NANO SILVER PARTICLES FOR THE PREVENTION OF INFECTIONS IN SYRIAN REFUGEES

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1. Abstract

Since the incessant wars that take place in Syria and many other places in the world, the number of refugees has extremely increased. A simple cut on their feet or in their arm can easily become infected and can be the starting point for more severe illnesses that can even kill them.

The objective of this project is to deal with infectious diseases in refugee camps, providing a solution to prevent the refugees from them. Based on the use of nanosilver particles in shocks, our idea is to make bandages with nanosilver particles because of its antibacterial activity.

The antibacterial properties were introduced into the bandages by drop-cast method, using 2% and 5% dispersions by weight of AgNP in water. To determine the size of the AgNP and their distribution over the bandages, Scanning Electron Microscopy was used. In the SEM can be observed that more nanoparticles were deposited in the bandage with less concentrated dispersion (2%). When higher content of AgNP is dispersed in water (5%) it is likely that some part of the nanoparticle precipitated. To determine antibacterial properties, *Escherichia Coli* (*E.Coli*) bacteria was used. The bacteria has not grown after the addition of the bandage containing 2% AgNP. In the dissolution with bandage containing 5% AgNP the bacteria has grown. Looking at the results it can be claim that the implementation of this project is possible.

2. Introduction

2.1. General Information

Nowadays, since the incessant wars that take place in Syria and many other places in the world (Afganistan, Iraq, etc.), the number of refugees has extremely increased reaching more than 4 million individuals. Refugees are assembled under large tents in the so called refugee camps. Most of these refugees camps, at least for Syrian people, are located in Jordan, Turkey, Libano and Greece. Refugees are living under poor conditions, exposed to the elements, and are totally dependent on humanitarian aid. Refugees usually suffer from diarrhea, respiratory infections and skin infections because of the poor conditions in the camps. A simple cut on their feet or in their arm can easily become infected and can be the starting point for more severe illnesses that can even kill them. Therefore, preventive actions must be undertaken to improve their living conditions, and prevent them from suffering diseases and problems that can be easily avoided by simple measures as, for example, using bandages containing nanosilver particles. In fact, bandages are essential for treating cuts or wounds to prevent them from infections.

2.2. Science and society

Nano silver, i.e., nanoparticles of silver, is being widely used because of its antibacterial activity. Nanosilver particles are too small to see, even with a classroom microscope. The particles measure between 1 and 100 nanometers, or billionths of a meter, across.

(Nano is a prefix meaning a billionth). By comparison, most humans hair is 40,000 to 120,000 nanometers wide. That is hundreds of times the width of a large nanoparticle. Ionic silver nanoparticles were first introduced in washing machines, refrigerators, air conditioners, air purifiers and vacuum cleaners by Samsung in 2003. To give an efficient example of the use of these particles, nanosilver in socks can eliminate feet odour, are very comfortable, conduct sweat and keep feet drier, having a strong and lasting antibacterial effect. These nanoparticles are now included in a wide range of products including cosmetics, food containers and detergents.

Silver has been used for the treatment of medical ailments for over 100 years due to its natural antibacterial and antifungal properties. The nano silver when gets in contact with bacteria and fungus will adversely affect cellular metabolism and inhibit cell growth. The nano silver suppresses respiration, basal metabolism of electron transfer system, and transport of substrate in the microbial cell membrane. The nano silver inhibits multiplication and growth of those bacteria and fungi which cause infection, odor, itchiness and sores.

3. Objective

The objective of this project is ***to deal with infections in refugee camps to prevent refugees from future diseases.***

4. Hypothesis

The project explained in this report will bring positive results to our society. Based on the use of nanosilver particles in shocks, **the idea is to make bandages with nanosilver particles. This way, the wounds will be treated faster and the risk of infection will decrease in a significant way.** Consequently, the methods in which nanosilver bandages can be used to prevent infections are going to be studied, and how this solution could be implemented in order to improve the living conditions of refugees in the camps.

5. Materials

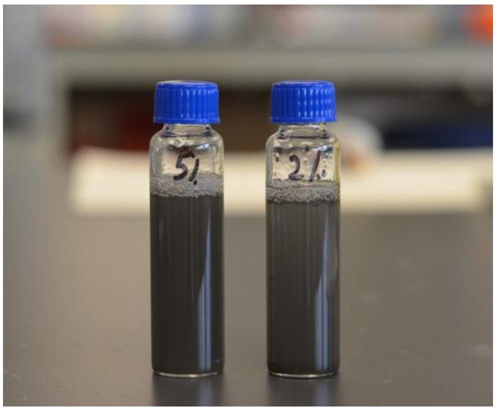
The most used and the cheaper type of bandage is the self-adhesive bandage. Therefore, this type of bandage is the one it's going to be used to mix with nanosilver particles.

