A STUDY ON THE ODORANTS EMITTED BY HUMAN BEHAVIORS AS SOURCES OF INDOOR AIR POLLUTION

Yasuhiro Hashimoto[1], Atsuo Nozaki[2], Hoshio Goto[2], Yuki Yamashita[2], Yasunori Narita[3]
[1] Tohoku Bunka Gakuen University, Miyagi, Japan, Hashimoto@ait.ac.jp
[2] Graduate School of Tohoku Bunka Gakuen University, Miyagi, Japan, nozaki_yamashita@ept.tbgu.ac.jp
[3] Life science research laboratory Co. Ltd., Fukushima, Japan, narita@lsrl.biz

Abstract
In late years, people are becoming increasingly concerned about body odors such as breath odor. Furthermore, body odor of residents is drawing attention as it has an influence on comfort of indoor space. Main body odor is breath odor, scalp odor, axillary odor, foot odor and excrement odor. By the way, it may include “cigarette smoking” and “alcohol drinking”.
The present study aims at determining the emission rates of VOCs in the expired air. A human subject was tested for the expiration of target substances following the intake of 500mL of beer. The results showed that ethanol emission rates decreased from 381511[μg/h] to 341603 [μg/h] over 180 minutes after alcohol intakes. Acetone emission rates increased from 349 [μg/h] to 1240 [μg/h] over 180 minutes after alcohol intake. Emission rates of acetone and 2- propanol of the cause of breath odor tend to increase with drink liqueur.

1. Introduction

In late years, there has been more interest indoor odor, because comfort indoor space is demanded by residents.
Conventionally, excrement, raw garbage, and cigarette smoke have been regarded as three major sources of odor emission.
In addition, people are becoming increasingly concerned about body odors such as breath odor.
Main body odor is breath odor, scalp odor, axillary odor, foot odor and excrement odor. We think that emitted odorant from human should be identified, clarified quantitatively.
Among the behaviors that increase the emission rate of human odor substances are "cigarette smoking" and "alcohol intake"; however, there are few reports that give quantitative values for the emission rates of the substances caused by those daily activities.
In addition, there is also VOC such as acetone other than aldehydes among odor substances emitted from human breath.
Acetone is generally said to smell sweet and cannot be regarded as an offensive odor necessarily. However, when the concentration exceeds 100[ppm], it becomes recognized as halitosis.
Then, in this report, we will clarify the odor emission rate in breath caused by taking in alcohol, and elucidate the influence of human daily activities on indoor air quality, focusing on human biological gas.

2. Experiment

2.1 Subject

The measurement target of this experiment was human breath before and after taking in alcohol. The subject was healthy males and their characteristics are shown in the table.1.International collaboration stretching across national boundaries is needed to solve the major problems of the future. The symposium will be devoted to presentation and detailed discussion of the papers. Essential to any successful conference is the cooperative interaction and congeniality of the participants.

Table 1 Outline of subject

Sex	Age	Height[cm]	Weight[kg]	Occupation
male	21	162	51.8	Student

2.2 Alcohol intake condition

Other than the physical characteristics of the subjects, the conditions of alcohol intake are among the

factors that have an influence on breath alcohol concentration after alcohol consumption.
The conditions of alcohol intake are shown in the table.2

Table 2 Outline of alcohol intake conditions

Meals before	Time passed after eating [h]	Variety of alcohol	Consistency of alcohol [%]	Amount of alcohol intake [mL]	Time needed for intake [min]
eated	2	brewer	5	500	10

2.3 Measurement substances
The substances measured in this study were aldehydes and VOCs
2.4 Measurement method
(1) Aldehyde
Solid-Phase Collection - Solvent Extraction – High performance liquid chromatograph
(2)VOC
Solid-Phase Collection - Thermal Desorption - Gass chromatograph / mass spectrometry
2.5 Measurement procedure
(1) The subject's mouth was washed out thoroughly with purified water.
(2)The breath of before alcohol consumption was sampling in a bag.
(3)The subject took in alcohol. He consumed beer within 2 minutes and repeated this activity 5 times in 10 minutes.
(4)The breath of after alcohol consumption samples were collected at fixed intervals.
(5)Aldehydes were extracted in DNPH from the air sample in the bag and qualitative and quantitative analyses were conducted using HPLC and VOCs were extracted in carbon tube from the air sample in the bag and qualitative and quantitative analyses were conducted using GC/MS.

