

Differential Modification of Sperm Parameters by Various Volatile Organic Compounds

Dal Woong Chol, Jong Ryeul Sohn, Kyung Whan Moon, Sang Hoon Byeon,
Dong Chul Yoo, HI Chol Kim, Young Whan Kim

*Department of Environmental Health, College of Health Sciences,
Korea University, Seoul 136-703, Korea*

Abstract

Porous building materials are not only sources of indoor air pollutants such as volatile organic compounds (VOCs) but they are also strong sinks of these pollutants. Volatile organic compounds have been implicated in impaired spermatogenesis, increase in the incidence of malformed sperm and decrease in the percentage of moving sperm. The aim of this study was to determine and compare the direct effects of various volatile organic compounds (phenol, formaldehyde; HCHO, ethanol, toluene, styrene) on motility and survival rate of human sperm *in vitro*. Semen samples from 3 health subjects were prepared using swim-up method and 1-10mM volatile organic compounds were added to the test medium. HCHO and phenol produced significant decreases in the motility and survival rate with a different potency. The most potent inhibition of motility and survival rate was observed after exposure to HCHO. Less than 1mM HCHO significantly inhibited sperm motility. When ethanol is added directly to sperm, at concentrations equivalent to that in serum after heavy drinking, these damaging effects were lowest compared with other volatile organic compounds. Present study shows that each compound has differential toxic potency to human sperm and we need special caution for the use of HCHO and phenol.

Introduction

Building materials can strongly affect indoor air quality. Porous building materials are not only sources of indoor air pollutants such as volatile organic compounds (VOC) but they are also strong sinks of these pollutants. Volatile organic compounds (VOCs) have been implicated in impaired spermatogenesis, increase in the incidence of malformed sperm and decrease in the percentage of moving sperm. The aim of this study was to determine and compare the direct effects of various volatile organic compounds (phenol, formaldehyde; HCHO, ethanol, toluene, styrene) on motility and survival rate of human sperm *in vitro*.

Materials and Methods

Semen samples from 3 health people were prepared using swim-up method and 1-10mM volatile organic compounds were added to the test medium (Ham's F10 78ml, Fructose 7mMol/L, Penicilin G + Streptomycin 2ml)

1) Human sperm motility

Motility of human sperm was measured after 2 hours incubation with 10mM HCHO, phenol, ethanol, toluene, or styrene by microscopy

2) Human sperm survival rate

Survival rate of human sperm was measured with supravital stain after 24 hours incubation with 10mM HCHO, phenol, ethanol, toluene, or styrene.

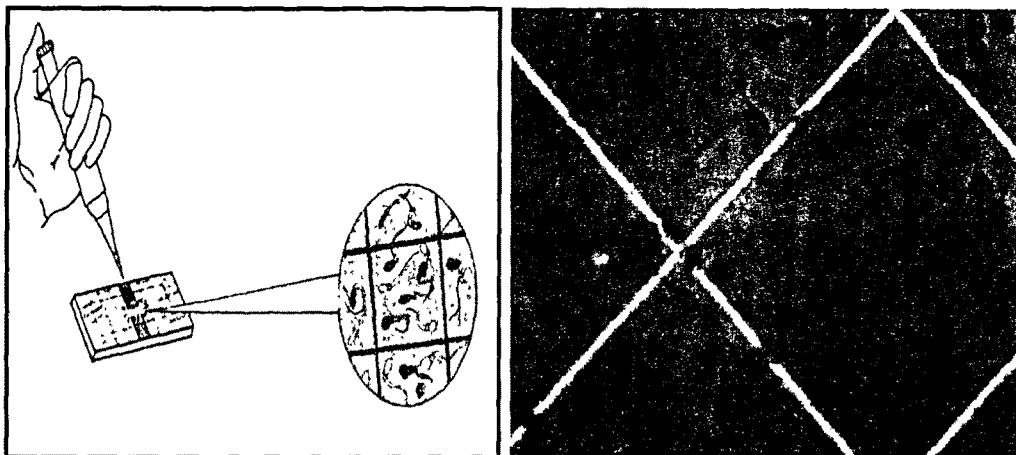


Fig. 1. Human sperms stained by supravital stain.

