



Hydrogel films with pine essential oil have the potential to be used as wound dressing

Thiago Rodrigues Müller / 15 de agosto de 2024 / In English

Chemical Engineering | Besides the advantages of hydrogel films, such as flexibility and permeability, the use of essential oils provides it with an antibacterial property and might be an alternative for the materials already on the market

*By [Thiago Rodrigues Müller](#)

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*Image: Hydrogel film, part of researcher Patricia Hubner's doctoral dissertation, developed in the Graduate Program of Chemical Engineering from UFRGS (Patricia Hubner/Personal Archive)

Comfortable application, fluid absorption, aid in the inflammatory process, biocompatibility, wound hydration and protection are some of the advantages of using hydrogel films as wound dressings. Also, with the addition of essential oils, such as wild pine and lavender, they can have antibacterial action. For her doctoral dissertation, developed in the Graduate Program of Chemical Engineering from UFRGS, Patricia Hubner assessed and tested the use of hydrogel films with pine and lavender oils as wound dressings.

One of the main differentials in hydrogel film dressings is the possibility of using them in the treatment of burns as deep as second-degree ones. Hubner explains that "it would eliminate that stage in the healing process when the patient needs to undergo debridement". Debridement is the manual removal of the necrotic tissue that gets in touch with the ointments during common treatment. "The dressing itself will provide an environment with the ideal humidity to support the healing process," she adds.

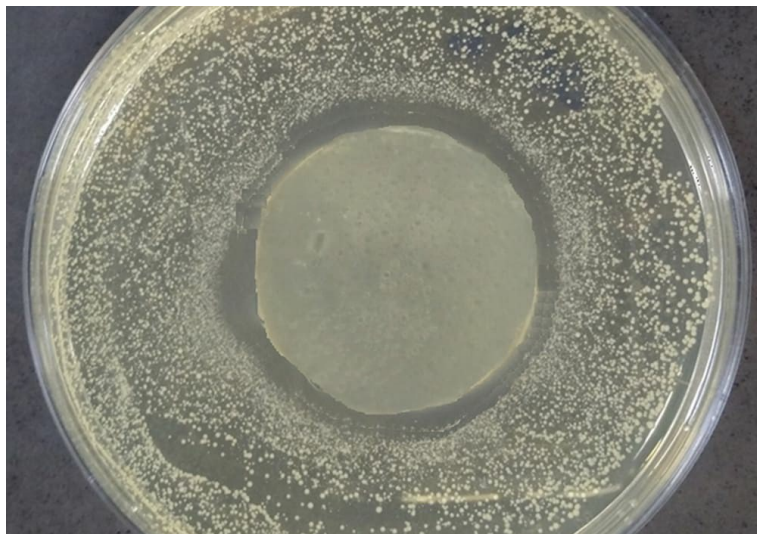
However, since this material can differ a lot depending on its composition, the use of essential oils also interferes with its properties. Therefore, Hubner made a series of experiments to test the viability, the properties and the antimicrobial activity of the dressings with lavender and pine oils. One of the main findings is that hydrogel film with pine oil shows good antibacterial activity – which means it can be a good alternative for preexisting materials in the market.

Hydrogels, gelatin and PVA

Hydrogels consist of a polymer chain that can be formed by natural or synthetic materials. In this case, the analyzed hydrogel was made of gelatin and a polymer named Polyvinyl alcohol or PVA. The main characteristic of these gels is its affinity with water. They're able to maintain their original form even if solubilized and to absorb a great quantity of water – or fluids, when used as wound dressings.

The films, however, are solid membranes also formed by various polymers – but that do not go through the process of crosslinking, used in the hydrogels, to make the connection between these polymers' chemical chains. It gives them more stability and prevents the solubilization. This process uses ultraviolet light, "that is going to act on the gelatin and the PVA, creating free radicals that are going to interact with each other and form this hydrogel," explains the researcher.

In the study, Hubner used two different materials: the gelatin – that shows higher biocompatibility (i.e., it suffers less rejection by living tissues or organs and degradability because it is natural), and the PVA – that shows higher resistance and stability. She tells that when working with gelatin alone, the hydrogel would dissolve when in contact with humidity. "Thinking about improving these properties, I realized I could use PVA as synthetic polymer and make the crosslinking to increase the stability came," she adds. Thus, the hybrid product combines the advantages of both materials.



Antibacterial test developed by Patricia Hubner, in a study from the Graduate Program in Chemical Engineering from UFRGS (Image: Patricia Hubner/Personal Archive)

Findings

The hydrogel can be characterized by many aspects. As wound dressings, however, the researcher says that the more pertinent analyses are related to water vapor and oxygen's permeability, elongation and swelling.

The water vapor can suppress the development of scabs in the wound, facilitating the healing process. However, if the bandage does not allow enough evaporation, it can favor the concentration of fluids and infections. Because the hydrogel hardly ever reaches a recommended water evaporation rate, the parameter used was just allowing more evaporation than the human skin. The study showed that an evaporation below the recommended rates might have been obtained because the gelatin and the PVA interact easily with water. Therefore, part of it was able to adhere to the material.

In the same way, a low transmission of oxygen can decrease the tissue regeneration and increase the proliferation of anaerobic bacteria that struggle to live among O₂. The results obtained in this regard are within the range of other studies about the subject.

The elongation, however, according to the researcher, can be defined by the dressing's capacity to stretch itself – i.e., its flexibility. Lastly, the swelling refers to when the dressing is efficient to absorb the wound's fluids. By controlling the swelling, it's possible to, for example, modify the liberation of the active agent, such as the essential oils.

By adding the essential oils, Hubner noticed a few changes: both the dressings with pine and the ones with lavender showed higher permeability to water vapor and swelling. The dressings with lavender also showed more permeability to oxygen and lower elongation.

To study the antibacterial action, tests were made with two bacteria: *Escherichia coli* and *Staphylococcus aureus*. The results indicated that the wild pine oil might be – as long as its concentrations are adjusted – as efficient against bacteria as – or even more efficient against bacteria than – the lavender oil, which has already been used for the same purpose in the market.

Hubner says that the use of the oils has limitations, such as how much of them can be used without altering the properties of the dressings. "If I had placed more oil in this film, we would probably have a lot of problems regarding its structure, and I would lose in other properties," she explains.

Hubner also says that pine is an innovative alternative – since it is underexplored in biomedical applications – despite its higher antimicrobial effect, not being toxic and not showing irritability in lower concentrations. She says this type of application isn't found commercially, but "on account of its behavior in our film, and the response it gave us, it would be a good alternative".

The study shows that the product has adequate and promising properties to be used as wound dressing. It also highlights the need for more studies about cytotoxicity and cellular proliferation. For the future, Hubner explains that, if the work continues with new sources, maybe the opportunity to patent a product will arise.

Translated into English by **Luisa de Figueiredo Dias**, undergraduate student enrolled in the course "Supervised Translation Training II (English)" of the Undergraduate Program in Language and Literature, under the supervision and translation revision of Professor Elizamari R. Becker (P.h.D.) – IL/UFRGS.

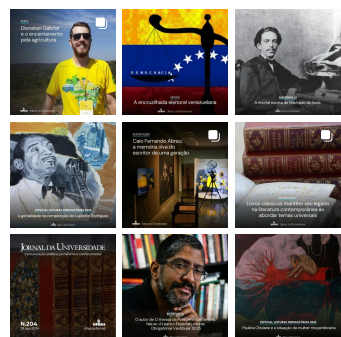
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(51) 3308.3368

jornal@ufrgs.br