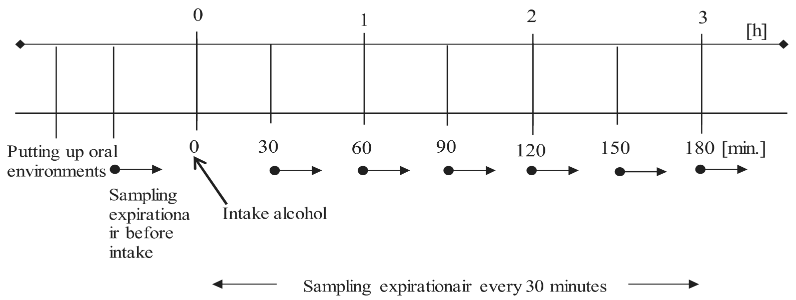

Figure 1 Measurement procedure

3. Results
3.1 Changes of aldehydes emission rates with intake alcohol
(1) Acetaldehyde
The result of acetaldehyde emission rates is shown in the figure 2.
The acetaldehyde emission rates in the breath 30 minutes after alcohol consumption became 239[μg/h], which was its maximum value during the measurement period. Then, as time passed, the emission rates continued to decline.
The consumed alcohol is absorbed in the stomach and the small intestine and degrades into acetaldehyde by alcohol dehydrogenase in the liver. During this period, acetaldehyde in the blood and breath increases, and is converted further into acetic acid. Then, acetic acid degrades into carbon dioxide and water and is finally ejected from the body.
Within the scope of this experiment, it can be considered that alcohol degraded massively right after the consumption (within 3 minutes) and resulted in the generation of acetaldehyde, which itself is believed to have soon been degraded by dehydrogenase.
Furthermore, 180 minutes after alcohol consumption, the value of acetaldehyde emission rates still

indicated 105[μg/h], which corresponds to 135 times the value before the consumption. This establishes that acetaldehyde was being emitted over a long period.

(2)Formaldehyde

The result of formaldehyde emission rates is shown in the figure 3.

The Formaldehyde emission rates were 2.47[μg/h] before alcohol consumption, which was larger than after the consumption. As a result, Formaldehyde emission rates were rather reduced by consuming alcohol.

It is known that formaldehyde is contained in cigarette smokers' breath, but the subjects of this experiment were non-smokers.

(3) n-buthylaldehyde

The result of n-buthylaldehyde emission rates is shown in the figure 4.

n-buthylaldehyde reached its maximum value, 1.30[μg/h], 30 minutes after the alcohol consumption, then reduced to approximately the pre-consumption level 60 minutes later. In another 90 minutes, it fell below the minimum limit of determination. The cause of the increase in n-buthylaldehyde emission rates during the 180-minute period is unknown.

It is worthy of note that n-buthylaldehyde is one of the specified offensive odor substances and the smell is defined as "irritating, sweet and sour, and burning".

(4) Isovaleraldehyde

The result of isovaleraldehyde emission rates is shown in the figure 5.

Isovaleraldehyde reached its maximum value, 0.96[μg/h], 30 minutes after the alcohol consumption. Then, as time passed, the emission rates continued to decline. Isovaleraldehyde has a "choking, sweet and sour, and burning" smell, and it is utilized as an odorant for fruit and liquor as well as a food fragrant additive.

It is also considered to be safe when used for the purpose of flavoring. Currently, it is believed that isovaleraldehyde in the breath was increased along with alcohol consumption because it had been added to the consumed alcohol.