Results and Discussion

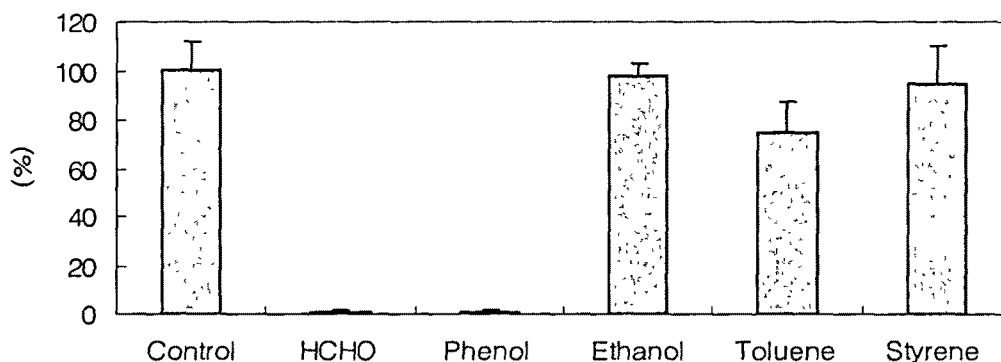


Fig. 2. Effects of HCHO, phenol, ethanol, toluene, or styrene (10mM) on human sperm motility.

Experiments were performed with sperms of 3 persons. Values are the mean \pm S.D. of three individual determinations.

10mM of HCHO and phenol produced significant decreases in the motility and survival rate with a different potency (Fig. 2 and 3). Other volatile organic compounds showed weak effects on the motility and survival rate. The most potent inhibition of motility and survival rate was observed after exposure to HCHO. 1mM HCHO totally inhibited sperm motility. 0.1mM HCHO also significantly inhibited sperm motility by 95%. When ethanol is added directly to sperm, at concentrations equivalent to that in serum after heavy drinking, these damaging effects were lowest compared with other volatile organic compounds.

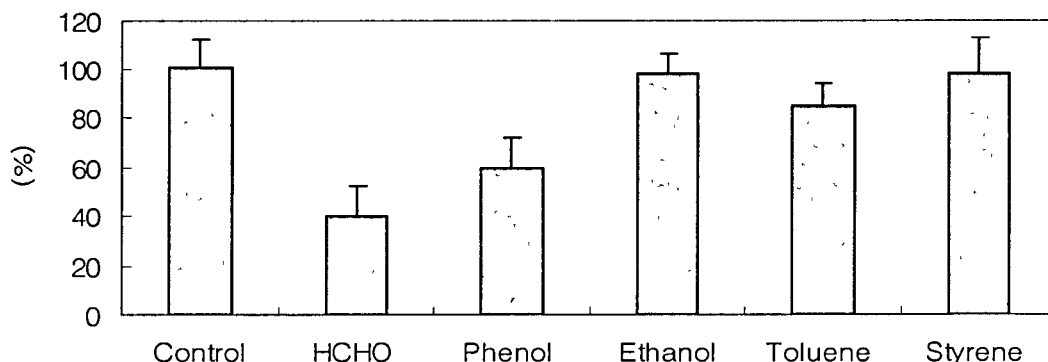


Fig. 3. Effects of HCHO, phenol, ethanol, toluene, or styrene (10mM) on human sperm survival rate. Experiments were performed with sperms of 3 persons. Values are the mean \pm S.D. of three individual determinations.

Conclusion

HCHO and phenol produced significant decreases in the motility and survival rate with a different potency. The most potent inhibition of motility and survival rate was observed after exposure to HCHO. A concentration of less than 1mM HCHO significantly inhibited sperm motility. When ethanol is added directly to sperm, these damaging effects were lowest compared with other solvents. Present study shows that each compound has differential toxic potency to human sperm and we need special caution for the use of HCHO and phenol.

Acknowledgment

This study was funded by a grant from Korea Institute of Environmental Science and Technology.

References

- Vigano, P., Brignate, C., Gonfiantini, C., Doldi, N. and Busacca, M. : Which is the best test to evaluate the integrity of sperm plasma membrane? *Acta Eur. Fertil* **21**, 231-234. 1990.
- Gray, L. E. Jr, Wolf, C., Lambright, C., Mann, P., Price, M., Cooper, R. L. and Ostby, J. : Administration of potentially antiandrogenic pesticides (procymidone, linuron, iprodione, chlozolinate, p,p'-DDE, and

ketoconazole) and toxic substances (dibutyl- and diethylhexyl phthalate, PCB 169, and ethane dimethane sulphonate) during sexual differentiation produces diverse profiles of reproductive malformations in the male rat, *Toxicol. Ind. Health*, **15**, 94-118. 1999.

Jager, S., Kuiken, J. and Kremer, J. : Triple staining of human sperm: technical aspects, *Arch Androl.* **12** (Suppl): 53-58. 1984.

Pajarinen, J., Karhunen, P. J., Savolainen, V., Lalu, K., Penttila, A. and Laippala, P. : Moderate alcohol consumption and disorders of human spermatogenesis, *Alcohol Clin. Exp Res.* **20**: 332-337. 1996.

World Health Organization. WHO laboratory manual for the examination of human semen and sperm-cervical mucus interaction, 3rd edn., Cambridge University Press, Cambridge. 1992.