An evaluation of sorbitol-fermenting bifidobacteria as specific indicators of human faecal pollution of environmental water

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Abstract

The value of selected indicators for the assessment of faecal pollution, as well as to distinguish whether the pollution is of animal or human origin, was investigated. Faecal coliform bacteria, faecal streptococci and sorbitol-fermenting bifidobacteria were included as indicator organisms. Comparative tests were carried out on samples collected from a stream and river exposed to predominantly faecal pollution of domestic animal origin. Water from the same stream and river was also tested after downstream exposure to runoff from a low socio-economic informal settlement with limited sanitation. Samples were collected from perennial flow during the dry season and from storm-water runoff after thunder showers. Sorbitol-fermenting bifidobacteria were found to be reliable indicators of human faecal pollution. The ratio of faecal coliforms to faecal streptococci was in the order of 3.5 to 4.7 immediately after heavy exposure to faecal pollution of human origin. This ratio may distinguish between pollution of human and animal origin under certain conditions but is not a reliable indication of pollution origin. The results show that runoff from the informal settlement constituted a major source of human faecal pollution for a river used as a downstream source of water for human consumption. It further showed that faecal pollution of human and animal origin can reliably be distinguished by means of appropriate combinations of indicators which may include sorbitol-fermenting bifidobacteria.

Introduction

Urban settlements contribute to pollution of aquatic environments (Quereshi and Dutka, 1979). Human activities within urban settlements create both point and non-point sources of inorganic and organic pollutants that find their way into rivers and streams. Surface runoff from informal settlements and residential areas with inadequate sanitary facilities adversely affects the quality of receiving waters (Jagals, 1994).

Indicator micro-organisms can be used to determine the level of faecal pollution in water. Bacteria from the faecal coliform group are popular to use *(Standard Methods,* 1992), and are a realistic indication of faecal pollution of water (Geldreich, 1976).

However, faecal coliforms have certain drawbacks as indicators, one of which is the specific indication of the levels of human faecal pollution (Geldreich and Kenner, 1969; Grabow, 1983).

An increasing requirement for microbiological indicators is to distinguish between faecal pollution of human and animal origin. The distinction between human and animal pollution may be very useful in epidemiological studies or tracing the source of faecal contamination of water (Mara and Oragui, 1983). A further value of such distinction is the development of sanitary education programmes for developing communities. A confirmed pollution source is useful information for focused sanitary programme design. This may help community development workers to obtain community participation to address the problem. It is, therefore, valuable to develop techniques using highly specific bacterial indicators (Jagals, 1994).

The Modder River (Fig. 1), is a major source of potable water for the city of Bloemfontein, South Africa. Surface runoff from a large low socio-economic rural urban development some 60 km east of Bloemfontein reaches a tributary of the Modder River. The impact of this surface runoff on the sanitary quality of Modder River water was investigated. Due to poor sanitation standards existing in the settlement, special emphasis was placed on testing the health-related microbial quality of the river water.

Keeping domestic and other farming-related livestock within city limits is customary in such developing regions. These usually substantial concentrations of animals also contribute to faecal pollution of the environment. However, the risk of infection to humans due to human faecal pollution is higher than risks due to faecal pollution of animal origin (Jagals et al., 1994). A mechanism to distinguish between animal and human faecal pollution may be a valuable tool to assess such a risk.

In the past, one of the methods recommended to distinguish between human and animal faecal pollution was to make use of the ratio between faecal coliforms and faecal streptococci (FC/FS ratio) (Geldreich, 1976). This method is unreliable (Jagals, 1994; Mara and Oragui, 1985; *Standard Methods,* 1992).

Various factors can give rise to inaccurate interpretation of results from such ratios (Mara and Oragui, 1985). These include differential die-off of these organism groups and inconsistent occurrence of these organisms in the intestines of humans and warm-blooded animals in various parts of the world. Other indicator methods are therefore required. During this study an alternative method was investigated to give a more reliable indication of the source of faecal pollution. Sorbitol-fermenting bifidobacteria were previously reported to specifically indicate human faecal pollution (Mara and Oragui, 1985). The occurrence of these organisms was investigated in the same pollution environment as the more generally used indicator organisms such as faecal coliforms and streptococci.

This study deals with an evaluation of sorbitol-fermenting bifidobacteria as indicators of faecal water pollution from a human source, and also assesses the impact of surface runoff from a high-density low socio-economic settlement with limited sanitation, on the microbiological quality of water in a river system used downstream for domestic and recreational purposes.

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