DEVELOPMENT OF IN VITRO TEST METHODS FOR EVALUATING DEPILATORY PRODUCTS' EFFICACY AND THEIR IMPACT ON SKIN BARRIER

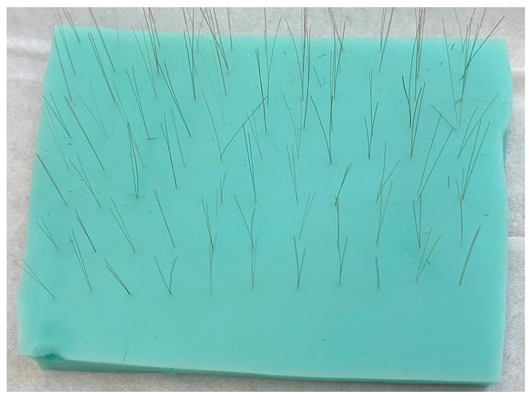
Leila Sorrells and Xuzi Kang, TRI Princeton, Princeton, NJ

Introduction:

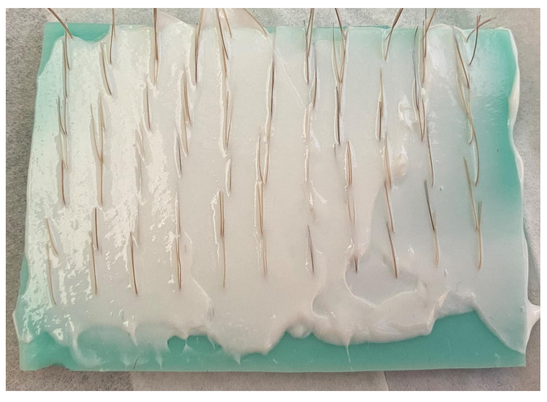
The objective of this study is to (1) develop an in vitro hairy skin model to test hair removal efficacy of 2 hair removal products, and (2) investigate depilatory effects on skin barrier function. Together, these objectives aim to provide a comprehensive understanding of depilatory products, guiding product development and offering reliable methods for evaluation. Chemical depilatories are prominent in hair removal applications, effectuating this by cleaving disulphide bonds in hair proteins, thus causing the hair to fragment and detach from the skin. These formulations typically include reducing agents such as sulphides and thioglycolates, combined in a high pH (pH > 10) base. An unfortunate consequence of these agents is the potential disruption of hair and skin structures, mandating a careful equilibrium between efficient hair removal and preservation of the stratum corneum, the skin's external barrier. Excessive damage to this barrier might elevate skin irritation levels and facilitate the penetration of deleterious substances. Furthermore, the in vitro screening of the products' efficacy presents another substantial challenge

Skin-like silicone model

Hair removal efficacy was assessed using a novel skin-like silicone model (shown below), 8 mm in thickness, with individually embedded scalp hair fibers (6.34 mm exposed). The model was preconditioned at 40°C for 1 hour to obtain a temperature around 34°C, simulating body heat, followed by depilatory application. The post-application hair loss, including partial losses, was recorded. The scalp hair thickness suitability for such a study was additionally verified using the leg hair of two males (one on the model and another on the leg). This reusable model allows customization of skin-like silicone size, hair density, hair length, hair thickness, and application/removal procedures.



Skin-like silicone with embedded hair fibers before testing

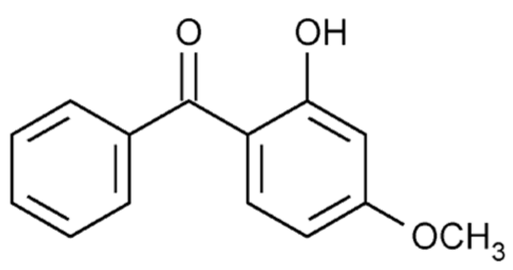


Silicone during testing of depilatory cream

Fiber removal grading scale (left to right) 2 fibers, 1 fiber, 0 fibers removed

Skin Barrier Testing

Additionally, Oxybenzone (OXB, molecular structure shown below on the left) was chosen as the test permeation agent in this assay since it is a widely used UV filter in sunscreen products. OXB, unlike most UV filters, mimics the structure of our hormones and can penetrate the skin, thus potentially, having harmful effects. Sunscreen formulators have tried different ways to prevent OXB from permeating the skin. However, worryingly, using a depilatory product could cause temporary disruption to our epidermis and increase the permeation of the sunscreen agent. Skin penetration of OXB was quantified using glass Franz diffusion cells (shown below on the right) on pre-treated human cadaver skin. A commercial sunscreen containing OXB was applied, and the concentration of OXB was analyzed at designated time intervals post-application via HPLC [1]. Validation studies differentiated the epidermal impacts between regular and sensitive skin formulations, establishing a comparative methodology for different products.

