

Tastes and odours in the aquatic environment: A review

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Abstract

This review deals with substances which impart tastes and odours to water and aquatic life. Most of these substances are of microbial origin. They are metabolites of certain cyanobacteria, algae and actinomycetes. Some of them, like geosmin and 2-methylisoborneol, can taint water and fish with an earthy/musty flavour even if present in concentrations of a few nanograms per liter. The methods of detection and identification of tastes and odours include sensory analysis and instrumental analysis by means of gas chromatography/mass spectrometry. The water industry faces difficult problems with the removal of off-flavours from potable water. Conventional treatment fails to destroy many of the odorous compounds. Treatment methods most often used in taste and odour control include activated carbon adsorption, ozone, chlorine dioxide and peroxone. Efficiencies, advantages and disadvantages of these as well as alternative methods, are discussed.

Introduction

Tastes and odours (T and O) appearing in surface waters have received increasing scientific attention over the last 30 years. Public opinion, demanding odourless water supplies and aesthetic recreational waters, has put constant pressure on the relevant authorities to prevent or remove off-flavours. On the other hand, progressive eutrophication and pollution of surface waters aggravates the problem, causing a steady increase in the number of taste and odour incidents.

In spite of the extensive literature on the subject, taste and odour problems continually recur, resulting in considerable costs. Interest shown by government and local authorities is essential regarding legislation on discharge limits and appropriate action towards watershed protection. Expertise, requiring interdisciplinary co-operation between biologists, chemists and engineers, is not always readily available.

A useful practical handbook on the investigation and treatment of various tastes and odours for the water purification industry was compiled by Lyonnaise des Eaux and the American Water Works Association (AWWA) Research Foundation (Mallevalle and Suffet, 1987). This book deals with a variety of odours encountered in water sources, methods of identification and the treatment options. There are also several valuable review articles on the subject. Sources of tastes and odours in water were discussed by Lin (1976a, 1976b) and Hoehn (1988). The chemistry of aquatic off-flavours was summarised by Skulberg (1988) and Juttner (1988). Treatment measures were described by Hrubec and De Kruijf (1983) and by Montiel (1983). A comprehensive study of tastes and odours was carried out by Le Roux (1988a). State-of-the-art overviews on aquatic odours were produced by Persson (1983, 1988).

Taste and odour surveys

World-wide research on T and O problems is evidence of its importance in many countries (Persson, 1983). A survey by Sigworth (1957), conducted among water works officials revealed that 82% of a total of 241 respondents had T and O problems originating from algae and 67% from decaying vegetation, which makes biological factors the prime causative agent of T and O problems. In treatment, only activated carbon

was applied successfully (82 to 85% of the plants), in contrast to other methods such as free residual chlorination, superchlorination, chlorine dioxide and aeration, for which success never exceeded 10%. Another survey of this kind, by Mackenthun and Keup (1970) revealed that biological problems in waterworks were reported by about 25% of the 800 respondents, with algal causes of T and O problems still ranked first. This study reported that chlorine and copper sulphate treatment were employed most often, with activated carbon in the third place (25% of the positive respondents). High costs of T and O treatment were also reported. Generally, the results of this survey are comparable with those obtained from the water-related industries in South Africa (Wnorowski et al., 1989).

Consumer-orientated surveys (Gallup Poll, 1973; Manwaring et al., 1986) indicated that organoleptic quality of drinking water became the main concern of consumers, after concern for safety had been eliminated. Although in both surveys only about 10% of the respondents rated their tap water "poor", as much as 30% complained of bad taste, odour, after-taste or colour. Twenty per cent of the respondents indicated that they used alternative sources of water (e.g. bottled water) or tap filtering devices. A recent investigation by the Water Quality Association in the USA (Anonymous, 1989c) indicated, that consumers' awareness and expectations of drinking-water quality is rising. Although 79% of the respondents considered their tap water to be "acceptable", only 70% regarded it as free from harmful contaminants and about 63% had a positive opinion about its quality.

In South Africa public opinion was also gauged regarding expectations about recreational water quality (Thornton and McMillan, 1989). Aesthetic values, mainly the lack of algal blooms and scums, and the lack of tastes and odours, were rated as the most important by respondents to the questionnaire.

Chemistry of off-flavours

Sources of tastes and odours in water

Water acquires its taste and odour from a variety of sources. Only a few are of truly natural origin, for example, mineral salts which may be leached from the substrate and which may impart a taste to the water. Most tastes and odours are the result of human influence: indirectly by rapid enhancement of the growth of aquatic organisms under eutrophication or directly by wastewater dumping or accidental spillage as well as by agricultural runoff. The most problematic condition at present appears to be

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