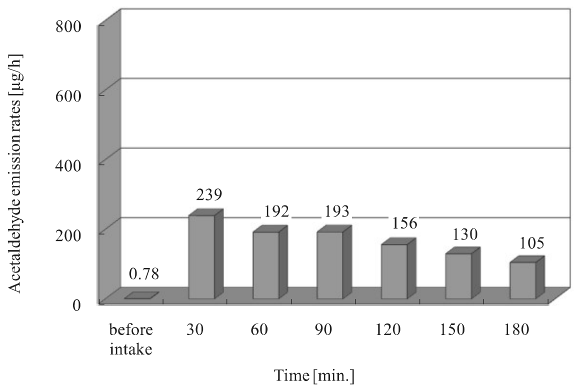

Figure 2 Acetaldehyde emission rates with intake alcohol

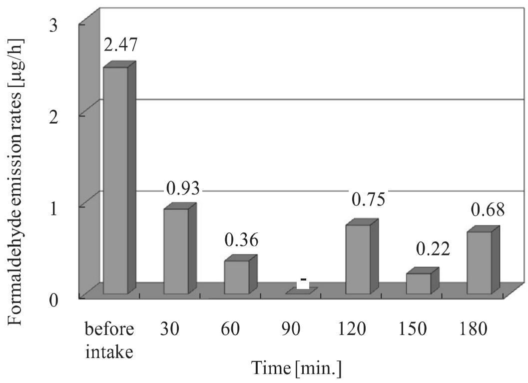

Figure 3 Formaldehyde emission rates with intake alcohol

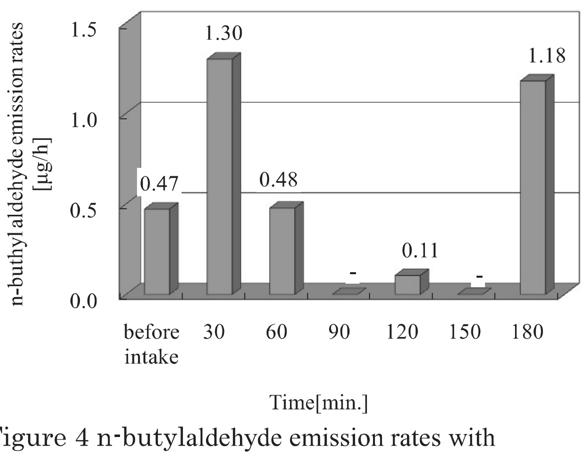

Figure 4 n-butylaldehyde emission rates with intake alcohol

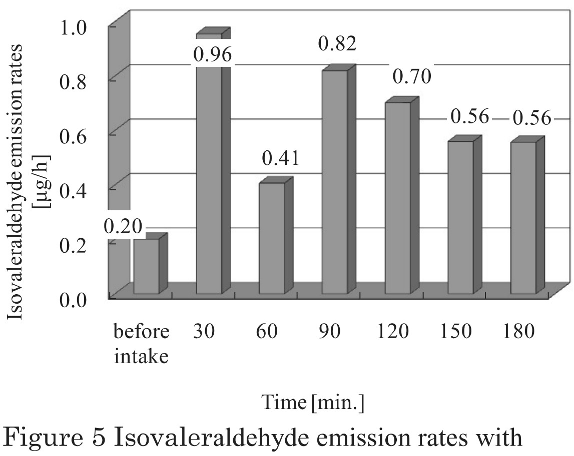

Figure 5 Isovaleraldehyde emission rates with intake alcohol

3.2 Changes of VOC emission rates with intake alcohol

As a result of examining the breath before and after alcohol consumption, several kinds of volatile organic compounds (VOCs) were detected, especially, the prominent generation of ethanol and acetone.

(1) Ethanol

The result of ethanol emission rates is shown in the figure 6.

The ethanol emission rates in the breath 30 minutes after alcohol consumption became 15900[μg/h], which was its maximum value during the measurement period. Then, as time passed, the emission rates continued to decline.

And the expired volume became stable at about 10500[μg/h] after 150 minutes had passed. The consumed alcohol is absorbed in the stomach and the small intestine and degrades into acetaldehyde by alcohol dehydrogenase in the liver. This study reveals that acetaldehyde is increased by alcohol intake and alcohol is degraded into acetaldehyde.

Ethanol shows a similar tendency and the concentration 30 minutes after alcohol consumption became about 1210 times as high as that before the consumption.

Additionally, it has been reported that, when consuming 500ml of 5% abv beer, blood alcohol concentration returns to normal in about three hours, though this varies with the drinker's physical characteristics.

In this study, 180 minutes after alcohol consumption, the value of ethanol emission rates still indicated 10386[μg/h], which corresponds to about 800 times the value before the consumption. This establishes that ethanol was being emitted over a long period.

(2)Acetone

The result of acetone emission rates is shown in the figure 7.

The emission rates acetone before alcohol consumption were 2033[μg/h]. The expired volume increased as time passed after alcohol consumption, and during the measurement period showed a maximum value, 3119[μg/h], 180 minutes after the consumption.

Acetone in the breath is known as the end product of lipid metabolism and is the only ketone body in the breath. The substance has a sweet smell that is not offensive, but it is clear that it is increased by alcohol that is one of the causative substances of halitosis.

(3)Ethyl acetate

The result of ethyl acetate emission rates is shown in the figure 8.

The ethyl acetate emission rates in the breath 60 minutes after alcohol consumption became 83.5[μg/h], which was its maximum value during the measurement period. Then, as time passed, the emission rates continued to decline.

Ethyl acetate is emitted during the fermentation process of brewer's yeast. The alcohol consumed in this experiment contained the substance, which could lead to the increase in its expired volume.

(4)2-propanol

The result of 2-propanol emission rates is shown in the figure 9.

The ethyl acetate emission rates in the breath 60 minutes after alcohol consumption became 129[μg/h], which was its maximum value during the measurement period. Then, as time passed, the emission rates continued to decline.

