Mandom Succeeds in Establishing an Evaluation Method for Thermoregulatory Sweat Glands by Visualizing and Quantifying Perspiratory Contractions

～In Pursuit of Next-generation Antiperspirants ～

Mandom Corporation (Head Office: Osaka, President Executive Officer: Motonobu Nishimura, hereafter "Mandom") has been aiming to produce next-generation antiperspirants that can control perspiration as a part of its research at the Laboratory for Advanced Cosmetic Science (collaborative research institute including the Osaka University Graduate School of Pharmaceutical Science and Mandom).

With the cooperation of Graduate School of Pharmaceutical Science, the Protein Research Institute, and the Graduate School of Medicine at Osaka University, we succeeded in visualizing the contraction of human sweat glands during perspiration.

Elucidating the mechanism by which sweat glands contract during perspiration requires the detailed understanding of its structure. Analysis of the 3D structure of human sweat glands reported in the previous study (press release June 21, 2017) revealed this unique structure and might serve as a basis to understand perspiratory contractions. However, the accurate contraction mechanism of the sweat glands to secrete sweat has not yet been clarified.

Thus, we focused on the coiled structure of human sweat glands, the part responsible for secreting sweat. Using live image method (a method involving visualization of 3D movements via videos), an essential technique to analyze the changes over time in 3D structures, we observed perspiratory contractions in the sweat gland and found them to be highly similar to those that occur in a live organism.

These results might lead to the development of a next-generation antiperspirant capable of suppressing perspiratory contractions of the sweat gland. This result would remarkably contribute to a better quality of life for consumers with hyperhidrosis or malodorous sweat.

We plan to present our research findings at the 30th Annual International Federation of Societies of Cosmetic Chemists (IFSCC) Munich Conference held on September 18–21, 2018.

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1. Production of a Next-generation Deodorant

The sweat gland is essentially a long tubule which is open on one end. The open end of the tubule is embedded in the surface of the skin (the exit route for sweat), whereas the other end extends a few millimeters down into the deeper layers of the skin, where it terminates in a tangled, coil-like structure. This coiled region comprises a secretory duct and an excretory duct, and the outermost layer of the secretory duct is surrounded by the myoepithelial cells. When the myoepithelial cells contract, sweat produced by the secretory duct of the gland is believed to be secreted through the excretory duct and out onto the surface of the skin (Figure 1)..

In recent years, consumers with sweating problems (hyperhidrosis and malodorous sweat) have increased due to factors such as global warming and societal changes. In order to help address this issue, researchers have included compounds such as aluminum chloride, which essentially seals off the openings of sweat glands, in antiperspirant formulations. However, these compounds have disadvantages: if one sweats considerably, the seal is lost; if the seal is too tight, Sweat is leaked from sweat duct and cause inflammation. We believe that, if we develop an antiperspirant that acts directly on the secretory part of the sweat gland and forces it to temporarily cease its activity (and thereby prevent sweating), we can address the heretofore unaddressed problems of consumers by applying antiperspirants.

2. Successful Observation of Perspiratory Contractions in the Human Sweat Glands

In order to develop antiperspirants that suppress perspiratory contractions, we need to first understand the mechanism of sweat gland contraction. We can then apply this information to explore compounds that can suppress these contractions. Thus, we intended to reproduce the perspiratory contraction of sweat glands that occur inside our body. We picked up and collected the coiled regions of actual sweat glands from the human skin (with ethics board approval), and, using 3D live imaging, we attempted to evaluate the perspiratory contractions of the sweat glands in a mimicked sweating condition. We examined the conditions necessary for observing perspiratory contractions, such as reagents appropriate for perspiration contraction and their concentrations and imaging resolution and shooting speed with which contractions can be observed. Thus, we managed to capture video footage of the extremely dynamic contraction of human sweat glands in response to a sweat-inducing stimulus (Figure 2).

3. Establishment of an Evaluation Method for Perspiratory Contractions Caused by Sweat-inducing Stimuli

During detailed analysis of footage of perspiratory contractions, we observed that, within a contracting sweat gland, the volume of sweat within the tubule of the sweat gland gradually increases such that sweat is pushed out of the open end. Using specialized image analysis software, we could compute quantitatively this change in volume, thereby establishing a method for objectively evaluating perspiratory contractions (Figure 3). This result indicates that the observation method established replicates the perspiratory contractions of sweat glands. Further, the analysis of data obtained via this observation method is a valid way to explore effective compounds (compounds capable of directly acting on sweat glands to suppress perspiration).

In the future, we will use this evaluation method to continue our development of next-generation antiperspirants that can directly control perspiratory function.

Mandom will continue to proactively prioritize the effects on and the feelings of consumers in the development of highly effective antiperspirants that can satisfy those that use them.

