DISSOLUTION OR LEACHING POTENTIAL OF HEAVY METALS FROM CONTAMINATED SOIL AND FOOD STUFFS USING DIGESTIVE TRACT FLUIDS

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1.0 Introduction:

Environmental contaminants are mainly incorporated by ingestion. Contaminated dust or soil may also be ingested together with insufficiently cleaned vegetables, wild mushrooms or fruits grown on contaminated ground. Furthermore, inhaled airborned particles may be swallowed down from the respiratory tract, thus additionally affecting the intake of contaminated materials by the gastrointestinal tract.

Chronic low level intakes of heavy metals have damaging effects on human beings since there is no good mechanism for their elimination. Metals such as lead, mercury, cadmium and copper are cumulative poisons. The major sources of these heavy metals are industrial effluents, and indiscriminate disposal of domestic or sewage drainage directed to the rivers untreated or partially treated. These metals cause environmental hazards and are reported to be exceptionally toxic (Ellen, Loon, & Tolsma, 2000).

In general only those contaminants mobilized by the digestive juices are available for absorption in the digestive tract, while pollutants fixed to indigestible particles leave the body without any effect. An in vitro test system is developed for examining the transition of pollutants from contaminated materials of soil and food stuffs into digestive juice by means of artificial digestive tract fluids model. The approach seeks to mimic the process of human food digestion and thereby assess the bioavailability of metals from consumed either accidentally or intentionally in the diet. The leaching or elution experiments are performed using synthetic digestive fluids at different operating conditions namely: temperature, pH, different exposure times and agitation techniques. The test system can be a useful tool for evaluating the individual health risks arising from polluted soil or other materials. Finally, the implications of risk assessment are addressed.

2.0 Problem Statement & Significance of Study:

Alternative approaches have to be sought to mimic the ‘bio’ aspect more closely by using earthworms as indicators of POP bioavailability from soils (Morrison et al., 2000) and (Jager et al., 2005). Recent reviews have highlighted developments in this area of bioavailability (Reid et al., 2000a) and (Dean and Scott, 2004). This review however is concerned with developments in the oral bioaccessibility of POPs from soil (and related materials). Bioaccessibility can be defined as ‘fraction of a chemical solubilized from a soil sample using *in vitro* test methods that simulate gastrointestinal conditions’ (Kelley et al., 2002). Different sample preparation approaches have been developed to undertake oral bioaccessibility studies.

The intake of contaminants may cause a severe health risk for children (White,P 1990). For adult an average soil intake of up to 50 mg/day was estimated (Calabrese et al. 1990). Contaminated dust or soil may also be ingested together with insufficiently cleaned vegetables, wild mushrooms or fruits grown on contaminated ground. Furthermore, inhaled airborne particles may be swallowed down from the respiratory tract, thus additionally affecting intake of contaminated materials by the gastrointestinal tract.

The in vitro digestion model can be a useful tool for improving health risk assessment by determination of a relative bioaccessibility factor, i.e. comparison of the bioaccessibility of a contaminant from the ingested matrix of interest with the bioaccessibility of the contaminant from the matrix used in the toxicity studies. The presence of toxic metals in food and contaminated soil need further assessment. Even low intake for a long duration can damage intend organs like kidney, liver and etc.

3.0 Research Objective:

To evaluate the different health risks arising from the ingestion of polluted soil or food stuffs by stimulating the digestive system, specifically:

(1) To investigate the effect of digestive fluids in eluting or leaching toxic metals from several matrices (contaminated soil and food stuffs) under different experimental conditions :

i) Different pH environment, ii) different temperature iii) incubation or exposure time
vi) presence of different fluids and enzymes, and (v) different agitation techniques

2) To determine the oral bioacessibility factor or exposure factor or biouptake of toxic metals contained in the soils and food stuffs.

3) To assess the risk to human health as result of consuming the metal in the soils and food stuffs.

4.0 Literature Review:

Previous studies (Kuo et al., 2000) has shown that the 14 elements some of them are necessary to human health, such as Ca, Mg and Zn whereas others have been shown to be toxic, such as Pb, Cd and Al.

Other estimates made from various countries have shown that the dietary intake for lead in adults is between 54 mg per day (Dabeca, McKenzie, & Lacroix, 1987) and 412 mg per day (Dick, Hughes, Mitchell, & David, 1978), and that of cadmium is between 10 and 30 mg per day (Reilly, 1991). For zinc and copper, the estimated daily intake is from 1 to 3 mg, and 10 to 20 mg, respectively (Fox, 1982).

Children have been shown to be more sensitive to Cd and Pb than adults and the effects are cumulative, the elements build up in the tissues. (Tripathi, Raghunath, Sastry & Krishnamoorthy, 1999). As a result, the regular absorption of small amounts of elements such as Pb may cause serious effects on the health of growing children, including retardation of mental development (e.g. reading and learning disabilities) and deficiencies in concentration, adverse effects on kidney function, blood chemistry and the cardiovascular system, as well as hearing degradation (Salma, Maenhaut, Dubtsov, Papp, & Zaray, 2000).

Oral intake of heavy metals contaminated soil material can occur, for example, through hand to mouth contact, especially when children play on polluted ground. According to the literature, children in general take up less than 100 mg soil per day. In special cases intake may be somewhat higher and can reach several g/day. The intake of contaminants may cause a severe health risk for children. For adults an average soil intake of up to 50 mg/day was estimated (White, P, 1990).

5.0 Research Methodology:

In this study, an in vitro test system (reactor/digester) which simulates the transition of pollutants from contaminated materials into digestive juices by means of a standardized artificial gastro-intestinal model will be used. The test system simulates the influence of the acidic environment of the stomach (gastric model) followed by the neutral or slightly alkaline environment of the small intestine (gastro-intestinal model).

Environmental matrices contaminated with toxic heavy metals will be analyzed for heavy metals content. The matrices with high metals contents (in particular arsenic and mercury) will be selected for elution study. A reactor or digester or fermenter (a digestive tract model) which mimic the action of human digestive system will be used.

The leaching or elution experiments will be performed using synthetic digestive fluids or ezymes (which act as extractants) at different operating conditions namely: temperature, pH, different exposure times and agitation techniques. The heavy metals in the extractants or synthetic digestive fluids will be analyzed using ICP-MS. The elution or leaching rate of the toxic heavy metals from the selected matrices in the presence of different synthetic digestive fluids conducted at different conditions mentioned above will be assessed. Finally, from the data obtained, the exposure level to heavy metals from ingestion pathways will be estimated using health risk assessment method.

References:

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