

An Adhesive Patch Device for Skin Microbiome Studies

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Introduction

Our understanding of the skin-residing microbiome on skin health has improved dramatically in recent years, and diagnostic or therapeutic applications based on the skin microbiome are starting to emerge¹. However, progress has been hampered by deficiencies in obtaining skin microbiome samples of sufficient quality and quantity, as the frequently used swab sampling methods generally capture only limited amounts of microbiome materials from the outermost layer of the epidermis. They are generally unable to collect species present in the deeper layers of the epidermis. This study investigated if a non-invasive adhesive patch device is capable of reliably obtaining sufficient amounts of microbiome samples, from populations present in superficial and deeper layers of the epidermis. This may open opportunities to use this new tool in a variety of clinical applications.

Materials and Methods

The adhesive patch sample collection kit used for this study was manufactured by DermTech Inc. (La Jolla, CA, USA). Each kit contains 4 adhesive patches (19mm in diameter). By applying the adhesive patches to skin (Figure 1), layers of epidermal cells together with all microbiome residing on or between the skin cells are collected via the patches. Total DNA was isolated from the samples collected with each patch and subjected to 16s rRNA quantification with qPCR². Microbiome counts were assessed (one copy of 16s rRNA = 1 microbiome).

Results

Figure 2 shows transmission electron microscopy (TEM) pictures of skin stratum corneum cells collected collected via adhesive patches. The microbiome residing on and between the epidermal cells would also be collected together with skin cells on patches. Figure 3 compares the adhesive patch with the traditional swab on skin microbiome sample collection. Bars represent the averaged microbiome counts from 5 skin test sites. The adhesive patch method seems to have outperformed the swab method.



Figure 1. DermTech Adhesive patch kit (A) that includes four 19mm adhesive patches (B) used for collecting epidermal skin samples (C, D).

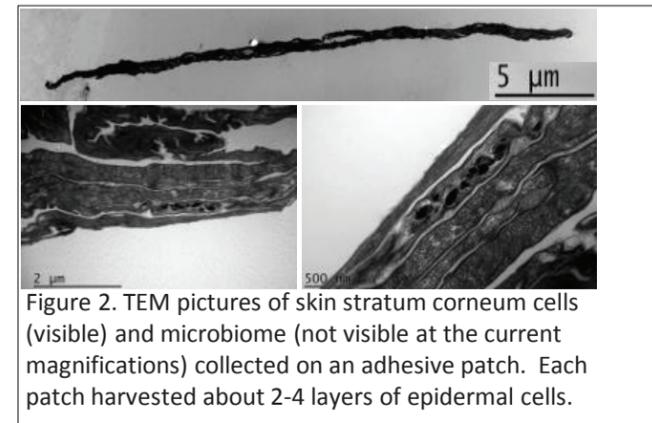


Figure 2. TEM pictures of skin stratum corneum cells (visible) and microbiome (not visible at the current magnifications) collected on an adhesive patch. Each patch harvested about 2-4 layers of epidermal cells.

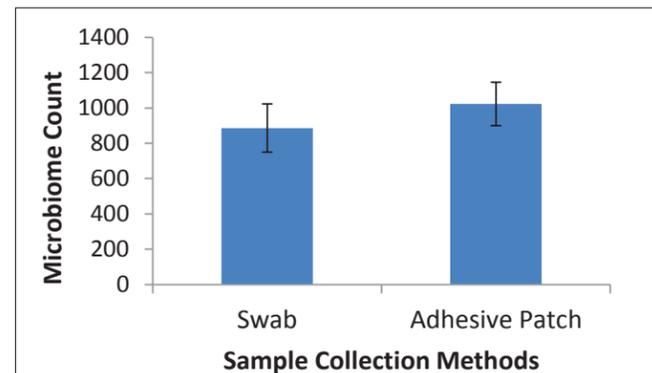


Figure 3. Comparison of microbiome counts in skin samples collected through the traditional swab and the adhesive patch kit (Bars are mean microbiome counts \pm SE from 5 skin test sites (one collection per site from the top surface of skin))

Table 1 lays out the experimental design to investigate microbiome changes from different skin sites of 3 test

subjects (with healthy, normal skin). Each site was sequentially collected with 4 adhesive patches. The microbiome from each patch was analyzed separately to detect changes in microbiome numbers as they correspond with deeper layers of the epidermis. Combined microbiome counts from the 4 patches from the same test site gave the total microbiome count on each test site. Figures 4 to 6 show the changes in microbiome counts on each patch or in each test site.