[Reference Material]

Figure 1: Sweat Gland Structure

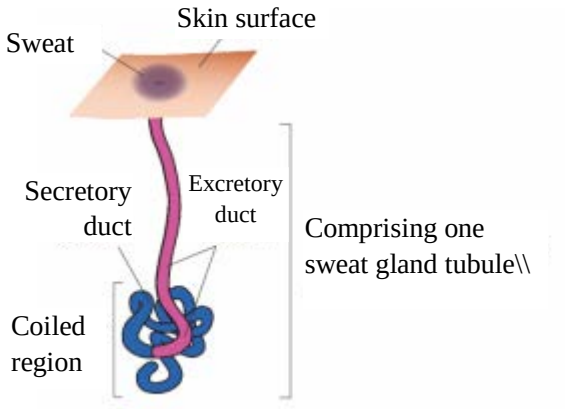


Figure 2: Footage of the Contraction of Human Sweat Glands in Response to Stimulus
(Red box: magnified region, yellow arrow: movement of the sweat gland tubule due to contraction)

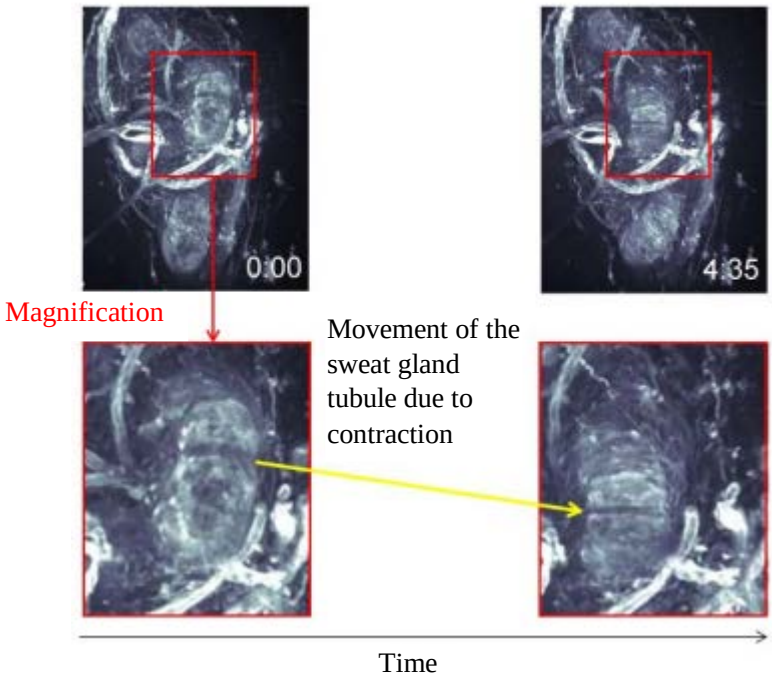
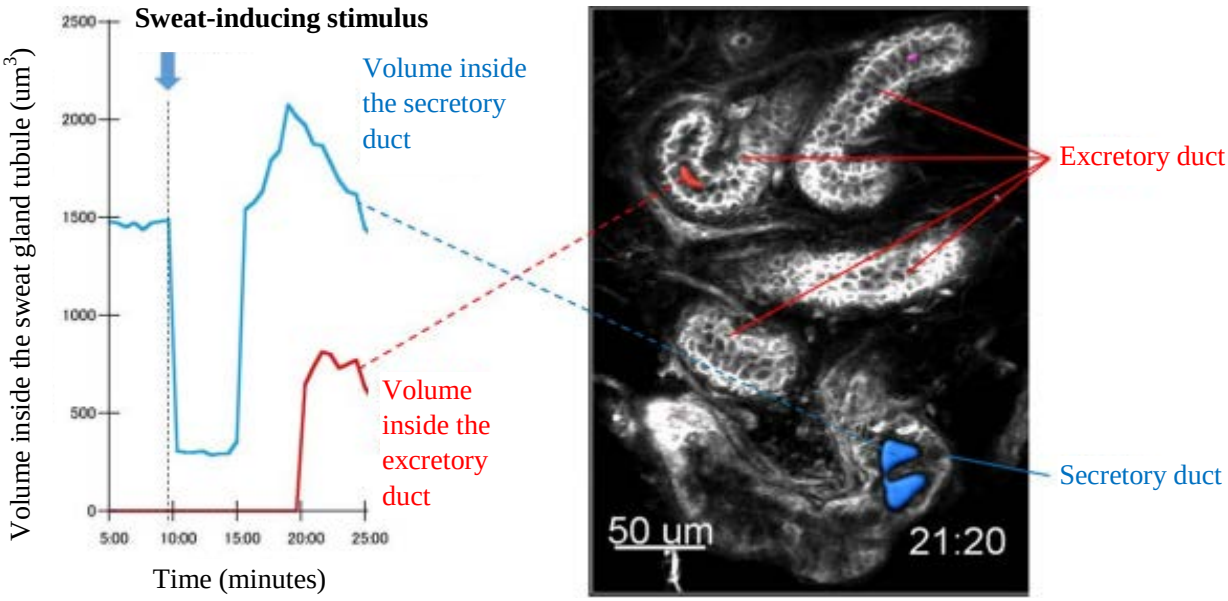


Figure 3: Change in Volume in the Sweat Gland Tubule Occurring During Contraction of the Gland During Perspiration



*This figure reflects our measurements of the volume inside the sweat gland tubule in specified regions of the secretory and excretory duct of the gland.

[Reference News Release]

"Successful Visualization of the Three-dimensional Structure of the Sweat Gland, which Regulates Body Temperature Hope for the Explanation and Treatment of Heatstroke and Hyperhidrosis and the Development of Next-generation Antiperspirants"
(June 21, 2017 News Release)

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