Properties:

- Nanosilver is **strongly antibacterial to a wide range of pathogens and absorb sweat.**
- **It prevents occurrence of dermal infections, mycoses and eczemas and help in their treatment.**
- It is a non-toxic, non-irritant and **does not cause allergic reactions**.
- It speeds up healing of small wounds and cuts.
- It improves blood supply and has an overall **positive effect in blood circulation**.

6. Experimentation and Methodology

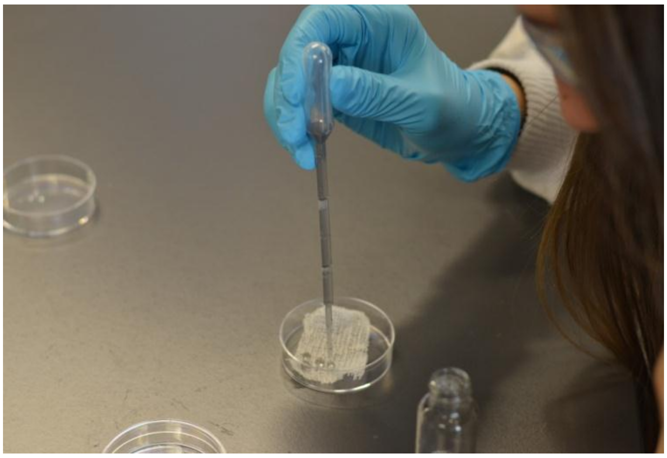
The antibacterial properties were introduced into the bandages by drop-cast method, using dispersion of silver nanoparticles (AgNP) in water. The bandages were self-adhesive on one side, into which the nanoparticles were deposited with the aim of immobilizing them on the surface.



In the image above, a dissolution of AgNP in different measures can be seen.

The process of this project consists on the following steps. The small pieces of the bandages in dimensions of 5cm x 5cm were cut, into which the AgNP was deposited. The silver nanoparticles were purchased from Sigma-Aldrich, having the average size of 70 nm. Two dispersions of the nanoparticles were prepared, one of them having a concentration of 2 % by weight and the other one of 5 % by weight. 15 drops were deposited into each piece of bandage.

The drying was performed by UV irradiation which allowed faster water evaporation from the wet bandages. In addition, it provides disinfection of the bandages, as it is known that UV irradiation kills bacteria.



The irradiation was performed in duration of 45 minutes within UV chamber (model BS 03, Dr. Gröbel UV-Elektronik GmbH) equipped with 20 UV lamps (wavelength range from 315 to 400 nm with a maximum intensity at 368 nm) and incident light irradiance of 7 mW/c

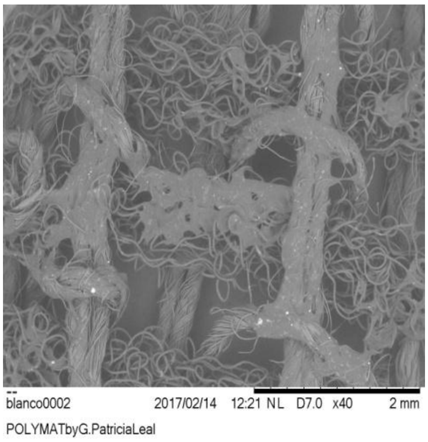
After the drying, the bandages were cut in small pieces (1cm x 1cm) and the following characterization was performed:

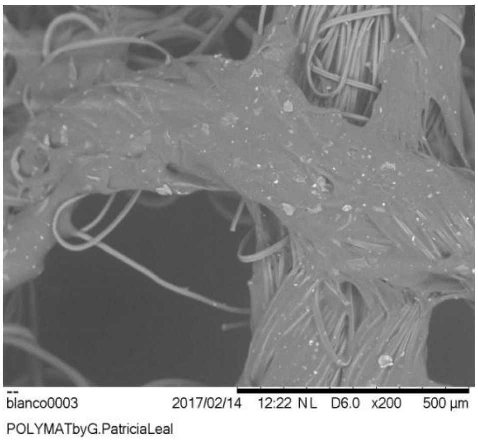
1. To determine the size of the AgNP and their distribution over the bandages, Scanning Electron Microscopy (SEM) was used (Hitachi, Tabletop microscope, TM3030).

