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Strong correlation between *in vitro* microfluidic skin model comprising precise sebum and sweat excretion with *in vivo* studies for makeup lasting claim substantiation

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Introduction

Long lasting effect and mattifying effect have become basics requirements for foundation products. *In vivo* studies are the gold standard method for testing makeup products, by applying them to multiple volunteers. Different methods can be chosen depending on the desired claims. However, this process takes several months to discriminate between makeup formulations. To find an alternative to volunteers, we have developed a fast and innovative *in vitro* method.

The **Microfluidic Universal Skin (MUS)** is an innovative microfluidic skin model that mimics the mechanism of sweat and sebum excretion. MUS is therefore ideal for evaluating the *in vitro* efficacy of makeup products regarding their resistance to sebum and sweat excretion.

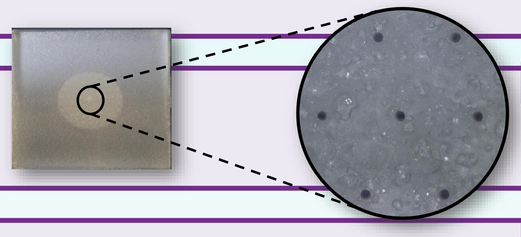
To assess the effectiveness of MUS, we compared the results of *in vivo* tests conducted on volunteers with those obtained *in vitro* with MUS.

Materials & Methods

In vitro protocol

Sweat & sebum gland excretion

Controlled parameters:
- Artificial sweat, pH=5.5 [1] & artificial sebum, viscosity = 56 mPa.s [2]
- Microfluidics system designed to mimic *in vitro* sebum and sweat excretion under controlled parameters such as flow injection
- Replication of human skin characteristics: gland density, roughness and hydrophobicity

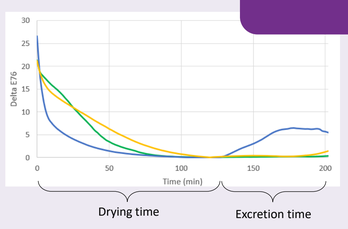


Makeup product application

- 3 liquid foundations tested
- 3,8 mg/cm²

Fluids / makeup interaction
- ➢ **Color variation**
- ➢ **Gloss variation**

Methodology:
- Standard images, parallel polarized images and crossed polarized images using MUS imaging system
- Continuous analysis (1 image every 2 minutes)

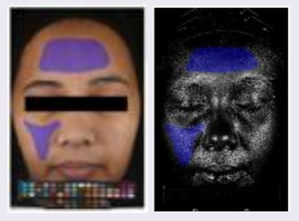


In vivo protocol

Inclusion criteria:
- 12 women selected
- Combination skin
- From 18 to 65 years old
- Phototype: II - IV

- 3 liquid foundations tested
- 2 mg/cm²

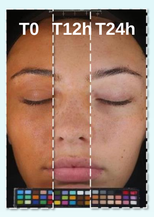
Methodology:
- 4 timepoints (T_0, $T_{immediate}$, T_{12h}, T_{24h})
- Clinical scoring by trained experimenter
- Front view images using the VISIA-CR® (standard, parallel polarized and crossed polarized images)
- Image analysis by Newtone



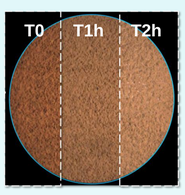
Results & Discussion

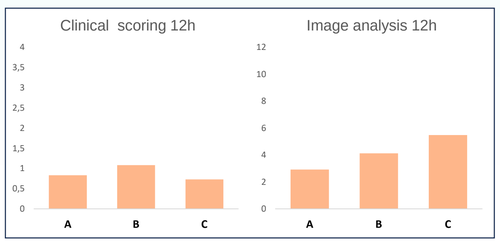
1) Color variation

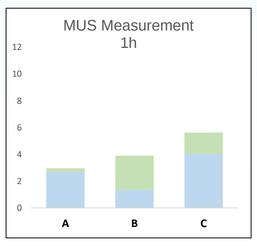
***In vivo*:** The clinical scoring study shows a similar trend between 12 and 24 hours. However, due to limitations in the human eyes gradation capabilities, the image analysis study is more accurate thanks to a multi-parametric analysis. In fact, the color variation of the products in image analysis shows the same trend at 12 and 24 hours. The product C has a higher color variation compared to products A and B. The product A is evaluated as the best product of all three in terms of long-lasting effect.

