

POSSIBLE HEALTH EFFECTS ASSOCIATED WITH HUMAN GEOPHAGIC PRACTISE: AN OVERVIEW

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Abstract

Human Geophagia, a phenomenon widely practised especially in Africa, is the craving and deliberate ingestion of clayey soils. It is frequently practised by women and children to relieve hunger, supply nutritional deficiencies or as folk medicine. Geophagic individuals are very selective in the type of clayey soil they consume, where it is obtained, and its physical state; as well as its colour, smell and texture. Though clayey soils are medicinal, they could equally be risky and hazardous to human health. Reports have associated geophagia with iron deficiency leading to anaemia, infestation with geohelminths, and abrasion of the gastro-intestines. This overview brings awareness on clayey soils consumed and throws light on the human health associated effects.

Introduction

Pica is a Latin word, named after the magpie bird that eats non-foodstuff objects, either because of hunger or curiosity^[1, 2, 3]. Geophagia, a form of pica, is the deliberate consumption of clay or soil by humans^[4] and animals and this practice has been in existence for more than a century^[5]. Other forms of pica include pagophagia (ice), praticophagia (plastics) and amylophagia (starch/dough)^[4, 6].

Clay minerals form an integral bulk of geophagic clays and soils. According to Ekosse^[7], clay minerals are secondary minerals derived from the chemical alteration of mostly feldspars and to a lesser extent micas. These minerals are alumino silicates and hydrated oxides. Clay mineral groupings include kaolinite – serpentine, pyrophyllite – talc, smectites, vermiculites, micas, brittle micas, and amorphous clays^[7]. The pyrophyllite in talc members are pyrophyllite and talc. Geophagic clayey soils are dominated by kaolin and smectite.

Many reasons have been proposed to explain geophagic tendencies which include ones which are cultural, medicinal, psychological, physiological and nutritional^[8, 9, 10, 11]. However, one of the concerns is whether this habit or addiction is beneficial or harmful to the consumer's health. Ingesting iron-rich clayey soils could result in significant dietary iron being supplied to the system which may affect the iron status of the geophagic individual^[8, 10, 12]. The contents and the *in vivo* function of the clayey soil consumed should comply with the needs of the consumer without being harmful. Although geophagia has been practised for many years, its benefits to human health and nutrition have not been adequately addressed. This review which focuses on current literature on the practise of geophagia with specific reference to associated pathological conditions aims to give perspective on this habit and/or addiction.

Human geophagic practice

Geophagic clayey soil

Consumers are very selective in gathering clayey soil for geophagia taking in consideration the colour, smell, flavour and texture of the earth^[2, 13, 14, 15]. The clayey soil is obtained from specific areas such as pits, on riverbanks and termite mounds^[13] and consumers have different preferences in the preparation of clays that they consume. Once the soil is obtained from a selected spot it is shaped and dried in the sun or in an oven^[13]. Some consumers prefer cold, wet clay and keep it in the refrigerator^[4] whilst others mix the clay with herbs or other plant material^[13]. Knishinsky^[16] even provides a few recipes where clay is used as ingredients in certain drinks and dishes.

The colour of the clayey soil is apparently important for the consumer in that it gives an indication of the contents of the specific soil or clay. White clay largely consists of kaolin^[17] which has the ability to absorb toxins and bacteria and is therefore commercially manufactured and sold as a remedy against diarrhoea^[16]. In a survey undertaken on school children Nchito *et al.*^[14] reported that brown earth was the most popular and white clay the second most popular soil consumed by Zambian children.

Red clay is rich in oxides of iron and aluminium^[17]. When iron is in the ferrous-oxide state it is poorly absorbed by the human body^[17]. Dreyer *et al.*^[18] (2004) observed that red earth absorb potassium at a pH between 2 and 6.2; the red clayey soil releases iron at pH 2 and absorbs at pH 6.2. Dreyer *et al.*^[18]

also stated that black earth absorbs sodium, potassium and iron and releases calcium and magnesium at both pH 2 and 6.2.

Countries

Earth eating is not restricted to one country or to one specific ethnic group. It is practised throughout the world. Geophagia is very prominent on the continent of Africa; the practise is described in the northern and southern Americas as well as on the continent of Europe and the British Isles.

Between 8%-65% of African-American women practise pica, including eating of, not only clay and soil, but also ice, baby powder and laundry starch^[19]. This was confirmed by Simpson *et al.*^[20] where 46 of the 150 women in the USA and 33 of the 75 in Mexico interviewed, practised pica. Blocks of magnesium carbonate are available at pharmacies in both Mexico and California and women purchase those for consumption instead of eating clay^[20].

Geophagia is not an uncommon phenomenon among women and children in African countries such as Cameroon, Nigeria, Ghana, Sierra-Leone, South Africa, Malawi, Zanzibar and Zambia^[6, 15, 21]. In Zambia brown and white earths are sold on the streets^[14].

In Britain, it is possible to purchase soils imported from south Asia^[22]. A study done on Swedish children playing in specific playgrounds found that they either deliberately or by accident consume soil contaminated with different metals including arsenic^[23]. In Germany, healing soil is commercially available and used as medicine against diarrhoea and gastric hyper-acidity^[24].