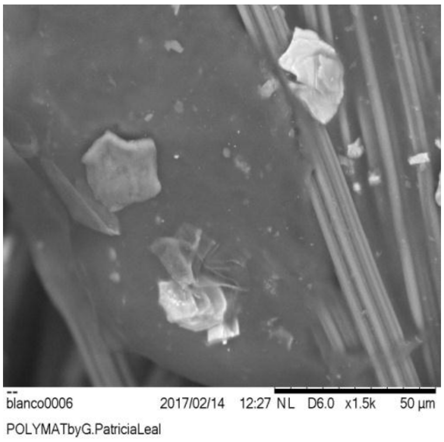
2. To determine antibacterial properties, *Escherichia coli* (*E.Coli*) bacteria was used. The bacteria cells were grown in liquid at 37°C and 250 rpm overnight. After that, the piece of bandages with 0% (blank sample), 2% and 5 % AgNP were placed into the solution containing *E.Coli* bacteria and left another 24 h at 37ºC.

7. Results

In the following pictures the SEM images of the bandages and their results are presented.



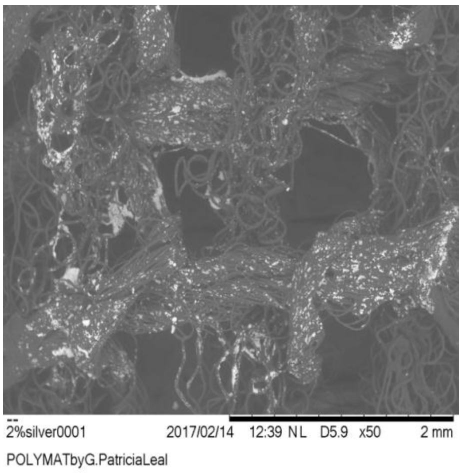


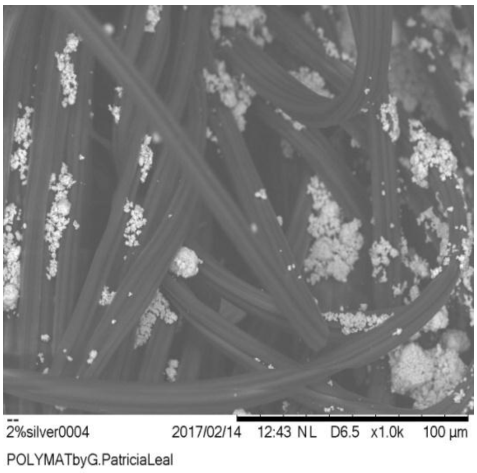


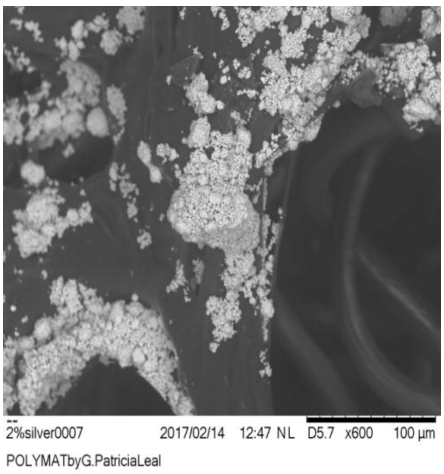
These SEM images correspond to the bandages within 0% (blank sample) AgNP

In the Scanning Electron Microscopy can be observed that more nanoparticles were deposited in the bandage with less concentrated dispersion (2%), which is the opposite that what we expected. When higher content of AgNP is dispersed in water (5%) it is likely that some parts of the nanoparticles got precipitated, thus less nanoparticles were in water, so less were deposited on the bandages.

The following SEM images correspond to the bandages within 2% AgNP.