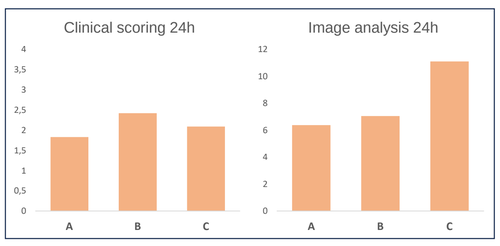


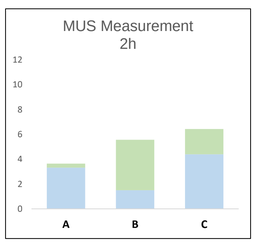
***In vitro* (MUS):**
The MUS model is an accelerated sweat and sebum excretion process. Therefore, 1 hours of *in vitro* MUS corresponds to 12 hours *in vivo,* and 2 hours *in vitro* corresponds to 24 hours *in vivo*. The three products are impacted differently by the two fluids, sebum and sweat. The cumulated color variation due to sebum and sweat is studied to predict their lasting effect over 12 hours and 24 hours.





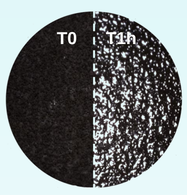


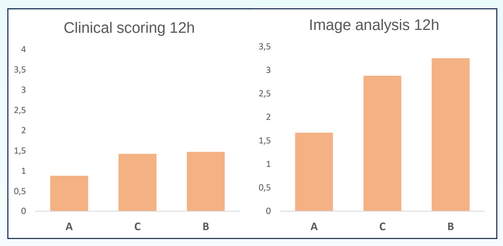


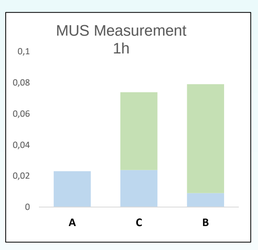


2) Gloss variation

The gloss parameter is used to determine resistance to sebum and sweat and to assess if a product has a mattifying effect. The gloss variation of the products on *in vivo* image analysis shows that product B is less resistant than the other two products C and A. MUS is able to predict the same trends as *in vivo* analyses. Product A has a low gloss variation, in contrast products C and B, which have a higher gloss variation.







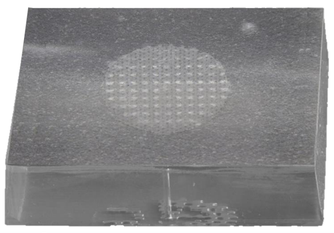
Discussion: Products A, B and C could be evaluated with two methods, *in vivo* analysis and the *in vitro* MUS model. These two models predicted the same resistance to fluids whether in gloss or color variation. By these two analyses, product A is the most resistant. The MUS model permit to predict the performance of products but also to provide informations on the impact of sebum and sweat.

Conclusions

In this study, we investigated the long lasting effect (color evolution & gloss evolution) of three liquid foundations using three distinct methodologies:

1. The clinical scoring method represents the subjective perception of a trained human eye and is extensively utilized by professionals as it provides insights into consumer perception.
2. Image analysis involves sophisticated algorithms with enhanced discriminatory power.
3. MUS replaces human volunteers with a skin model capable of mimicking sweat and sebum excretion. This skin model is combined with sophisticated image analysis to assess color and gloss variations.

The results obtained from these three techniques were in excellent agreement. To conclude, MUS is an *in vitro* model correlated to *in vivo* for the evaluation of makeup products.



References

[1] C.J. Harvey, R.F. Lebouf, A.B. Stefaniak. Formulation and stability of a novel artificial human sweat under conditions of storage and use (2010)
[2] E.O. Butcher and A. Coonin. *The physical properties of human sebum* (1949)