HBM Biological Application Data Sheet

ACROLEIN

Update: May 2010

Identity

Name (parent)	Acrolein
UN number	1092
CAS number	107-02-8
Intervention value (AGW in mg/m^3)	1
Structure	C_3H_4O

Occurrence

Chemical state (at 20°C)	Liquid
Physical appearances	Colorless or yellowish liquid, with a acrid, pungent odor.
Industrial products	Acrolein is used in the preparation of polyester resin, polyurethane, propylene glycol, acrylic acid, acrylonitrile, and glycerol. Acrolein is formed during the incomplete combustion of organic materials, tobacco smoke and the burning of fat containing foods.

Physicochemical properties

Molecular weight	56.1
Vapor pressure (mbar at 20°C)	293
Octanol/water partition coefficient (log Po/w)	-0.01 [1]
Water solubility (in mg/L at 25 °C)	20.6

Toxicokinetics (parent)

Uptake by inhalation	In anesthetized dogs, exposed for 1 – 3 minutes to concentrations of 400 – 600 mg/m^3 at ventilation rates of 6–20 respirations/minute absorption was 80–85% of the administered dose. Retention was independent of the respiratory rate. The author estimated that only about 20% of the inhaled dose reached the lower respiratory tract [2]. In mice exposed to a concentration of 2.5 mg/m^3 acrolein for 10 minutes, the upper repiratory uptake was estimated to be >92 % [3].
Uptake by skin absorption	The extent of skin absorption of acrolein is not know. Effects of dermal absorption of acrolein are restricted to the exposed region due to the high reactivity of acrolein, cited in ATSDR [4].
Uptake via gastrointestinal tract	Rats administered oral doses of 2.5 or 15 mg/kg [2,3-^{14}C]acrolein: doses of 2.5 mg/kg were extensively absorbed, only 12–15% of the initial dose was found in the feces. In the high-dose Group (15 mg/kg), 28–31% of the initial dose was recovered from feces [5].
Distribution	Tissue distribution of acrolein is limited. Similar levels of [2,3-^{14}C]acrolein in the kidney, spleen, lungs, blood, liver, fat, adrenal glands, and ovaries of rats sacrificed 168 h after dosing [5].
Metabolism	Epoxidation followed by conjugation with glutathione, Michael addition of water flowed by oxidative degradation, and glutathione addition to the double bond (following or preceding oxidation or reduction of the aldehyden moiety). The glutathione adducts are further metabolized to mercapturic acids [5].
Excretion via lungs	Excreted mostly as CO_2: in rats exposed to [2,3-^{14}C]acrolein by oral gavage or i.v.-dosing 26 – 31% of radioactivity was exhaled as CO_2 [5].
Excretion via urine	Predominant excretion route: in rats exposed to [2,3-^{14}C]acrolein by oral gavage or i.v.-dosing 36% - 69% of radioactivity was excreted in urine. The following metabolites were identified: oxalic acid, malonic acid, N-acetyl-S-2-carboxy-2-hydroxyethylcystein, N-acetyl-S-2-carboxy-2-hydroxyethylcystein, N-acetyl-S-2-carboxyethylcystein and 3-hydroxypropionic acid [5].
Excretion via feces	Minor excretion route: in rats exposed to [2,3-^{14}C]acrolein by i.v-dosing, 1-2% of radioactivity was excreted in feces [5].

Toxicodynamics

Mechanisms of	Acrolein is a potent irritant.

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toxicity	Inhalation of acrolein can cause: irritation of the nose, throat and lungs, pulmonary edema, lung hemorrhage, and death [2]. Oral acrolein exposure may result in gastrointestinal discomfort, vomiting, and stomach ulceration and/or hemorrhage [2]. Dermal exposure to acrolein vapors or liquids may cause stinging of the eyes, lacrimation, and reddening, ulceration, or necrosis of the skin (10% acrolein solution) [2].
Classifications for carcinogenicity	IARC-classification: group 3 [6].
Classifications for reprotoxicity	There is no evidence that inhaled acrolein is a reproductive/developmental toxicant. Developmental effects were not observed in animals independent of maternal toxicity [2, 7].
Classifications for sensitizing properties	Skin sensitizer and weak sensitizer to airways (astma).

Biological monitoring

Biomarkers	3-hydroxypropylmercapturic acid (3-HPMA) in urine
Molecular weight	221.3
Involved enzymatic metabolism	Glutathione- S-transferase
Biological material	Urine
Type of sample	Spot urine, 24-hour urine
Sampling strategy	< 24 h
Excretion pattern	Half-life of acrolein in urine 20 minutes [8]
Materials	Not reported
Transportation	Not reported
Storage	-20°C [9]
Stability	Not reported
Measurement principle	LC-APCI-MS/MS-SRM [10] HPLC-MS/MS [9, 11, 12] LC-MS-MS [13]
Aliquot for 1 analysis	1 mL [11] 0.2 mL [10] 2 mL [9]
Pretreatment	Solid phase extraction
Limit of quantification	LOD: 5 µg / L (HPLC-MS/MS) [9] LOD: 6 µg/ L (HPLC-MS/MS) [12] LOQ: 50 µg/ L urine (HPLC-MS/MS) [11] LLOQ (lower limit of quantification): 35 µg / L (LC-MS/MS) [13] Estimated LOQ: 0.9 µg/L (LC-APCI-MS/MS-SRM) [10]
Recommended adjustments	Creatinine
Preferred units for expression of results	nmol / g of creatinine
Conversion factor	1 mg / g of creatinine = 0.51 mmol / mol creatinine
Biological exposure value US	n/a
Biological exposure value Germany	n/a
Background values	200 – 800 µg/24 h (non-smokers) [12] 1200 – 2800 µg/24 h (smokers) [12] Median: 683 pmol/mg of creatinine (non-smokers) [10] Median: 2900 pmol/mg of creatinine (smokers) [10]
Possible confounders	Acrolein is formed during the heating of fatty food Smoking, passive smoke, traffic. Natural ingredient in several foodstuffs. Use of the drug cyclophosphamide. Acrolein is formed endogenously as a product of lipid oxidation and the metabolism of α-hydroxyamino acids [2]. Other compounds also metabolize to 3-HPMA (e.g. allylamine, allyl halides, and allyl alcohol and ester).

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