By using World-class, Cutting-edge Analytical Tools, Mandom Succeeds at Comprehensively Analyzing the Compounds of Body Odor
~ Development of a Method for Classifying Odor Type Based on Specific Axillary Sweat Compounds ~

[Received the 2011 Paper Award from the Japanese Association for the Study of Taste and Smell]

Mandom Corporation (Head Office: Osaka, President Executive Officer: Motonobu Nishimura, hereafter "Mandom"), along with its research partner Human Metabolome Technologies (a venture company out of Keio University), has been using world-class, cutting-edge analytical tools in the field of metabolome[1] research and succeeded in the metabolomic analysis of axillary sweat and the detection of over 300 compounds therein. Further, we discovered the existence of multiple compounds that affect axillary odor type. Finally, we found that classifying axillary odor type by measuring specific axillary sweat compounds was possible.

In the future, we intend to implement this new technology in the development of new deodorants capable of responding to a multitude of different odor types.

The technical paper describing the research titled, "Analysis of axillary odor-specific compounds via metabolomic analysis of human axillary sweat," will be awarded the Outstanding Paper Award at the 45th Annual Meeting of the Japanese Association for the Study of Taste and Smell (October 5–7, 2011).

1. Involvement in the Explanation of the Origin Mechanism of Axillary Odor

Axillary odor is generated when sweat and sebum are digested by the normal bacterial flora of the skin. However, the pathways of this digestive process are complicated, and many different metabolites are involved in the generation of odor. Thus, many different odor compounds are mixed together in axillary sweat, causing a multitude of different axillary odor types. Consequently, accurate understanding of the mechanisms by which various types of axillary odors arise is necessary for the development of effective odor-preventative deodorant products. Therefore, comprehensively analyzing the compounds of axillary sweat—the progenitors of odor—and exploring compounds specific to each type of odor and the metabolic pathways that are involved in their production are crucial.

At Mandom, we conducted an odor analysis of 118 Japanese men (aged 18–63 years) in 2007 and found that axillary odors can primarily be categorized into three types (A-type: acid-odor, C-type: curry-like/spicy- odor, M-type: milky-odor).

Thus, we applied CE-TOFMS*[2]—known to be highly sensitive and having high resolving power and used recently in the search of biomarkers for diseased states—to analyze axillary odors. By conducting metabolomic analysis of axillary sweat compounds collected for each odor type, we attempted to explicate the origin mechanisms of axillary odor.

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2. Discovery of New, Characteristic Axillary Sweat Compounds for Each Axillary Odor Type

We collected sweat from the axillarys of Japanese men who possessed odors matching to those discovered via odor analysis (A-type: acid-odor, C-type: curry-like/spicy-odor, M-type: milky-odor) and used CE-TOFMS to perform metabolomic analysis of these samples. Furthermore, we conducted a comparative analysis of A-type, C-type, and M-type odors and analyzed the compounds associated with the stronger and more unpleasant A- and C-type axillary odors.

Odor Evaluation

Characteristics of Axillary Odor Types

	A-type	C-type	M-type
Prevalence*	**17%**	**18%**	**56%**
Odor Strength	**moderate~strong**	**strong**	**weak**
Unpleasantness	**moderate~high**	**high**	**low**

*** Results of the evaluation of 118 Japanese males**

After metabolomic analysis on axillary sweat was conducted, we detected over 300 compounds, including organic and amino acids Figure 1. After detailed analysis of each of these compounds was conducted, we discovered characteristic axillary sweat compounds for each odor type: 4 for A-type, and 20 for C-type. These odor-causing compounds were newly identified, to our knowledge. Some of these compounds contribute to the generation of A- and C-type axillary odors.

3. Enabling Classification of Axillary Odor Type by Measuring Specific Axillary Sweat Compounds

In order to discover the marker compounds for A- and C-type axillary odors, we used a statistical analysis method used in the detection of disease biomarkers—decision tree analysis*[3]—and found that the amounts of two specific axillary sweat compounds (No. 110 and No. 030) could be used to categorize axillary odor type with high fidelity (Figure 2). We believe that these axillary sweat compounds could contribute to the generation of C- and A-type axillary odors. Before this discovery, we differentiated between axillary odor types on the basis of odor analysis by using the human sense of smell; next, by measuring the amounts of specific axillary sweat compounds, we could classify axillary odors into their different types.

Our research comprehensively analyzes the axillary sweat compounds of each type of axillary odor with the idea that sweat, the cause of body odor, is a metabolic product just like blood and urine; this has led to the identification of specific axillary sweat compounds for each axillary odor type as well as the elucidation of odor generation pathways. Finally, to our knowledge, this is the first study indicating the validity of metabolomic analysis of the metabolites on the surface of human skin. At Mandom, we intend to continue applying this cutting-edge analytical technique to our investigation of the mechanisms of body odor and to develop deodorants with high odor-preventative power.

