

Geophagia

The hazards to health of soil in the diet

Barry Smith, *Keyworth*

Children and young adults the world over may be exposed to chemical elements in soils through either accidental or deliberate ingestion of soil, or dusts derived from soils. In Europe and North America such exposure probably originates principally from accidental ingestion during hand-to-mouth contact. However, in many ancient and rural societies, and amongst a wide variety of animals, exposure occurs principally through the deliberate ingestion of soil, or soil-derived ‘medical’ preparations (often associated with immigrant communities). Such behaviour is medically known as either pica (the eating of unusual objects, cf. *Pica pica*, the magpie) or more specifically as

geophagia. Other forms of pica commonly reported since the sixteenth century include the eating of coal, cinders, plaster, dung, ash, snow, and ice (pagophagia).

“... you can neither sleep nor have appetite for food, until you taste some soil ...”

Whilst increasingly uncommon in modern societies, geophagia is common among traditional societies and has been

recognised since the time of Aristotle as a cure-all for health problems including poisoning and famine foods. Soil may be eaten from the ground as a paste, but in many situations there is a cultural preference for soil from ‘special sources’, such as termitaria, or from traditional herbal–soil mixes. These preparations may be taken as a ‘special remedy’ during pregnancy and by children. It remains a matter of conjecture whether the soil itself is an active component of the preparation or simply a binder. In the case of geophagy amongst animals such preferred soils are often referred to as ‘licks’, although in such cases it is not only the soluble salts that are consumed but also relatively insoluble clays and associated minerals. In this context it is interesting to note that studies undertaken for the Department for International Development (DFID) by the BGS and collaborators in Uganda and the UK have demonstrated that the bioavailability of many trace nutrients is higher in these preferred soils and herbal preparations than more common, less ‘attractive’, soils.

Geophagia is considered by many human and animal nutritionists to be either:

- a learned habitual response in which clays and soil minerals are specifically ingested to reduce the toxicity of various dietary components common to the local environment (for example, in tropical rain forests, where many plants and fruits have evolved toxins to reduce their palatability)
- an in-built response to nutritional deficiencies resulting from a poor diet often rich in fibre but deficient in magnesium, iron, and zinc (essential nutrients during motherhood, early childhood, and adolescence); such diets are common in tropical countries, particularly where the diet is dominated by starchy fibre-rich foods such as sweet potatoes and cassava

From a historical perspective, geophagy has also been commonly associated with various mental disorders and afflictions with a wide variety of rather unpleasant cures. Even today the theory of geophagia as a subconscious response to dietary toxins or stress



Derelict Brunton arsenic condenser at Devon Great Consoles mine. Arsenic oxide was previously produced at the works by roasting arsenopyrite. Elevated levels of arsenic were found in soil samples taken at the site.

Tim Cullen, BGS © NERC



Children may be exposed to toxins or biological pathogens through accidental or deliberate ingestion of soils during play.

must be balanced against the habitual eating of soil that has been reported to develop into extreme, often obsessive, cravings. These cravings are often reported to occur immediately after rain. For example, one woman interviewed during our studies said 'You can neither sleep nor have appetite for food, until you taste some soil'. Another stated that the urge for soil consumption was particularly strong after rain 'The soil smells nice wherever you go, either in kitchen, the latrine, and in the field'. Typical quantities of soil eaten by geophagics in Kenya have been reported to be 20 grams per day. This is almost 400 times more than typical quantities of soil thought to be ingested as a result of inadvertent ingestion through hand-to-mouth contact (e.g. 50 milligrams per day). Whilst eating such large quantities of soil increases exposure to essential trace nutrients, it also significantly increases exposure to biological pathogens and to potentially toxic trace elements, especially in areas associated with mineral extraction, or in polluted urban environments.

Geophagia is common amongst animals as varied as gorillas from Central Africa and macaws from South America. There can hardly be a clearer demonstration of animal geophagia than the daily ritual of a flock of colourful macaws feasting on clay from the banks of rivers before starting to feed amongst the tropical rainforest canopies.

Similarly, inadvertent ingestion of soils increases exposure to toxins associated with contaminated land sites within the UK and Europe. Analysis of exposure scenarios indicates that the direct ingestion of even minimal quantities of soil by the young can account for more than 50 per cent of their total exposure to a given pollutant from all other sources. This is due to the much higher concentration of contaminants in soils compared to foods and drinking-water sources. Other, less conspicuous, forms of inadvertent ingestion may also occur. For example, dried soil is often used as a desiccant to protect kidney beans and groundnuts from rot in Africa, and earths and clays have been used to make flour and butter substitutes in Europe during the early part of the twentieth century. It is also generally considered that the teeth of ancient Egyptians were worn away prematurely because of the high levels of wind-blown sand in bread.

The BGS has been undertaking research to investigate the bioavailability of potentially toxic trace elements such as arsenic and lead in UK soils associated with a range of contaminant sources (e.g. mine wastes, mineralisation, and industrial sites). The objectives of these projects are to increase our understanding of the risks and benefits associated with geophagia and to enable the bioavailability of a particular contaminative source to be accurately taken into account during site-specific risk assessment. Whilst the latter is unlikely to reduce significantly the remediation requirements for grossly contaminated sites, it is likely to reduce the need for remediation of marginally contaminated soils such as those associated with diffuse pollution and the periphery of pollution plumes, leading to a more sustainable approach to the remediation of contaminated land.

For further details contact:

Professor Barry Smith
Tel: 0115 936 3423
E-mail: bsmi@bgs.ac.uk



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Drying cassava in direct contact with soil leads to increased cerium levels in the flour produced.