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3D Printing of Topical Patches with Salicylic Acid: A New Frontier in Cosmetics and Pharmaceuticals

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SUMMARY

3D printing is heavily researched in the pharmaceutical field over the last two decades and, more recently, in cosmetics research. Fused deposition modelling (FDM) is one of many methods of printing. The FDM process allows printing structures in various sizes and shapes by using read-ymade filaments and/or filaments loaded with active ingredients produced by various methods. However, using FDM for producing topical applications for the skin is limited. Therefore, in this work, FDM is used to print topical patches containing salicylic acid for acne treatment. By utilizing Eudragit EPO as the polymer, the patch can be printed at a lower temperature, safeguarding the integrity of salicylic acid. The patch shows good mechanical strength, and successful in vitro release of salicylic acid is achieved. This research signifies the potential of 3D printing for efficient and customizable skincare applications.

INTRODUCTION

Three-dimensional printing, an innovative technology widely adopted in various fields, has entered the pharmaceutical industry over the last two decades (Araújo et al., 2019), ((Economidou et al., 2018). More recently, this technology has found applications in cosmetics studies (Stevic, 2017), where it is used to produce customized facial masks and topical patches. One of the techniques used is fused deposition modelling (FDM). FDM is an Extrusion-Based Printing method where three-dimensional objects are formed by extruding and depositing layers of thermoplastic material through an extrusion nozzle; during that process, the 3D printer deposits the molten material layer by layer, gradually building the object (Jiao et al., 2022), (Shahrubudin et al., 2019). Even though FDM is a cheap and fast printing method, there has been limited research on using FDM to produce topical products for the skin (Yang et al., 2021). As a result, this research explores the development of a 3D-printed patch using FDM containing salicylic acid as the active ingredient for treating acne.

MATERIALS AND METHODS

Eudragit EPO was bought from Evonik Industries. Talc powder, salicylic acid, and Triethyl Citrate (TEC) were supplied by Sigma-Aldrich. The filament is formulated with the following percentages: 44.7% Eudragit EPO, 36% talc powder, 12% salicylic acid, and 7.3% Triethyl Citrate (TEC), and is produced using a single screw Noztec Pro extruder. The filament is extruded at a lower temperature of 100°C, and the patch is printed at 110°C using a Makerbot (FDM) printer (Makerbot Industries, LLC, USA), with the bed temperature set at 30°C. A transparent Adhesive Bandage from ClearHeal is used as a patch adhesive (Fig.2). The release of salicylic acid is measured by Franz cell using cellulose acetate (0.45 nm) membrane in Mcilvaine's citric acid-phosphate buffer (4.7). The mechanical strength of the filament was evaluated using a Zwick/Roell Z010 universal uniaxial testing machine.

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RESULTS AND DISCUSSION

By using Eudragit EPO as the polymer, the patches were printed at a lower temperature compared to previous studies. This lower-temperature printing process proved beneficial in preventing the degradation of salicylic acid (Goyanes et al., 2016). The patches' dimensions were set at a height of 1 mm, width of 15 mm, and length of 50 mm, with an average weight of 1.14 g. The patch shows decent mechanical and tensile strength. Moreover, the successful *in vitro* release of salicylic acid was measured by using Franz cell diffusion technique.

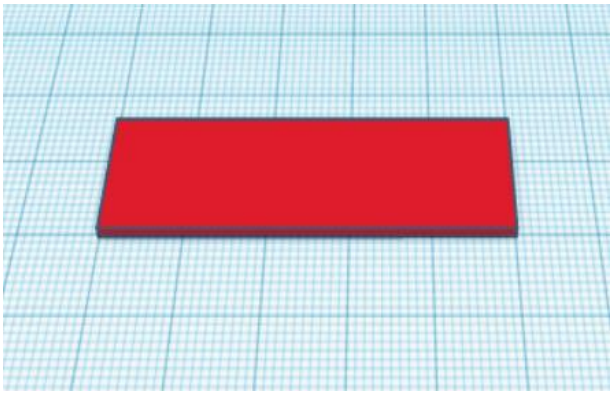

Fig. 1. *Patch design*

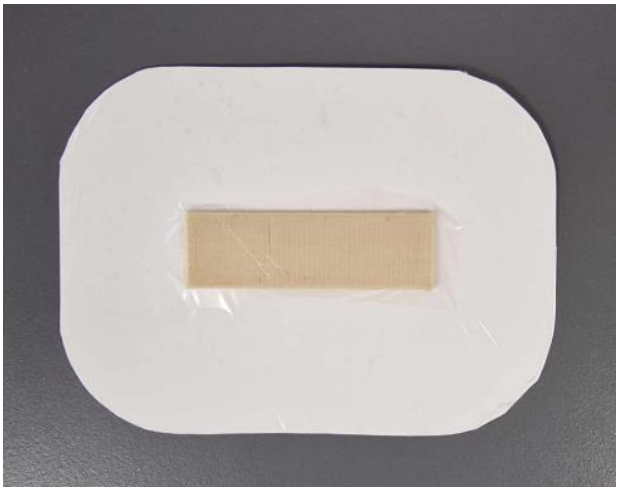

Fig. 1. *Printed patch with Adhesive Bandage.*

CONCLUSIONS

To conclude, the formula used in this study proves to be suitable for 3D printing patches, and it can be upgraded for scaling up production, allowing the creation of patches in various sizes and shapes. These promising results open the way for a new, faster, and more cost-effective method for developing topical patches using 3D printing (FDM) with versatile formulae for different purposes.

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