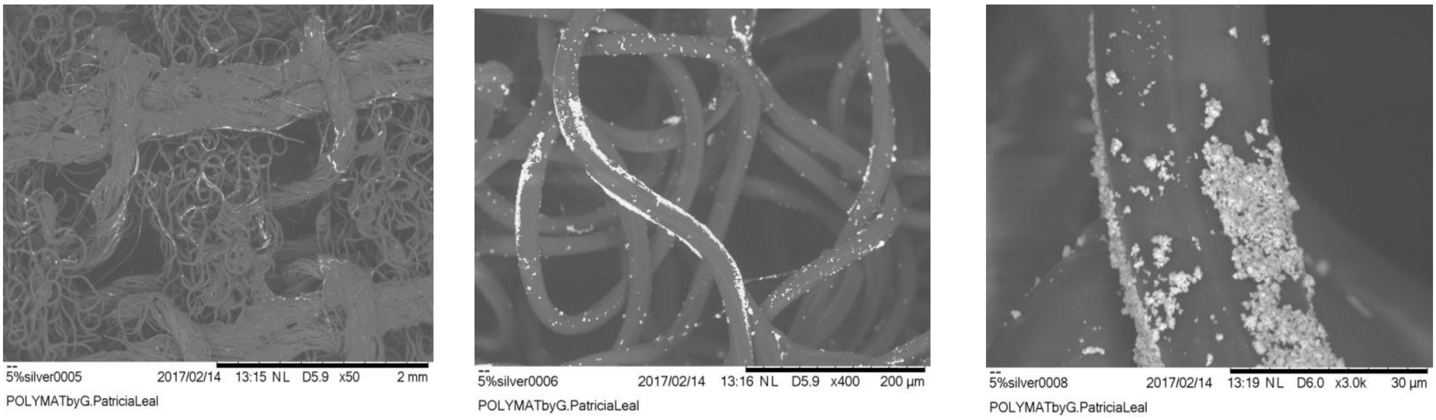






The nanoparticles have a size of less than 100 nm, but we can see in all the images that they are aggregated in bigger aggregates and that are well distributed over the fibers of the bandages, although in some parts a higher content of AgNP can be observed than in others.

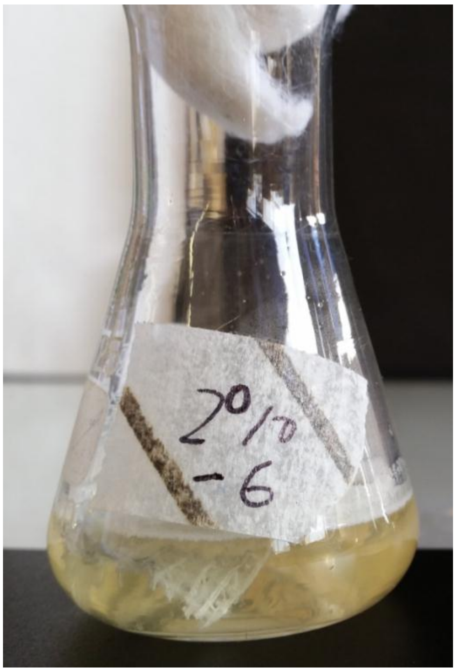
In case of 5% dispersions, although fewer particles are observed in general, better distribution can be observed and even some of the fibres were covered completely by the nanoparticles.



These SEM images correspond to the bandages within 5% AgNP.

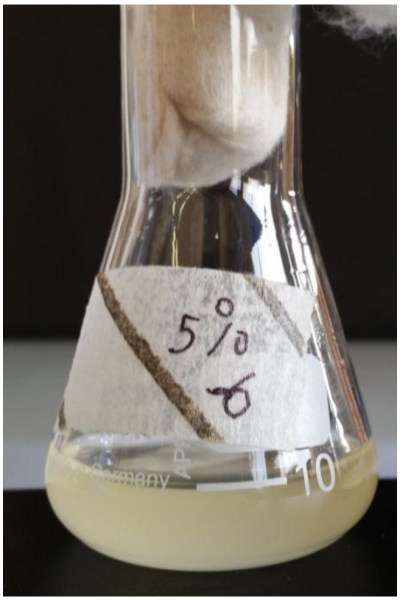
For the determination of the antibacterial properties *Escherichia coli* (*E.Coli*) bacteria was used. These are the obtained results.

It can be said that the dissolutions with blank bandage (0%AgNP) is turbid, as it was expected, which means that E.Coli bacteria has grown in high number.



Oppositely, the dissolution with bandage containing 2% AgNP is transparent. Moreover, the bandage within the solution can be observed, which means that the bacteria has not grown after the addition of the bandage containing 2% AgNP.

In the dissolution with bandage containing 5% AgNP it can be claim that the dissolution is turbid, denoting that the bacteria has grown. Although unexpected, this result is also seen in the SEM images, where less amount of AgNP was shown, due to the possible precipitation in consequence of more concentrated initial dispersion of AgNP.



8. Conclusion

8.1. Is the implementation of the project possible?

The implementation of this project is possible since the dissolution of 2% in the bandage, bacteria can be fully exterminated. This result indicates that with a minor amount of nanoparticles, an added value product may be obtained (bandages with antibacterial properties). This may be very useful or even indispensable for the refugees living under extremely hard conditions in the refugee camps, where it is not possible to get prompt help of medical personnel.

The silver nanoparticles were purchased from Sigma-Aldrich, having an average size of 70 nm. The cost of 5 grams of AgNp was 160€. Since a low amount of nanoparticles can be used to get the antibacterial function, the implementation of this project is not only effective, but it is also economically possible.

8.2. Future research

The future research of this project should be oriented to tackle two key issues.
First, the exact dispersion needed of AgNP over the bandage, to obtain the antibacterial property, should be studied. In order to distribute the nanoparticles homogeneously, deposition using an atomiser is propose.
Secondly, the effectiveness with different types of bacteria, more specific and common in refugees camps.

Furthermore, another research line should be focused on the industrial production of this antibacterial bandages.

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