

Fact Sheet: Endotoxins

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What is Endotoxin?

Endotoxin is a lipopolysaccharide (LPS) that is part of the cell wall of gram negative bacteria (Taber's Cyclopedic Medical Dictionary, 19th Ed. F.A. Davis Co., Philadelphia, PA. 2001). Rylander and Jacobs (1994) indicate that endotoxins are made up of complex LPS compound, which consists of polysaccharide chains connected by core oligosaccharide to a lipid part.

Endotoxins are relatively heat stable. They are released into the environment during cell growth and after the cell dies when the integrity of the cell wall is ruptured (Stedman's Medical Dictionary, 1977; Bradley, 1979).

Endotoxin is ubiquitous. They are found in organic dust resulting from the processing of cotton, poultry, municipal solid waste, biosolids, bagasse, hemp, hay, grain and vegetable dust (Rylander and Vesterlund, 1982). Endotoxin has been found in dust in homes (Park et al., 2000). House dust endotoxin was associated with animals in the home and air conditioning (Gereda et al., 2001).

Environmental measurements of endotoxin are expressed as either Endotoxin units (EU) per m³, a measurement based on biological activity, or as ng/m³, a measure of chemical activity (Swan et al., 2003).

What are the Health Effects?

Endotoxin can be toxic to humans and animals. Endotoxin can cause fever and malaise (influenza-like symptoms). Inhaled endotoxin increases the activity of macrophages, which lead to a series of inflammatory conditions (Millner et al., 1994; Rylander, 2002). Rylander (2002) indicates that the internalization of endotoxin in macrophages and endothelial cells results in local production of inflammatory cytokines into the migration of inflammatory cells into the lung and the penetration of cytokines into the blood. These result in inflammation, toxic pneumonitis and systemic symptoms.

Endotoxins present in organic dust have been implicated in toxic pneumonitis or organic dust toxic syndrome (ODTS) (Rylander et al., 1989; Rylander, 1997). Inhalation of endotoxin can also result in a decrease in lung function and inflammatory responses (Michel et al., 1997).

Recently it has been indicated that exposure to organic dust containing endotoxin may decrease the risk for atopic sensitization among children and lung cancer among workers (Rylander, 2002). In the past endotoxin health effects have been primarily associated with inducing airflow obstruction and aggravating asthma and allergies. However it appears that endotoxin may play a beneficial second role in that in early childhood it may have an atopy-protective effect by augmenting early Th-1type immune development (Liu and Redmon, 2001).

Lange (2003) indicates that there is another important issue and that is that the occupational exposure to endotoxin may result in reduced lung cancer. This reduced lung cancer has been identified in textile, agriculture, and other workers (Enterline, P.E, et al., 1985; Rylander, 1990; Mastranglo et al., 1996; Lange, 2000).

Who is at Risk?

Work related health effects have been documented for several occupational environments. These are the predominant ones:

- Cotton industry
- Farming (livestock, pigs, poultry, grain)
- Animal feed and grain industry
- Potato processing industry
- Fiberglass industry
- Slaughter houses
- Waste and compost industry (sewage workers, solid waste handlers, recycling facilities, composting facilities)
- Vegetable and fiber production
- Automobile industry.

Also since endotoxins are common in house dust and homes with pets especially cats, infants and children especially with allergies or asthma are at risk of endotoxin inflammation (Gereda et al, 2001; Park et al., 2004; Park et al., 2000).

Are There any Exposure Limits or Regulations?

There are no regulations in the United States or Europe. There are suggested guidelines. The only guidance is from the International Commission on Occupational Health, which has published levels of endotoxin exposure that produce acute effects:

- 20–50 ng/m³ – mucous membrane irritation.
- 100–200 ng/m³ – acute broncho constriction.
- 1000–2000 ng/m³ – organic dust toxic syndrome

In the Netherlands, the Exposure Standards Setting Committee (DECOS) is proposing a personal inhalable dust exposure measured as an eight hour time weighted average of 200 EU/m³ (Swan et al., 2003).

In view of these guides, what concentrations of endotoxin levels have been observed in various industries? The table below indicates some of the levels observed

Industry	Endotoxin levels ng/m ³	Reference
Municipal sewage workers	0-370	Melbostad et al., 1994
Cattle sheds	1,000 -10,000	Swan et al., 2003
MSW recycling	1,000	Swan et al., 2003
Grain handling	Up to 70,000	Swan et al., 2003
Waste water treatment	Up to 300	Liesivuori et al., 1994
Indoor composting of biosolids	0-462	Epstein et al., 1997

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What is the Risk to Sewage Workers and Especially the Handling of Sludge and Biosolids?

Since the human gut contains a very high level of endotoxin, it is expected that fecal matter and consequently sewage, sludge and biosolids would also contain endotoxin. What then is the risk to workers?

There have been several European studies (Melbostad, et al., 1994; Rylander, 1999); Douwes et al., 2001; Thorn et al., 2002; Thorn and Kerekes, 2001; Krajewski et al., 2004; Lidwien et al., 2005). The literature does not cite any studies in the United States or Canada.

Douwes et al. (2001) questioned 147 sewage treatment workers. Endotoxin levels were measured in two treatment plants. Personal endotoxin exposure levels was low at <10 Endotoxin Unit/m³. They indicated that exposure to other pollutants such as volatile organic compounds, industrial chemicals, and pathogens may have resulted in health effects. They, therefore, indicated that good hygienic practices may prevent some of the symptoms reported.

Krajewski et al. (2004) in a study in Poland used a questionnaire to evaluate worker complaints and exposure. They reported no statistically significant relationship between the reported health complaints and such variables as job title, exposure to endotoxins and glucans, tobacco smoking, age and period of employment as sewage worker.

Is the Public at an Unusual Risk to Endotoxin from Exposure to Sludge and Biosolids Management?

There is no scientific or medical literature indicating that the public is at risk from exposure to endotoxin from sludge or biosolids. Brooks, J., Gerba, C.P., and Pepper, I.L. (2004) stated in their studies of bioaerosol dispersion during land application of biosolids that "Overall, land application of biosolids would appear to create minimal adverse public health affects with respect to aerosols."

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