QUANTITATIVE EVALUATION FOR TRANSFER RESISTANCE OF FACE FOUNDATION PRODUCTS: FAST SCREENING (*IN-VITRO*) VS. CONSUMER-CENTRIC (*IN-VIVO*) ASSESSMENT

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1 INTRODUCTION

The successful development of foundation products relies on a winning combination of compositional elements (i.e. film-formers, emulsifying agents, absorbing fillers, and pigments) that then meet a wide array of consumer-perceived performance attributes. One of these attributes is the ability of the product to resist transferring from one surface to another. In order to validate this behavior, our work aims at investigating both fast screening approaches (*in-vitro*) and consumer relevant methodologies (*in-vivo*) as potential tools to aid in effective evaluation of product performance.

2 MATERIALS AND METHODS

The *in-vitro* transfer assessment was collected through use of a drawdown machine paired with both clear polyester films and bio-skin plates. These drawdowns were altered to simulate real-life consumer events such as sweat and sebum secretion. Fabric swatches were placed on top of these drawdowns, with light pressure, and left for a period of time to allow for transfer via absorption to occur [1]. Whereas, the *in-vivo* transfer assessment was obtained by contacting the consumers face with a cotton gauze pad after they had self-applied foundation. Consumers initiated transfer through pressing the cotton against their face in two specific areas while following instructed gestures. These gestures are illustrated below in Fig -1. Both *in-vitro* and *in-vivo* methods utilized image analysis of the transfer substrates through an in-house algorithm which quantifies transfer of foundation through a segmentation process that differentiates between clean white substrate and the beige/ brown coloring of foundation that has transferred. Examples of such images and segmentation can be seen below in Fig -2. More specifically, the algorithm provides metrics on the area (in pixels) of the cotton occupied by foundation, as well as the average color intensity of that same area – considered the optimal metric.

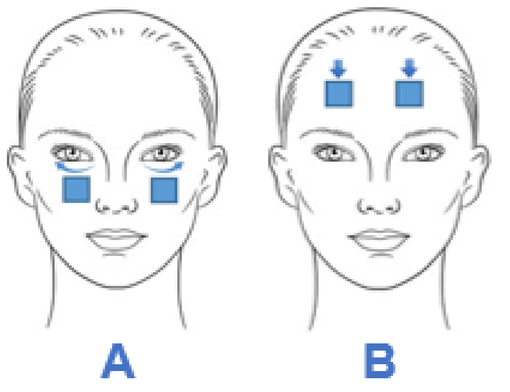

Fig -1. The in-vivo *method includes induced transfer gestures, completed by consumers, on their face after having applied foundation. Gesture A – swiping, one continuous motion, under each eye. Gesture B – pressing against forehead, 5-minute duration.*

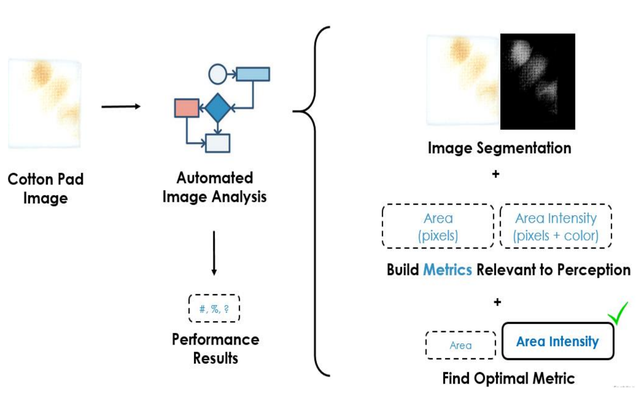

Fig -2. Image analysis involves segmentation process for analyzing foundation transfer onto substrate, followed by calculations of metrics based on pixel count and color intensity of the transfer site.

3 RESULTS & DISCUSSION

Method Development - Reproducibility between Panels

In-vitro measurements of four commercially-available long-wearing foundations were taken and significant quantitative differences were observed. These results therefore provide evidence for this methodology as a fast formulation screening solution. Translating the *in-vitro* approach to actual consumers resulted in diminished sensitivity between formulas, highlighting the potential advantages between *in-vitro* and *in-vivo* testing whether comparing sweat or sebum environments, reference Fig -3. Further, we found that a swiping motion across the skin versus simply pressing the substrate resulted in a greater correlation to our *in-vitro* screening approach. Reproducibility of the method was achieved through testing two independent sets of consumers where statistical similarity was seen, reference Fig -4.

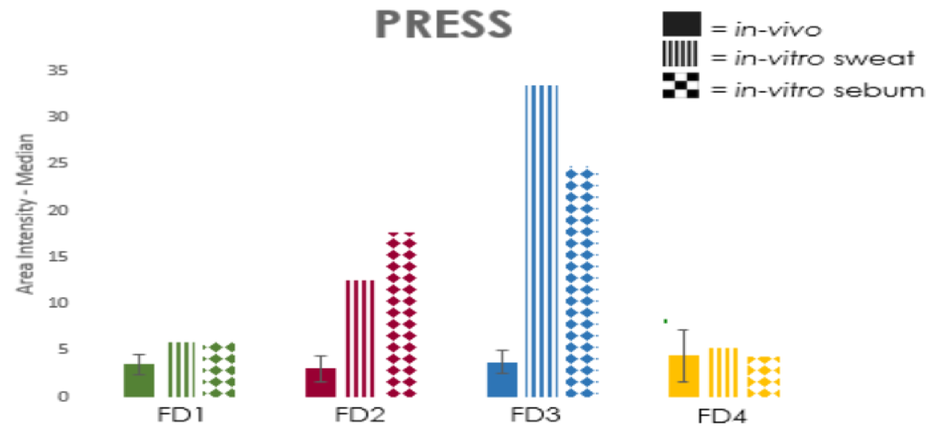

Fig -3. Comparison of in-vitro *fast-screening results to* in-vivo *consumer-centric assessment.*

