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Measurements of Dermal and Oral Emissions from Humans

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SUMMARY
Human related pollutants (bioeffluents) emitted through skin and via exhaled breath were measured. Two climate chambers were connected via flexible ducts. The ducts were in one chamber attached to a breathing mask, through which five subjects exhaled on one occasion the air into the other chamber: Human bioeffluents emitted orally were in this way isolated from those that were emitted dermally. On another occasion, the subjects exhaled the air into the chamber where they were sitting, thus exposure contained oral and dermal bioeffluents. Another twenty subjects assessed the air quality in the chambers. They judged the air quality in the chamber with dermal bioeffluents to be lower than in the one containing orally exhaled bioeffluents, and similar to the air quality in the chamber with all bioeffluents. The chemical compounds with slightly elevated concentrations differed between the two chambers.

PRACTICAL IMPLICATIONS
A better understanding of the impact on indoor air quality of human bioeffluents emitted orally and dermally will allow the development of efficient methods to reduce exposures to pollutants emitted by humans. This may be relevant especially in the future low energy buildings, where the presence of humans will increasingly shape the indoor air quality.

KEYWORDS
human bioeffluents, perceived air quality, sensory assessment, chemical analysis

1 INTRODUCTION
Humans emit large number of volatile organic compounds (VOCs) called bioeffluents. They are mainly emitted via the skin and the breath. They depend mainly on diet and the medical condition of an individual, as well as on hygiene and the use of cosmetics. Human bioeffluents, especially skin oils, can undergo reactions with ozone, which create yet another subset of compounds related to the presence of humans (Wisthaler and Weschler, 2010). Studies have been conducted to determine major components of bioeffluents both emitted by the skin and through the exhaled breath (e.g. Marples, 1970; Fenske and Paulson, 1999), but no studies can be identified that separate the effects of emissions from the various body parts on perceived air quality (PAQ). This study thus investigated the difference between the effects of dermal and oral emissions on PAQ.

2 METHODS
Measurements were performed in twin stainless steel chambers each being 30 m^3. In one session, 4 males and 1 female subjects wearing shorts and tank tops were exposed in one chamber, and each exhaled the air through the mask and flexible duct to the other chamber; the duct was equipped with the miniature fan running at low speed. In another session, the same subjects exhaled air directly into the chamber where they were sitting. Twenty other subjects were recruited to assess the acceptability of air, odor intensity and air freshness in the chambers. The air for assessments was exhausted from the chambers through glass tubes by keeping an overpressure

in the chambers. Six conditions were assessed, two with the air in empty chambers, one with air in the chamber with dermal emissions, one with dermal emissions with added pure CO_2, one with air with oral emissions and one with air polluted by oral and dermal emissions. The chambers were ventilated with an outdoor air supply rate that maintained the CO_2 level at 2,000 ppm. The air in both chambers was sampled to Tedlar bags for subsequent analysis with PTR-MS.

3 RESULTS

Figure 1 shows that the acceptability of air quality and odor intensity for dermal emissions were statistically different from those for oral emissions and for empty chambers. They were similar to the results obtained from the chamber containing both dermal and oral emissions. The acceptability of air quality and odor intensity in the chamber containing oral emissions was similar to the results from empty chambers. Adding pure CO_2 to the chamber containing dermal emissions did not affect the results of the sensory evaluations.

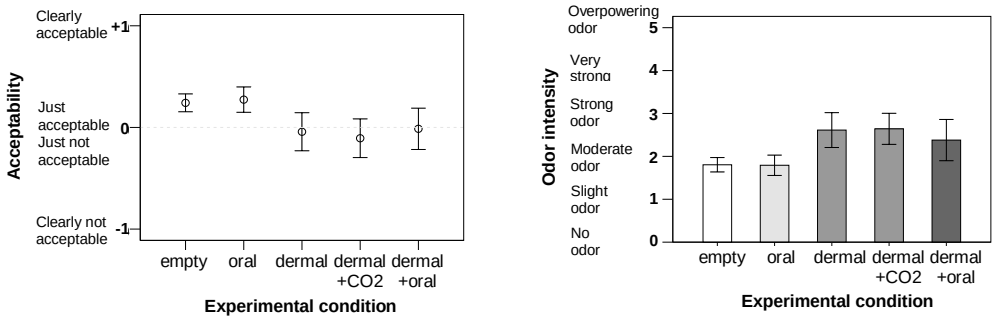

Figure 1. Ratings of air in chambers at different conditions; bars show 95% confidence intervals

Chemical analyses did not show any appreciable difference between oral and dermal emissions. Concentrations of acetone, propanone and isoprene were slightly higher in the chamber with oral emissions as expected and shown in earlier studies measuring pollutants in exhaled breath (Fenske and Paulson, 1999). Formaldehyde, acetaldehyde, ethanol and methanol were slightly higher in the chamber with dermal emissions even though the two latter compounds have normally been attributable to human breath.

4 DISCUSSION & CONCLUSION

The present study was an exploratory exercise and should be repeated before the observed results can be generalized. Future studies should investigate among others the impact of ozone as well as thermal conditions on the source strength and composition of pollutants emitted by humans. Despite the many limitations, the indication that bioeffluents from different body parts evoke different perceptual response warrants continued attention especially in the context of development of effective methods for air quality control.

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6 REFERENCES

Fenske, J.D and Paulson, S.E. (1999) Human breath emissions of VOCs, *Air & Waste Management Association*, Volume 49, Issue 5

Marples, R. R. (1970) The role of the aerobic microflora in the genesis of human fatty acids in human surface lipids, Journal of investigative Dermatology, vol.55, no.3, pp. 173-178.

Wisthaler, A. and Weschler, C.J. (2010) Reactions of ozone with human skin lipids: Sources of carbonyls, dicarbonyls, and hydroxycarbonyls in indoor air, *Proc. Natl Acad. Sci. USA*, 107, 6568-6575