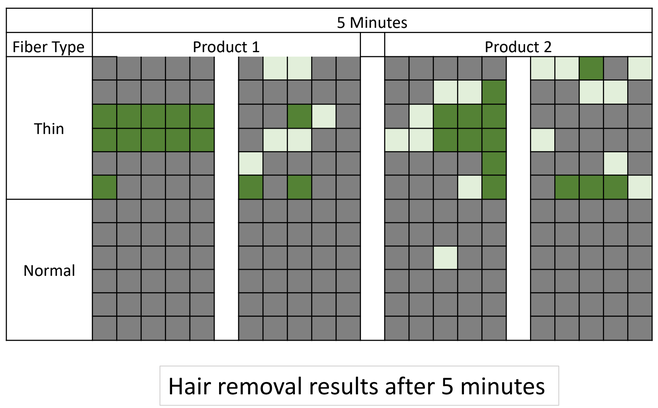


Molecular structure of OXB

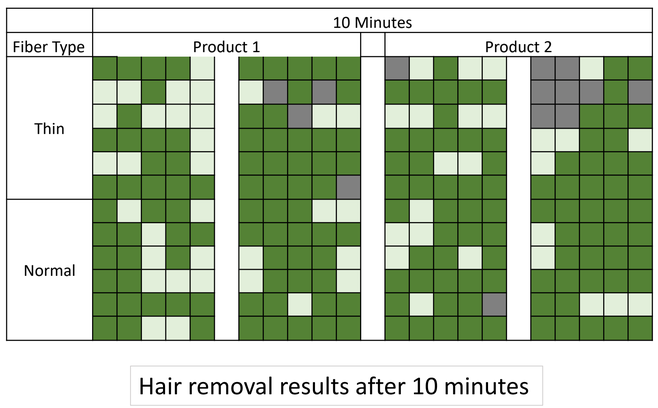
Franz diffusion cells setup

Results

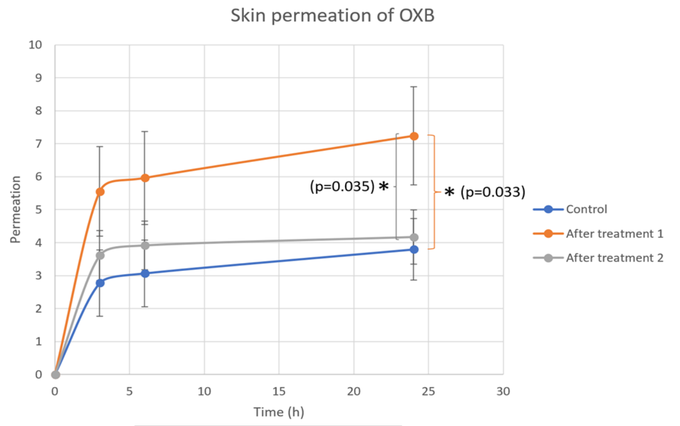
Validation test data show how hair removal from different products can be measured at different time points. The use of hair of different diameters also shows how treatment effects can be evaluated for different target consumer groups. The data show that in the thin hair group, 80% of the hair is lost using product 1, and 73.5% is lost after using product 2 after 10 minutes, which is significantly more than the 5 minutes groups (28.5% and 33.5%), and that hair removal was faster with thinner hair comparing to normal hair. Interestingly, scalp hair is found to be more resistant to hair removal than leg hair thus it is recommended to use fine hair fibers to match product performance on other human body hair. Hair removal from the two products tested was similar (shown below in the left two figures). Results from permeation studies showed that depilatory product 1, the "regular" product, significantly impacts the epidermis (permeation increased by 90.3%) while product 2, the "for sensitive skin" product, does not (permeation increased by 9.7%, not statistically significant). This method can be used to compare different formulations and determine whether they are friendly to our skin (shown below on the right).



Hair removal results after 5 minutes



Hair removal results after 10 minutes



Skin permeation results

Conclusion:

The study successfully developed two innovative in vitro test methods for depilatory products, achieving the dual objectives of assessing hair removal efficacy and evaluating the impact on skin barrier function. Using a silicone skin model with embedded hair fibers, the research provided a standardized approach for measuring hair removal effectiveness. This unique solution capitalizes on cost-effectiveness and customizability. The analysis of the products' impact on the stratum corneum revealed crucial insights into balancing hair removal efficiency and skin integrity preservation. Comparative evaluations between regular and sensitive skin formulations contributed to a nuanced understanding of the products' effects on the epidermis and overall hair removal. These findings support further innovations in the field, guiding the development of safer and more effective depilatory products, and have the potential to become standard procedures for in vitro testing. Future work may include extending these methodologies to a broader spectrum of depilatory formulations and potentially integrating other skin safety parameters. The skin-like silicone model can be developed further for applications in testing shaving razors and creams, testing waxing products, and as an alternative to animal skin testing overall.

Reference:

1. *Zhang, Qian, et al. "Transepidermal water loss and skin conductance as barrier integrity tests." Toxicology in Vitro 51 (2018): 129-135.*