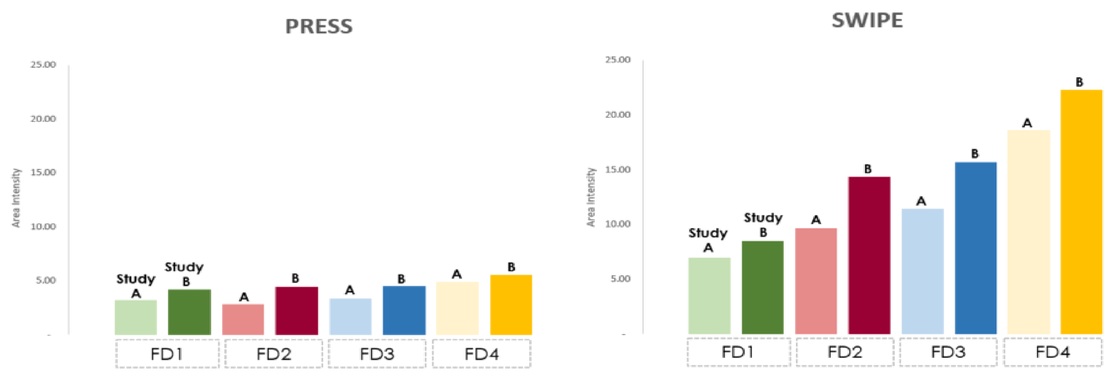

Fig -4. In-Vivo *transfer results – validation testing for method reproducibility and assessment of gesture impact (press vs swipe). Formulas (FD) tested twice, represented by independent Study A vs independent Study B.*

Method Development – Differentiation between Formulas

Further testing was conducted to differentiate between formulas similar to the *in-vitro* work. Six long-wearing foundation formulas were tested and distinguishable differences between them were observed (Fig -5). Statistically distinct groupings were established between 'low', 'medium', and 'high' performing formulas in relation to the amount of transfer seen. The press gesture provided a lesser degree of overall transfer that generated three statistically distinct groupings. Whereas the swipe gesture generated two statistically distinct groupings and showed a higher degree of overall transfer. The press gesture resulted in all formulas exhibiting mean values of eight or less – relating to the visible threshold. Conversely, all foundations aside from FD1, assessed using the swipe gesture, resulted in mean values above this threshold.

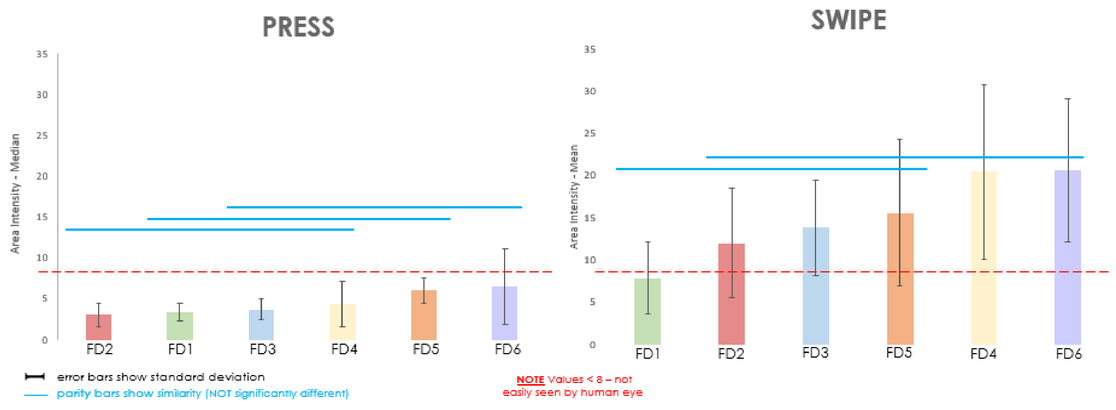

Fig – 5. In-Vivo *transfer results on six different foundations assessed by either Press or Swipe. Dotted red-line indicates threshold of visual human perception of transfer on substrate.*

4 CONCLUSIONS

The *in-vitro* method allows for high repeatability of application of face foundation, amount of sebum and sweat presented, and level of transfer induced by establishing a highly-controlled environment. To the contrary, the *in-vivo* method permits additional variance that more closely mimics real-world cases of transfer seen on users of face foundations. Future work will be dedicated to further understand the relation between the values generated by this computational analysis and human perception of transfer.

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Badami, J. V., & Bui, H. S. (2021). Quantification of the Color Transfer from Long-Wear Face Foundation Products: The Relevance of Wettability. In Surface Science and Adhesion in Cosmetics (First, pp. 379–399). essay, Wiley-Scrivener.

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