Measurement of emission fluxes of human skin gas by passive flux sampler.

（パッシブ・フラックス・サンプラー法によるヒト皮膚ガス放散量の測定）

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1. Introduction

Volatile organic and inorganic compounds emanating from human skin are potentially non-invasive biomarkers of individual physical or physiological status. However, determinations of such volatile compounds have been rarely reported due to difficulty of sampling and their very low concentration levels. In this study, authors have developed new design of passive diffusion samplers called by Passive Flux Sampler[1)] (PFS), which is a simple device to determine an emission flux of gases emanating from the surface of the human skin and applied to measure influences of individual physical conditions of volunteers on the fluxes.

2. Experimental

2.1 Passive Flux Sampling system

This type of PFS, for the collection of human skin gas, simply consists of main body, O-ring type retainer and trapping filter (Fig.1). The PFS can be applied to measure various chemical components by changing the trapping solution: 2,4-dinitrophenylhydrazine (DNPH) for carbonyl compounds and phosphoric acid for ammonia. The PFS is the softly fixed on the surface of skin using an elastic tape for 30 ~ 60 minutes at room temperature (Fig.2). At the same time, the sampler was put on the petri dish at room temperature, to correct target gas in internal space of PFS as background. The target gases diffused in a headspace are collected in the filter. After extraction and preprocessing, collection amounts of analytes, *W* were determined by analytical equipment: HPLC for carbonyls and indophenol - FIA method for ammonia. The emission flux, *E* calculated by (1).

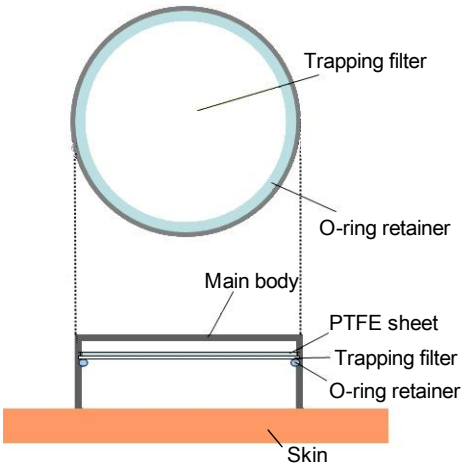

Fig.1 Schematic view of the PFS

$$E = \frac{W}{S \cdot t} \quad \cdots\cdots\cdots (1)$$

E:emission flux (ng・cm^{-2}・h^{-1}) *W*:collection amount (ng)

S:cross-section of the exposed human skin(cm^2) *t* :sampling time(h)

Fig.2 Collection of human skin gas

3. Results and Discussion

3.1 Acetaldehyde/Drinking

Acetaldehyde is well known as a metabolite of ethylalcohol, with a higher blood concentration after drinking. As can be seen in Fig.3, the emission flux of acetaldehyde from the skin surface of each volunteer apparently increased after drinking and lasted for ten hours or more. Moreover, there seems to be two peaks in the variations of the fluxes. This suggests there are two or more emission routes of acetaldehyde from the surface of the skin.

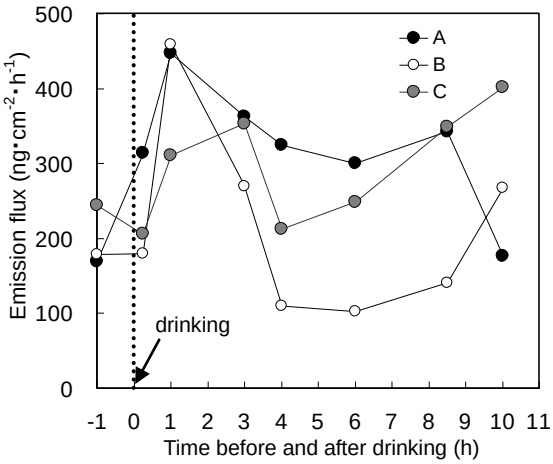

Fig.3 Time courses of emission fluxes of acetaldehyde of volunteer A, B and C.

《Protocols》

Subjects: 3 males

Age: 21~24

Sampling time: 30 min

Sampling position: left forearm

Beverage: Liqueur (Shochu Highball, Alc.4%),350mL

Supplemental measurement: Dermal moisture(F) Body temperature(℃)

3.2 Acetone/Fasting

The clinical measurements of acetone are very important for the diagnosis and treatment of diabetic and excess diet[2], because acetone is a member of ketone bodies which are products of the metabolic reaction of fatty acids when there is low blood glucose. Fig.4 shows changes in emission fluxes of acetone during fasting. The emission fluxes of acetone of each volunteer apparently increased after 20 hours after fasting.

