MCPA in drinking-water
Draft background document for development of WHO Guidelines for Drinking-water Quality

MCPA is the International Organization for Standardization (ISO)–approved common name for 4-(2-methyl-4-chlorophenoxy)acetic acid. It is a phenoxyacetic acid herbicide that is found in various formulations: as the free acid (Chemical Abstracts Service [CAS] no. 94-74-6), as a dimethylamine salt (CAS no. 2039-46-5), as a sodium salt (CAS no. 3653-48-3) and as a 2-ethylhexyl ester (CAS no. 29450-45-1) (1, 2). Although MCPA may be applied in various forms, the parent acid is the active portion of the herbicide formulation (3–5).

Major uses
MCPA is a post-emergence herbicide that is widely used against broadleaf weeds in agriculture and horticulture. It is also used on grassland and lawns (6–8).

Potential for occurrence in water
All forms of MCPA will dissociate in water to the acid (anion) form (9). The physicochemical characteristics of MCPA compounds in the environment will therefore be those associated with the acid form. MCPA is highly soluble in water and has a low octanol–water partition coefficient (10).

MCPA is not persistent in soil (9), with a half-life ranging between 15 and 50 days (11, 12). Its rate of degradation depends on several factors, including soil type, soil pH, soil moisture content, concentration of MCPA, climatic conditions and organic matter content (12). MCPA does not readily degrade in sterile buffer solution at pH 5–9 (9). Biological degradation is an important process in determining MCPA’s environmental fate. MCPA in rice paddy water in the dark is totally degraded by aquatic microorganisms in 13 days (11), whereas its biodegradation is negligible in anaerobic aquatic systems (5). The predominant soil metabolites are unextractable residues and carbon dioxide (13), although chlorophenols and chlorocresols can be formed (14), particularly by photolysis (11). If chlorophenols and chlorocresols reach water, they may give rise to unacceptable tastes in drinking-water.

MCPA was shown to be mobile in soil in laboratory studies (9). Surface water may be contaminated via spray drift and runoff, whereas groundwater may be contaminated because MCPA’s mobility in soil suggests a potential for leaching.

MCPA has been found in a number of surface waters in the United States and Canada. However, concentrations were usually less than 1 µg/L (10, 15). MCPA has been occasionally found at very low concentrations in drinking-water, usually below 0.1 µg/L (10, 15).

Toxicity
The Joint FAO/WHO Meeting on Pesticide Residues (JMPR) evaluated MCPA in 2012 (16, 17) and established an acceptable daily intake (ADI) of 0–0.1 mg/kg body weight (bw) for MCPA ion, based on the overall no-observed-adverse-effect level (NOAEL) of 12 mg/kg bw per day from four subchronic studies in rats (18–21) for changes in clinical chemistry parameters indicative of effects on the kidneys at 35 mg/kg bw per day and using a 100-fold safety factor. This overall NOAEL was
supported by a NOAEL of 12 mg/kg bw per day for parental and offspring toxicity from a two-generation reproductive toxicity study in rats (22, 23) and a NOAEL of 15 mg/kg bw per day for maternal toxicity in a developmental toxicity study in rabbits (24). JMPR considered that this ADI would adequately cover the kidney and spleen effects observed in a 2-year rat study at 19 mg/kg bw per day (25). The ADI was established for the sum of MCPA and its salts and esters, expressed as MCPA acid equivalents.

An acute reference dose (ARfD) of 0.6 mg/kg bw for MCPA ion, based on the overall NOAEL for maternal and developmental toxicity in rats of 60 mg/kg bw (26) and using a 100-fold safety factor, was also established by JMPR (16, 17). The ARfD was established for the sum of MCPA and its salts and esters, expressed as MCPA acid equivalents.

**Derivation of a health-based value**

The upper bound of the ADI determined by JMPR is 0.1 mg/kg bw. A health-based value (HBV) of 0.6 mg/L (600 µg/L) can be derived from this ADI based on a 60 kg adult drinking 2 litres of water per day and using the default allocation factor of 20%.

MCPA is rarely found in food. JMPR concluded that the daily intake of MCPA in food was up to 1% of the upper bound of the ADI (17). Data from all other potential sources of exposure are considered insufficient to justify modifying the default allocation factor for drinking-water of 20%.

**Considerations in applying the health-based value**

The HBV for MCPA is protective against health effects resulting from lifetime exposure to MCPA from drinking-water. Short-term exceedances above the HBV are unlikely to have an impact on health, unless these exceedances are due to massive contamination, such as that found in emergency or spill situations. In such circumstances, the JMPR ARfD would provide a useful point of reference for the derivation of an action level and the provision of advice to consumers.

Routine monitoring of MCPA is not considered necessary. However, Member States should consider local usage and potential situations such as spills in deciding whether and where to monitor. In the event that monitoring results show levels above the HBV on a regular basis, it is advisable that a plan be developed and implemented to address the situation.

**Analysis in water**

Methods for the routine analysis of MCPA are available to measure it at concentrations well below the HBV. For example, Method 555 (Rev. 1.0) of the United States Environmental Protection Agency.

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1 Formal guideline values are established when one of the following criteria has been met: 1) there is credible evidence of occurrence of the chemical in drinking-water combined with evidence of actual or potential toxicity, 2) the chemical is of significant international concern or 3) the chemical is being considered for inclusion or is included in the World Health Organization’s Pesticide Evaluation Scheme (WHOPES). For some chemicals, no formal guideline values are established when occurrence is likely to be well below a level that would be of concern for health. Establishing a formal guideline value for such substances may encourage Member States to incorporate a value into their national standards when this may be unnecessary. When a formal guideline value is not established, a “health-based value” may be determined in order to provide guidance to Member States when there is reason for local concern. This reference value provides both a means of judging the margin of safety in the absence of a specific guideline value and a level of interest for establishing analytical methods.
which employs high-performance liquid chromatography with a photodiode array ultraviolet detector, has a method detection limit of 0.8 µg/L (27).

Treatment technologies
Methods for reducing MCPA concentrations in drinking-water to levels well below the HBV are available, but they are more advanced than conventional water treatment. For example, activated carbon adsorption and/or ozonation, membrane filtration, ultraviolet irradiation and advanced oxidation processes have been reported to be effective (10).

Conclusion
It is not considered necessary to establish a guideline value for MCPA, as it usually occurs in drinking-water at concentrations well below those of health concern. Where monitoring results show the presence of MCPA in drinking-water on a regular basis, an HBV of 0.6 mg/L can be applied. In an emergency or spill situation, an ARfd of 0.6 mg/kg bw may provide useful guidance.

References