Women and children

Black women from rural areas with a family history of geophagia tend to indulge more than others in the practice^[6, 25]. This phenomenon also occurs more frequently in women and children in low-income groups particularly to relieve hunger pains^[26]. During pregnancy women experiencing morning sickness tend to consume clayey soil as a preventive measure for nausea and vomiting^[6, 27]. Pregnant women undergo psychological changes with abnormal cravings, amongst others, for soil and/or clay^[6].

The consumption of soil among children could be done on purpose or involuntary by putting soil/clay covered hands or toys in the mouth^[23]. One reason for this eating disorder among children has been ascribed to a nutritional deficiency of either iron or zinc^[28]. Geophagia has also been described in children who are mentally retarded^[1, 3, 28], and it is suggested that these children cannot distinguish between normal foodstuff and non-foodstuff items^[3].

Nutritional and medicinal purposes

Clayey soils are consumed for nutritional and medicinal purposes. It is described that geophagia is a craving for a specific nutrient or due to a deficiency of a mineral^[1]. Geophagic practice has been demonstrated to supply 17%-55% of recommended pregnancy supplementation of calcium, magnesium, zinc, iron, copper, manganese, selenium, potassium, nickel and cobalt^[29]. Hamilton *et al.*^[30] indicated that geophagia was practised because the human body has a need for iron and zinc.

Clayey soils have been consumed particularly to relieve diarrhoea and stomach upset^{15, 6} and it has been reported that high cation exchange capacity (CEC) clays have the ability to absorb diarrhoea-causing enterotoxins³¹. Kaolin, sold as Kaopectin, has the ability to absorb diarrhoea causing toxins and cure an upset stomach^{15, 6, 20}. Smectitic clays, rich in magnesium carbonate (MgCO₃) on the other hand act as a laxative²⁰. Magnesium carbonate is available in pharmacies as a remedy for heartburn or as a laxative²⁰. Clayey soils also tend to protect the gastrointestinal epithelium as it forms cross links with glycoproteins in the intestinal mucosa³².

Nutritional intestinal absorption affected by geophagia

Clayey soils consumed by humans are rich in macro- and micronutrients but these elements are not necessarily absorbed by the gastro-intestinal (GI) system³³. The soil may actually reduce/absorb the already available elements in the GI system, thereby further diminishing nutrient levels and preventing the absorption of minerals from food^{1, 5, 33}.

Dominy *et al.*⁵ used the TNO intestinal model previously described by Minekus *et al.* in 1995 to investigate the influence of clay on the absorption of nutritional substances and simulates the stomach, duodenum, jejunum and the ileum. Kaolin was used to determine the absorption abilities of three alkaloids namely guinine and two types of tannins⁵. Digestion was simulated over five hours while the pH was being controlled. The outcome of their observation was that kaolin absorbed < 30% of the bio-available fraction of guinine and the two tannins⁵. Another confirmatory study done on seven (7) edible clays from Nigeria, Cameroon, Gabon, Kenya, Togo, Zaire and Zambia showed that they are able to absorb tannic acids while releasing calcium, copper, iron, magnesium or zinc in amounts which could be of nutritional significance³⁴.

Children from Lusaka practising geophagia were identified and their anaemia and parasite infection status determined^{14, 35}. The children, with haemoglobin levels of 8 mg/dl or higher, were recruited to participate in a small intestine permeability survey³⁵. The children were separated into four different groups and each group was supplied with different tablets namely placebo/placebo (43), placebo/multimicronutrients (39), iron/placebo (43) and iron/multimicronutrients (41)¹⁴. These children were given a solution of lactulose:mannitol (L:M) (4:1) in a volume according to their body weight³⁵. Urine samples were collected over five hours following the intake and the concentration of lactulose and mannitol determined. The study concluded that both geophagia participating and non-participating children had similar L:M ratios signifying that earth in the intestine as a result of geophagia did not influence the intestinal permeability. No differences were observed in the results of the different groups that were supplied with iron, multimicronutrient or placebo tablets.

In order to rule out the possibility that healing soil available in Germany, could contain harmful concentrations of thorium, a study was undertaken by Höllriegel *et al.*²⁴ where six volunteers consumed the soil for 15 days in different quantities. Twenty-four hour urine samples were collected before, during and after participating in the project and were analysed for thorium. It was found that thorium excretions in the urine samples did not increase as was expected indicating that the thorium concentration in the soil samples were not harmful to the consumers²⁴.

Pathological conditions associated with geophagia

In general geophagia does not lead to major health problems but in exceptional cases the practice can result in serious health problems². Screening laboratory tests required to determine pathological abnormalities as a result of geophagia includes the following: to complete full blood count and iron studies to determine iron deficiency anaemia, peripheral blood smear to detect eosinophilia and stool tests to rule out parasitic infections and electrolyte levels on serum to determine chemical pathology abnormalities². Physicians treating earth eating patients should be aware of the following: poisoning as a result of heavy metals, electrolyte disturbances, vitamin, iron and zinc deficiencies and parasite and bacterial contamination².