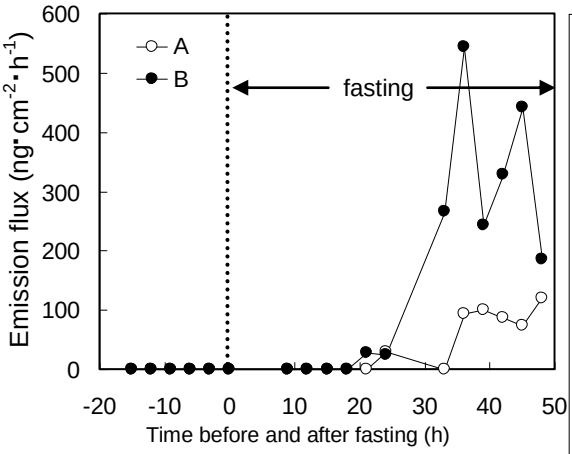

Fig.4 Acetone flux according to fasting

《**Protocols**》
Subjects: 2 males
Age: 21~22
Sampling time: 30 min
Sampling position: left forearm
Fasting duration: 48 hours
Supplemental measurement : Dermal moisture(F) Body temperature(℃)

3.3 Ammonia

Ammonia is a metabolite of protein and its blood concentration increases when a hepatic function decreases and a blood lactate accumulates[3)4)]. However, the emission of ammonia from human skin is unknown. Then, this study aimed to detect the ammonia by PFS.

Fig.5 shows the emission fluxes of ammonia from four voluntary subjects (#1~#4) at five sampling positions (n=3). Emission fluxes of ammonia were successfully obtained and relatively higher values were found in back and sole. However, the variations within one volunteer also large in the two sites. This means back and sole are not suitable sampling position due to a possible influence of ammonia-producing bacterium on the surface of the skin and other. Emission flux measured at palm depended on the diffusion length in the PFS as shown in Fig.6. This is probably because influence of sweating and contamination of hands. Therefore, have decided to use forearm as a sampling position for the measurement of ammonia from human skin.

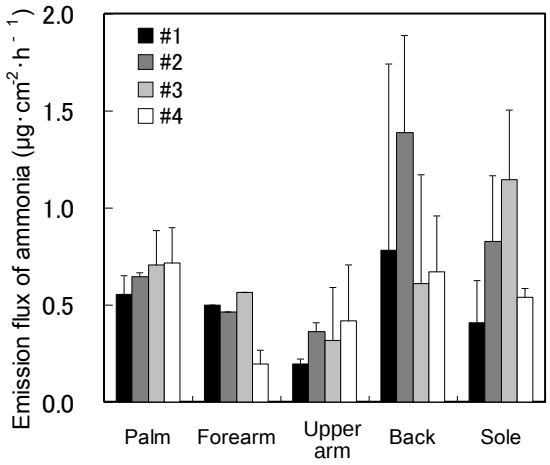

Fig.5 Emission fluxes on each sampling position
(Mean and standard deviation of triplicate measurement in each subject)

《**Protocols**》
Subjects: 2 males and 2 females.
Sampling time: 1 hour
Sampling position: Forearm, Palm, Back Sole, Upper arm (leftside)
Supplemental measurement : Dermal moisture (F) Body temperature (℃)

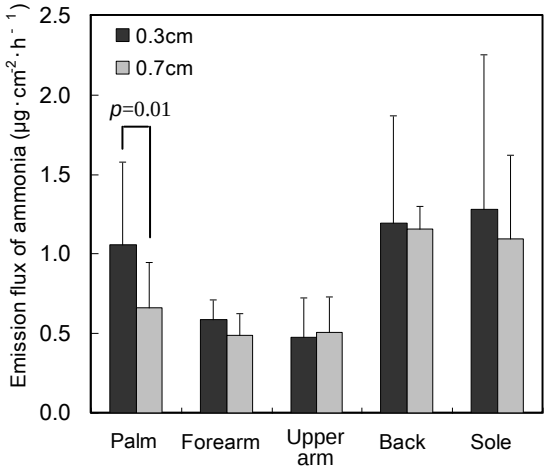

Fig.6 Effect of diffusion length on emission flux
(Mean + standard deviation at each sampling position)

《**Protocols**》
Subjects: 2 males and 4 females.
Sampling time: 1 hour
Sampling position: Forearm, Palm, Back Sole, Upper arm (leftside)
Supplemental measurement : Dermal moisture (F) Body temperature (℃)

4. Conclusion

The PFS is a simple device suitable for simultaneous and multiple sampling of human skin gas and quantitative demonstration. This type of non-invasive measurement may have the possibility to be a simple and efficient tool for diagnosis of physical conditions, when clinical significance of measurements of these compounds emanating from human skin is established.

5. Reference

1) Sekine,Y.,Toyooka,S.,Watts,S.F., *J.Chromatogr.B*,859,201-207(2007) 2) K.Naitoh *et al*., *Instr.Sci.Tec*.,39,267-280(2002) 3) Nose K. *et al*., *Anal. Sci*., 21, (12),1471-1474(2005) 4) Buono, M.J. *et al*., *J. appl. phys. Respir. Environ. & Exer. Phy.*, 39, (1),135-139(1984)