIR and nanoparticles were synthesized by means of dialysis at concentrations of 0.1%, 0.05% and 0.025%, using as solvent dimethylsulfoxide (DMSO). The nanoparticles were then characterized by Uv–vis and DLS spectroscopy. The FTIR results confirm the modification due to the presence of ester car–bonyl bands and aromatic ring bands. Sizes were observed in the range of 518.7 to 232.9 nm for all concentrations, however 0.05% was outstanding, due to the lower value of PDI. The nanoparticles were successfully prepared and have potential for the drug delivery system.

**Keywords:** Polymer; Synthesis; Nanostructured.


# CHEMICAL MODIFICATION OF ANGICO GUM AND INVESTIGATION OF ITS BIOTECHNOLOGICAL POTENTIAL

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**Abstract:** Gums are complex natural carbohydrates that represent an abundant class of macromolecules of great importance for the industrial area as raw material. Among them, we have the angico gum which are resins exuded from native trees of the Northeast of the genus Anadenanthera colubrina var. cebil. The chemical modification acts in the improvement of the application of the materials as to its advantages, improving the natural characteristics for the use of these polymers as compatible biomaterials or, as polymer matrices for the drug delivery, aiming at the operational interaction of the drug interaction sites and the hydrophilic fields optimizing the therapeutic index. The present work aims at the esterification of gum from angico (GA) with propionic anhydride in order to investigate its activities regarding biocompatibility, antimicrobial activity, antioxidant and nano-structured system formulation. The chemical modification was verified by means of the spectra obtained by the Infrared Spectroscopy (FTIR) analysis comparing the spectra of the angico gum (GA) with the angiotonic gum modified with propionic anhydride (GAMAP) by evaluating the insertion of the functional groups after the modification and by means of the X-ray Diffraction(XRD) verifying the crystallinity of the obtained material comparing with the starting material. The GAMAP derivative had no antibacterial effect against S. aureus and E. coli. However, it was satisfactory in hemolytic assays with human erythrocytes. The GAMAP derivative showed antioxidant activity against the capture of the ABTS • + radical. Derived biopolymers are presented as promising biomaterials for use in biotechnological applications.

**Keywords:** Exudate; Chemical Modification; Biotechnology.


# INVESTIGATION OF BACTERIAL CELLULOSE MODIFIED WITH MERCAPTOSILANE IN THE ADHESION OF HUMAN FIBRO–BLASTS

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**Abstract:** Cellulose is the most abundant polymer on earth, and it can be produced by plants, algae, fungi and bacteria. Cellulose synthesized by bacteria presents unique properties as high water holding capacity, biocompatibility, biodegradability and three–dimensional architecture similar to the extracellular matrix. Despite being a promising support for cell cultivation, bacterial cellulose (BC) does not allow proper cell adhesion on its surface. So the purpose of this study is to modify the BC surface in order to improve the adhesion of cells, particularly of human fibroblasts. Therefore, BC membranes synthesized by *Komagataeibacter xylinus* were modified with (3– mercaptopropyl)trimethoxysilane, being evaluated the following parameters: silane concentrations (0.538, 0.135 and 0.034 mmolmL–1), solvent (acetone and a mixture of ethanol and water) and drying method (at room temperature and at 120°C). The modified membranes were analyzed by FTIR, TGA, SEM and XPS. XPS analysis demonstrated that the surface modifications were modest in all the tested conditions, however the applied treatments increased the thermal stability of the platforms. SEM analysis showed that the most significant modification occurred for the surface treated with the highest silane concentration using ethanol and water as sol–vent and dried at 120°C, yet all membranes maintained the BC characteristic three–dimensional nanometric structure. Cell adhesion and proliferation using human fibroblasts as well as resazurin cell viability assays are being performed.