Iron deficiency anaemia

In a case study a female, sixty years of age, with diabetes, ischaemic cardiomyopathy and hypertension went for a routine medical check-up². A stress echocardiogram indicated normal cardiac functions. However her stools were very dark in colour and she had severe iron deficiency anaemia with a

haemoglobin value of 7.8 g/dl. She then admitted that she had recently started with an old childhood habit in consuming soil replacing the taking of regular meals².

In another study a group of earth-eating school children from Lusaka, positively identified with helminth infection, were evaluated for their anaemia status³⁵. This was done as the selection criteria for participation in a research survey for small intestine permeability. Only 11 children from the original 417 had haemoglobin levels of less than 8 g/dl and were therefore excluded from the survey. The average reference ranges, for both haemoglobin and serum ferritin of the participants, were within normal values³⁵. This survey indicated that helminth infected children that consume clay were in general not anaemic.

A study by von Garnier *et al.*²¹ was performed on a 34 year old Cameroonian lady who had practised geophagia by eating kaolin for 15 years. She was diagnosed with iron deficiency anaemia and was subsequently treated by oral iron replacement therapy however her haemoglobin remained low. She was then advised to discontinue the consumption of kaolinitic soil and treated by intravenous iron replacement therapy. The result was that one month later the anaemia was corrected and three months later she still had a haemoglobin level within the normal reference range²¹. It can therefore be deduced that the kaolin did in fact interfere with iron absorption.

Bacterial and parasitic infections

Clayey soil may be contaminated with bacteria and other harmful substances^{13, 25, 36}. In 1980 Stagno *et al.*³⁷ published a case study on a group of 11 preschool children from Atlanta, United States of America. Eight of these children had a history of geophagia and seven of them tested positive for *Toxoplasma*³⁷. One child was simultaneously infected with *Toxoplasmosis* and *Toxocara gondii*. It is thought that the cause of the infection could probably have been the result of oocysts from cat faeces in the soil³⁷. In another case a 33 year old lady from South Dakota, the owner of 11 cats and two puppies consumed earth from a hole in her backyard³⁸ and on visiting the clinic, prominent eosinophilia was observed³⁸. In addition Toxocaridae was confirmed in the serum using the ELISA technique³⁸. The lady was treated with albendazole and prednisone and on the follow-up visit, one month later her eosinophilia count was within normal range³⁸.

In another study, children from Lusaka consuming soil/clay, were identified by means of a questionnaire¹⁴. Stool samples from these children were analysed for *Ascaris lumbricoides* (helminth) infection by counting eggs per gram faeces¹⁴. Those children that were infected were treated (with albendazole). It was however found that there was a higher incidence of *Ascaris lumbricoides* infection together with a haemoglobin value of <13.0 g/dl in children consuming soil in comparison to those not consuming soil.

Clayey soil could be infected with earthworms and snail shells, and for that reason geophagic individuals were advised against soil consumption in Zanzibar and Tasmania¹⁵. An extensive study was done in Zanzibar by Young *et al.*¹⁵ where stool samples from geophagous participants were analysed for *Ascaris*, *Trichuris* and hookworm infections. The results on the stool samples were as indicated, with *Ascaris* (5.6%), *Trichuris* (33.2%) and hookworm (32.9%) infections. However the soil samples consumed by these participants were not contaminated with infectious parasitic stages. So in contrast to other findings describes above, Young *et al.*¹⁵ could not confirm that hookworm (helminth) infection was directly related to the practise of geophagia.

Heavy metal contaminations

Heavy metal poisoning due to geophagia is possible^{3, 39}. Lead toxicity/poisoning not only affects the consumer but could also affect an unborn baby in pregnant females^{1, 3, 22}. Simpson *et al.*²⁰ warned against women eating soil and thereby consuming high levels of magnesium that could be harmful not only to herself but if pregnant, also to the unborn foetus. Geophagic women, specifically when pregnant should undergo laboratory tests to determine the magnesium concentrations in their serum²⁰.

A survey was done by Luoba *et al.*⁴⁰ on geophagous pregnant women to determine the silica content in their stools. They concluded that stools from geophagous women had higher mean silica content than the control group who did not eat soil⁴⁰. There was also a difference in the stools' contents with a higher silica content in those who ate soft stone in comparison to those who consumed soil from termite mounds⁴⁰.

Lamson^[27] described that young men from Iran had a deficiency of zinc that caused them to eat soil/clay. The men were small in figure and sexually underdeveloped. Once they were treated with zinc they matured sexually and stopped the clay eating habit^[27].

Conclusion

Geophagia is practised throughout the world, mainly by women and children. Not only does clayey soil contain medicinal properties but it is also consumed to relieve hunger and/or added as an additional ingredient in the preparation of drinks and meals. Geophagic soils could also be regarded as a source of nutrients. Geophagic consumers nonetheless should be aware of the health problems that could arise as a result of parasitic infections, bacterial contamination, and possible heavy metals contents. An in depth study on geophagic participants looking into the psychological, cultural and nutritional impacts will hopefully clarify the phenomenon of practising geophagia.

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