Table 1. Experimental Design

Test Subject	Body Test Sites			total
	Fore arm	Inner elbow	Forehead	
Y	4	4	4	12
M	4	4	4	12
T	4	4	4	12
total	12	12	12	36

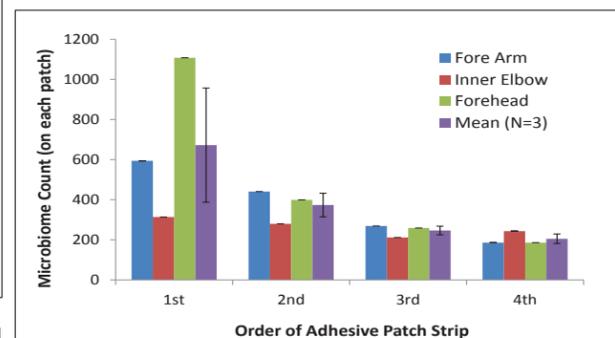


Figure 4. Microbiome counts on each adhesive patch from 3 skin test sites of Subject Y. Microbiome number counts decrease in deeper skin layers.

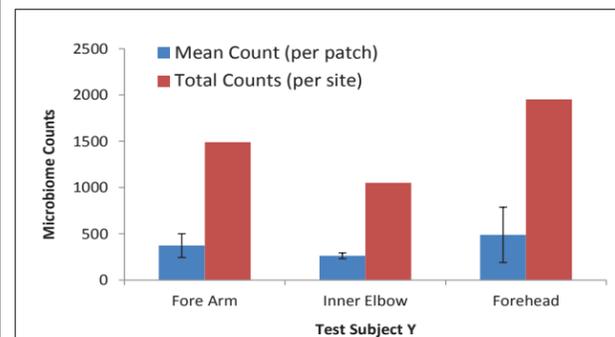


Figure 5. Mean (per patch) and total microbiome counts (per test site, pool of microbiome from 4 patches collected from the same sites) from Subject Y. Microbiome counts varied at different skin locations

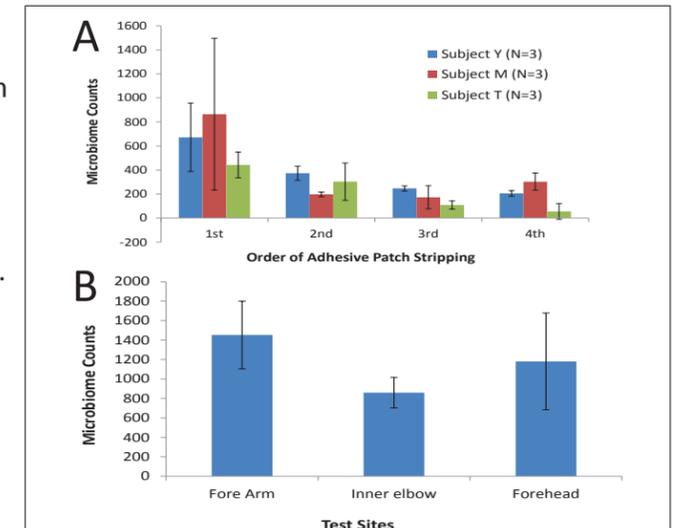


Figure 6. Mean microbiome counts from the first to the 4th adhesive patch from all test sites (3) of 3 test subjects (A, bars are mean counts \pm se, N=3), and mean total microbiome counts from the 3 test sites of 3 test subjects (B, bars are mean counts \pm se, N=3x4)

Conclusion

This study demonstrated the successful collection of skin microbiome samples from all skin sites of all test subjects. The outermost epidermal skin layers yielded the highest microbiome counts and numbers decreased with deeper layers of the epidermis. As each adhesive patch harvesting step removed about 2-4 layers of epidermal cells together with the microbiome residing in these cell layers, the adhesive patch tool allowed us to also collect and study microbiome samples from the deeper epidermal layers and not just those on the skin surface. This may help overcome the limitations encountered by the traditional swab method which collects the surface microbiome only. This unique feature and advantage may lead to numerous uses of this adhesive patch sampling tool in clinical applications that benefit from investigating and assessing skin microbiome compositions or populations from different epidermal layers without and with the ability to also assess and monitor skin cell gene expression signatures.

References

1. Elizabeth A. Grice. The skin microbiome: potential for novel diagnostic and therapeutic approaches to cutaneous disease. *Semin Cutan Med Surg.* 2014 June ; 33(2): 98–103.
2. 3. Kennedy and Kong., Research Techniques Made Simple: Bacterial 16S Ribosomal RNA Gene Sequencing in Cutaneous Research. *Journal of Investigative Dermatology* (2016) 136, e23-e27.

Supported by DermTech, Inc.