**Keywords:** Bacterial cellulose; Mercaptosilane; Human Fibroblasts.


# MULTILAYERED FILM ARCHITECTURE AS A STRATEGY TOCONTROL DRUG LOAD AND RELEASE PROPERTIES

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**Abstract:** The layer–by–layer technique has been widely used for the self–assembly of multilayered films, with a particular interest in the production of drug carriers for biomedical use. Despite the considerable interest in post–assembly techniques for drug loading, such as drug conjugation with the film moieties, little attention has been driven to the effect of film deposition conditions in the drug release performance. Herein, we use the traditional poly (acrylic acid) (PAA)/poly (allylamine) (PAH) multilayered platform for understating the influence of polyelectrolyte solution pH and drug loading method in the release of calcein (CAL), a chosen model drug molecule. Films were assembled over glass substrates using the dipping layer–by–layer method, using different polyelectrolyte solution pH (4.5 or 8.8), while the drug loading process was carried out during or post film assembly (pH 7.1 in both cases). We also tested the barrier effect of the biopolymer– based multilayered carboxymethylcellulose (CMC)/ chitosan (CHI) films deposited over the payload region as a strategy to avoid the drug burst release. Results show higher CAL loading capacity for films assembled at pH 4.5 and post–assembly drug loading; the more sustained drug release profile is observed for films deposited at pH 8.8 and drug loading during film deposition. These results also indicate that film area, rather than the number of bilayers deposited, controls the drug loading capacity, suggesting that CAL molecules are majorly adsorbed in the outer layers of the film by electrostatic interaction with the non–complexed carboxylate groups of PAA. Finally, CMC/CHI barrier deposited by LbL spraying method drastically reduces burst release effects, extending the drug release profile for up to 10 days. Our findings indicate that simple film deposition parameters may be used to control the performance of multilayered films suitable for drug delivery applications.

**Keywords:** Layer–By–Layer; Drug Delivery; Chitosan.


# INFLUENCE OF BIOPOLYMER BASED THIN FILMS ON MICROPATTERNED PDMS PROPERTIES

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**Abstract:** Surface properties play a key role in how biomaterials interact with the environment. In the context of biological phenomena, several studies report changes in cellular behavior promoted by changes on chemical and physical properties of surfaces involved in the interaction process. Surface topography has also been reported to be a key player for cell adhesion in some research, although its effect is still not well elucidated. To investigate these effects on the cellular behavior, it is necessary to implement a methodology with a strict control over the surface properties. By combining lithographic techniques with multilayer coating strategies, such as layer–by–layer technology, it is possible to functionalize patterned surfaces for the study of biological phenomena, such as cell adhesion. As regards the functionalization materials, natural polymers are particularly interesting as they are usually weak acids and bases that can be fine–tuned by pH and ionic strength. In this study, thin films of hyaluronic acid (HA) and chitosan (CHI) were developed by Layer–by–Layer technique on a micropatterned polydimethylsiloxane (PDMS) to evaluate its performance in the modulation of cellular behavior. Briefly, the PDMS substrates were treated with oxygen plasma and pre– coated with a polyethyleneimine precursor layer before films assembly. The characterization of these coatings was carried out using the Atomic Force Microscopy (AFM), Contact Angle and UV–Vis. AFM and UV–Vis results confirmed the deposition of films with 29 nm of thickness across the substrate extension. This coating was able to considerably reduce the hydrophobicity of the PDMS, reducing contact angle measurements by up to 50%, improving its biocompatibility for cell culture. Although much work is still needed, the findings highlight the functionality gains promoted by nanostructured coatings of biomaterials through the Layer–by–Layer deposition technique and can contribute to the development of new biomaterials with applications in biomedical systems.

**Keywords:** Biopolymers; Layer–by–Layer; Surface Properties.


# MORPHOLOGICAL CHARACTERIZATION OF HYALURONIC ACIDS AND THEIR CLINICAL INDICATIONS

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Area: ( ) Food and Agriculture ( X ) Medical and Pharmaceutical ( ) Multifunctional Applications

**Abstract:**The versatility of Hyaluronic Acid (HA) as a skin filler makes it a product with diverse characteristics depending on the manufacturer, type of crosslinking, and product concentration. These differences are important in clinical practice because they will determine the correct indication of each product, its local stability, and its durability. The objective of this study was to compare the superficial and internal morphology of lyophilized samples from four different commercial HA presentations, associating their characteristics with the perfect clinical indication. Rennova Ultra® 24 mg / mL (1), Rennova® Ultra® 20 mg / mL (2), Rennova Deep® 20 mg / mL (3) and Rennova Ultra® Deep® 20 mg / mL (4) were freeze–dried at –80 ° C for 2 days and subsequently lyophilized for 2 days using L101 equipment (Liotop, São Carlos – Brazil). Samples were fixed in stubs and metalized with carbon for SEM analysis. Photomicrographs with magnification of 40X, 100X and 500X and 1,500X were obtained using the FEG–MEV scanning electron microscope JSM–7500F (Jeol Ltda, Tokyo – Japan) from the Advanced Microscopy Laboratory (LMA) of the Chemistry Institute of Araraquara – UNESP. Gel 1 presented pores or chambers with larger diameter compared to the other gels, thus showing a looser structure and with less capacity to withstand tensions. The second showed a slightly dense structure compared to 1. The more homogeneous structure was presented in gels 3 and 4, which suggests a higher crosslinking rate indicating greater collectivity, as well as dermal volumizing capacity, supporting higher tensions. It is ob–served that, due to their morphological characteristics, gels 2, 3 and 4 are more suitable to correct greater loss of volume while gel 1 is more suitable for surface filling, since it has a structure with more pores and consequently supports less stress your clinical indication may be the lip contour and small loss of collagen.