2-propanol is emitted similarly to ethyl acetate, during the fermentation process of brewer's yeast, and its expired volume is also considered to have been increased by alcohol.

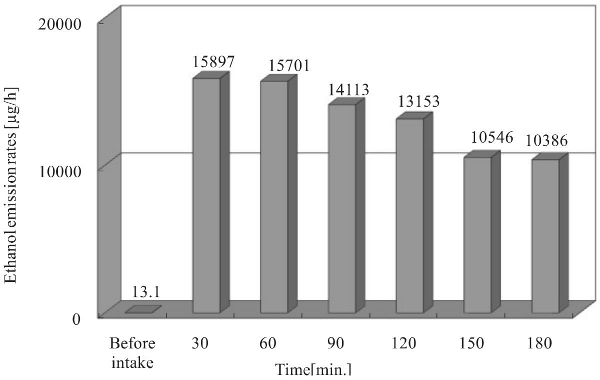

Figure 6 Ethanol emission rates with intake alcohol

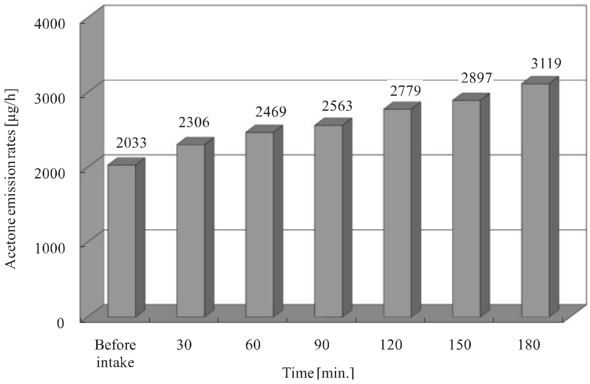

Figure 7 Acetone emission rates with intake alcohol

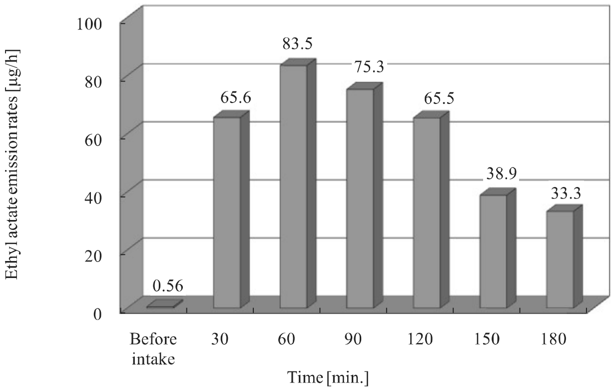

Figure 8 Ethyl acetate emission rates with intake alcohol

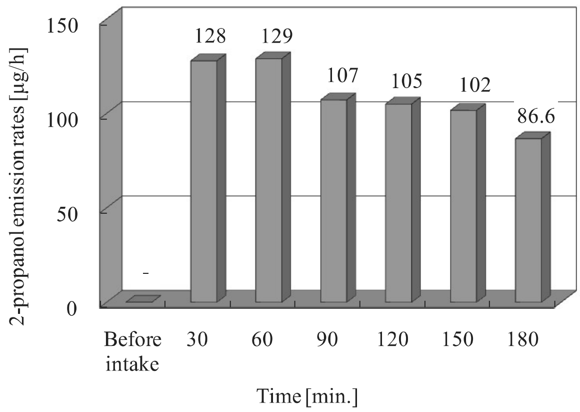

Figure 9 2-propanol emission rates with intake alcohol

4. Conclusions

(1)The odorant emission proportions in expired breath caused by alcohol and their changes were elucidated.
(2)After alcohol intake, acetaldehyde is emitted over a long period.
(3)It has been verified that not only acetaldehyde, but also n-butylaldehyde, isobarelaldehyde, ethanol, acetone, ethyl acetate, and 2-propanol are emitted by alcohol intake.
(4)The consumption of alcohol tends to increase the volume of acetone and 2-propanol that are causes of halitosis.
(5)It is necessary to consider VOCs in addition to aldehydes when investigating odor control methods after alcohol consumption.

References

1) T.Suzuki: Body Theory of Odor, 1998
2) Y.Kiyosumi: Predictions of Breath Alcohol Concentration after Alcohol Intake, Fuzzy Inference- Journal, Vol.10, No.1, 1998
3) Vijay A. Ramchandani, Sean O'Connor: Studying Alcohol Elimination Using the Alcohol Clamp Method, Alcohol Research & Health, Vol.29, 2006

Acknowledgements
This study was carried out under the activities of specified Environmental Technology Research Association .We express deep gratitude to all those concerned.