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Novel sustainable plastic-free cosmetic packaging and product

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Introduction:

The appearance of polymeric materials has represented a great advancement in the scientific community due to their unlimited tuning capacity to achieve the desired properties. These polymeric materials have generally been used as packaging systems, either as primary or secondary packaging. Several properties have been tackled in order to have depute mechanical properties, texture or colors. Nevertheless, their ability to degrade after its use or even to reuse the packaging for another purpose has never been thought of.

The aim of this work is to develop a novel cosmetic product that contains no water in order to allow an external primary packaging that can be water-soluble. The overall aim is to find a solution of the excessive plastic single use packaging systems and to even allow a subsequent use of the packaging system. In this way, it will be contributing to various United Nations Sustainable Development Goals (SDGs) such as guaranteeing sustainable cities and communities, responsible consumption and production and life below water [4]. Figure 1 represents the main characteristics of this novel application compaired to the traditional one, using the comparison with an asorbic acid hydrogel as an example.

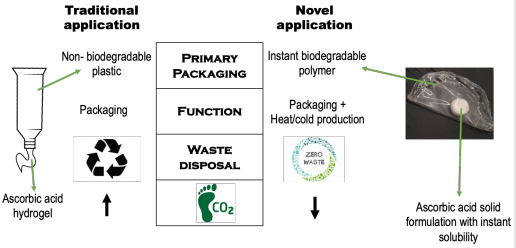


Figure 1. Main characteristics of the traditional vs the novel application.

Materials & Methods:

1. Solid cosmetic or sponge (product 1):
   a. Preparation of an alginate-base solution, i.e. 1.5% and 3% (Fig. 2)

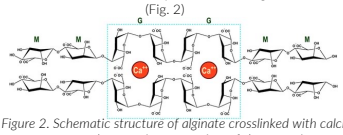


Figure 2. Schematic structure of alginate crosslinked with calcium

   b. Incorporation of therapeutic agents such as ascorbic acid (AA), i.e. 5%, 15% and 20%
   c. Low temperature sublimation
   d. Characterization: oxidation of AA + weight evolution

1.1. Exfoliation agents: preparation and incorporation of silica microesferes as exfoliation agents using water-in-oil emulsion technique (Fig. 3)

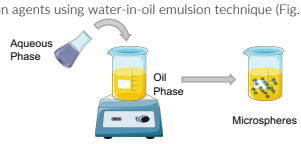


Figure 3. Schematic representation of the formation of microspheres.

2. Biodegradable film (product 2)
   a. Preparation of an alginate-base solution (i.e. 1%, 2% and 3%)
   b. Incorporation of therapeutic agents or exfoliation agents
   c. Drying process at room temperature and/or 37ºC
3. Final product: combination of product 1 & product 2
   a. Characterization: weight evolution

Results & Discussion:

We were able to create a solid cosmetic/sponge (product 1) with different concentrations of alginate. These sponges are water-soluble and have an instant degradation in seconds. Different concentrations of ascorbic acid (AA) can be added such as 5%, 15% and 20%. These sponges are stable (without oxidation) for more than a month (Fig. 4).

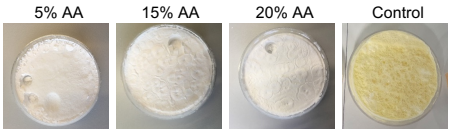


Figure 4. Oxidation evaluation for more than a month of the sponges. Three concentrations (5%, 15% and 20%) of ascorbic acid (AA) were used, a positive control was also used.

The creation of sponges can be explained through the formation of crystals and a crosslinking reaction (Fig. 5).

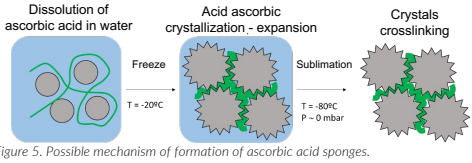


Figure 5. Possible mechanism of formation of ascorbic acid sponges.

A biodegradable film (product 2) was created and used as primary packaging. This film is flexible, water-soluble with instant degradation and can contain therapeutic agents and exfoliating agents, such as silica microspheres (Fig. 6A). The sponge, sponge with microspheres and the final product (combination of sponge and film) were stable for 45 days (Fig.6B)

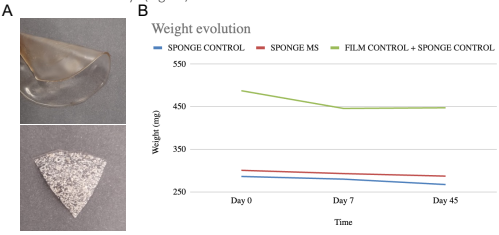
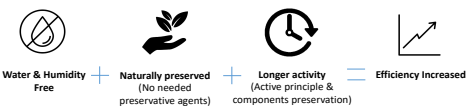


Figure 6. Biodegradable film (A) and weight evolution of product 1 and final product (B).

Conclusions:

- A solid cosmetic (sponge) and biodegradable film (primary packaging) based only in natural ingredients was created, avoiding the use of plastics.
- Different therapeutic agents can be added to the both product.
- The creation of water-free products with no need of preservative agents creates an increased efficiency of the therapeutic agent.



Acknowledgements:

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References:

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