**Keywords:** Hyaluronic acid; SEM; reticulation


# VISCOELASTIC PROPERTIES OF CROSS–LINKED HYALURONIC ACID POLYMERS BY RHEOLOGY

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**Abstract:** Hyaluronic acid is a polymer used in a wide medical application, being a natural polymer that can be stabilized by chemical crosslinking, resulting in a water–insoluble viscoelastic polymer, less susceptible to enzymatic degradation and better elasticity compared to the in natura product. The objective of this work was to obtain crosslinked gels from hyaluronic acid, using the crosslinking agent 1,4–butanediol diglycidyl ether, in relation to different mass / mass ratios of the agent, seeking the preparation of high hydrophilicity gels. In agreement with the objectives of this work it was possible, so far, to confirm the production / preparation of gels with particles showing sphericity observed by optical microscopy, which adds effective gain to the viscoelastic properties of the product, important with regard to subcutaneous application. No aspects of rheological properties; The gels prepared in this work were evaluated within the range of the physiological stress region (0.1 to 2) Hz from the G 'parameter evaluation. Gels produced with 13 25% BDDE have accepted measurements for use as a facial filler and the 37% BDDE gel has been classified as a viscosupplementation. Gels prepared with 37 and 50% BDDE showed high G 'values and were indicated for applications as strong gels. From the evaluation of parameter G ", the gels prepared with 13 and 25% BDDE presented modules with values below 100 Pa; values close to the gels present in the market. Gels prepared with the addition of 37% and 50% BDDE may be final polished with the addition of the addition of solubilized HA to facilitate gel extrusion. Values obtained for tan δ, varying in the range of $0.33 \leq \tan \delta \leq 0.43$ for 13 to 50% BDDE crosslinked gels, which are presented as gels with higher elastic behavior, and for 13 to 50% crosslinked gels. 37% BDDE is indicated for use in regions that require parameters similar to synovial fluid.

**Keywords:** Hyaluronic acid; Crosslinking; Polymers in medicine; Thermal analysis


# THERMAL EVALUATION OF CROSS–LINKED DERMAL FILLERS WITH HYALURONIC ACID AND BDDE

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Area: ( ) Food and Agriculture (x) Medical and Pharmaceutical ( ) Multifunctional Applications

**Abstract:** Dermal fillers are as medical indications in routine clinical practice, the base substance for their formulation is hyaluronic acid (HA) is important substance to maintain the youthful appearance of the skin. This natural polymer can be modified at the carboxylic, hydroxyl, acetamide group and at the reduced terminal by crosslinking, esterification, and etherification reactions, among others. The objective of this work was to obtain gels by crosslinking reaction from hyaluronic acid, using the crosslinking agent 1,4–butanediol diglycidyl eter, against different mass / mass ratios of the agent, seeking the preparation of gels and evaluation by analysis. thermal TG–DTA and DSC confirmed the obtention of different gels. Ther–mogravimetric results obtained in water mass loss in relation to HA concentration in the different formulated polymer systems. In the DSC evaluation, the degree of cross– linking, in the absence of ionic strength adjustment, was obtained from the solvent peak crystallization temperatures ($T_c$) in the polymer lattices according to the order: $T_c$13% ~ Tc25% (– 22, 3–22.5 ° C) > $T_c$36.6% (–23.6 ° C) > $T_c$50% (–27.0 ° C); the minimization of melting temperatures, $T_f$, $\Delta T_f$, for the composition gels 50 and 13%, from $\Delta T_f$ = 9.9 $^{O}$C (pure water) to $\Delta T_f$ = 3.8 $^{O}$C (buffered solution with just ionic strength), reflecting the minimization of solvent–solvent and solvent–polymer interaction energies compared to gels prepared in pure water; ionic strength adjustment being an important aspect of the gel adjustment to the physiological behavior that will be applied. In addition, allotropic transition, change from cubic to hexagonal structure (characteristic structure of frozen water), based on endothermic / exothermic peaks present at T = –18 / –50 oC (heating / cooling), present only for swollen gels in buffer solution with NaCl–adjusted ionic strength; determining the glass transition temperature, Tg, only for gels with a high degree of cross–linking: Tg36,6% and 50% = –53 oC (heating branch); Tg for low cross– linking gels possibly below –80 $^{O}$C.

**Keywords:** Hyaluronic acid; Crosslinking; Polymers in medicine; Thermal analysis.