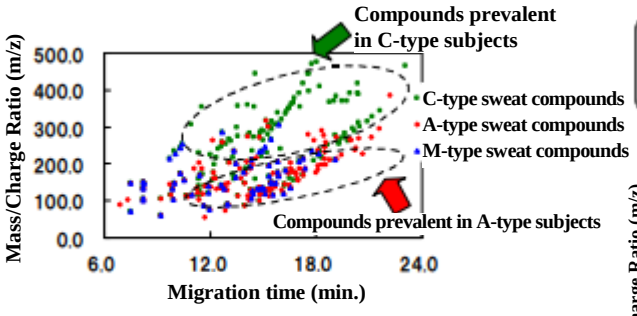

Figure 1: Plot Diagram of Axillary Sweat Compounds Detected for Each Odor Type

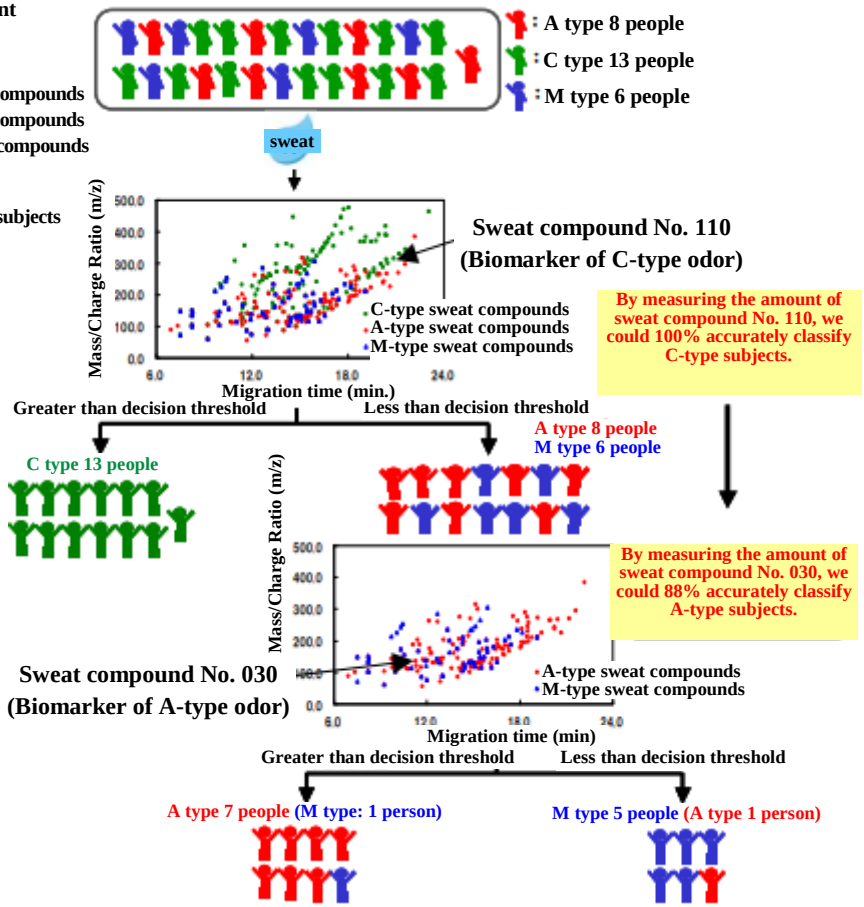

Figure 2: Classification of Axillary Odor Types by using Decision Tree Analysis

*1. Metabolome Research

In Japan, creative, original, and cutting-edge research specializing in metabolomes began in the 1990s; in the modern day, Japan leads the world in this research field. The metabolome of an organism is a concept used to comprehensively analyze the types and amounts of metabolites such as organic acids and amino acids present in the blood, urine, and cell parts. Since metabolic substances are susceptible to factors such as diet, disease, and drug intake, suitably expressing the associated dynamic changes, in recent years, this research method has received remarkable attention in fields such as pharmacokinetic analysis and disease marker search.

*2. CE-TOFMS

By using capillary electrophoresis (CE), which is especially useful in the analysis of ionic compounds, and time-of-flight mass spectrometry, which has a short analysis time and high resolution, this technique allows researchers to obtain precise information on molecular weight and molecular structure. This method can, in an analysis time of about 30 min, analyze more than 1000 kinds of ionic substances and is very suitable for the analysis of compounds in complicated sample matrices such as those of metabolites.

*3. Decision tree analysis

This is a method for deciding and classifying the most optimum among multiple variables when elements from multiple groups need to be categorized into predefined, specific areas. It is one of the statistical analysis methods applied in the identification of biomarkers of diseases.