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Physico-Chemical Properties of Termite Mound Clay (*Humbas Mati*) And Its Scientific Base for Healing Ability in Sri Lankan Traditional Medicine

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Abstract

Sri Lankan traditional medicine includes mud therapy and various types of muds were used for therapeutic purposes such as Termite mound clay (Humbas mati), Potter wasp clay (Kumbal mati) and Kambiseenipas. This study is designed to analyze the physico-chemical properties of Termite mound clay and to justify the scientific base for its healing ability. Termite mound clay was collected from Boralesgamuwa, Colombo. Particle size analysis by hydrometer method to identify the clay, sand and silt percentages was conducted at the Department of Agricultural and Plantation Engineering, The Open University of Sri Lanka. pH, electrical conductivity, total nitrogen, available phosphorus, Ca, Mg, K, Na, Fe, Zn, Cu and Sulphur were analyzed using standard methods including pH meter, conductivity meter, modified Kjeldahl oxidation method, Bray 1 method, atomic absorption spectrophotometer and flame photometer at the Soil and Plant Nutrition Division of the Tea Research institute, Talawakelle. The articles on mud therapy on joint diseases, facial disorders and edema were obtained from the search engines Google scholar and PubMed. Furthermore, traditional medicines that included various types of mud were obtained from the series Talpathe piliyam and the Ayurveda Pharmacopoeia. According to the results, termite mound clay of this study has 86% clay, 8% silt and 6% sand. The pH varies from 3.6 to 3.8. Electrical conductivity was 10.74 µs/cm. Chemical analysis of this study revealed that the total nitrogen and available phosphorus were 15% and 42 ppm respectively. Furthermore, K+, Ca2+, Mg2+ and Na+ were higher in as 45.8ppm, 151.7ppm, 9.7 ppm and 241.7ppm respectively. Chemical analysis of available Fe, Zn, Cu and Sulphur were 9.6 ppm, 1.1ppm, 0.11ppm and 48.3 ppm respectively. Results of this study agreed with several research findings on the healing ability of termite mound clay on joint disorders, skin related diseases, edema and to treat pregnant mothers with iron and Ca supplements and young children with diarrhea. Termite mound clay has the same physico chemical properties as the other muds used in mud therapy and justified for its healing ability. Therefore, termite mound clay could be used as a low-cost substitute in present day mud therapy.

Key words: *Mud therapy, physico chemical properties, traditional medicine, termite mound clay, healing ability*

1. Introduction

Various types of mud have been used since ancient times in the indigenous medical systems globally including Sri Lanka. Mud is generally a mixture of inorganic matter, organic matter and water which, due to various physicochemical factors has

undergone geological and biological processes. One of the five constituent elements of this universe, earth (Mud) has a pivotal role to play in our health and wellbeing. Mud therapy traces its roots back to ancient times when various cultures recognized the healing potential of earth's natural elements (Rastogi, 2012). From the banks of the Dead Sea to traditional Indian Ayurvedic and Naturopathic practices, mud therapy has been a consistent presence in diverse wellness traditions. Mud therapy, also known as pelotherapy, is the age-old wisdom of utilizing natural elements of wellness and exploring its advantages of therapeutic properties to enhance our overall state of general health and wellbeing (Rastogi, 2012).

Sri Lankan traditional medical system has given prime importance for *Kumbal mati* (Potter wasp clay) and *Humbas mati* (Termite mound clay) related to therapeutic purposes (De Silva *et al*., 2024). *Humbas mati* is the mound clay formed by termites: an insect of the Blattodea order and isoptera infraorder. Both types of mud are considered *parthiva dravya* (substances originating from earth). Termites are social insects that live in colonies and termites of the genus *Macrotermes* (isoptera, sub family Macrotermitinae) build their mounds using aggregates of the soil material from up to several meters' depth. Many termites are wood feeders, though they may also feed on dead plant material and various kinds of organic matter gathered from surrounding area (Kirton, 2005) and subjected to intense degradation where it is digested by termites. Termites are detritus feeders, and contribute to nutrient cycling and energy flux, thus structuring communities. Furthermore, termites' activities in soil improve the nutrients and organic matter dynamics and structure of the termite mound clay (Rückamp *et al*., 2012).

Clay types are widely used as major mineral ingredients in traditional pharmaceutical science of *Rasashastra* (alchemy), *Samhita grantha* and *Ayurveda pharmacopeia* because these clays are enriched with cations. According to *Charaka Samhita*, termite mound clay has been used for different kinds of diseases in different types of prescriptions such as *Urusthambha* and also hydrocele (*Mutraja vruddhi*) and various edemas (*Shotha*). There are no detailed studies carried out in physico chemical properties of termite mound clay in Sri Lanka except Molligoda *et al*., (2021) on pH, moisture content and ash value. The main objective of this research is to analyze the physical and chemical properties of the termite mound clay comprehensively and to justify scientifically the healing ability of termite mound clay in mud therapy of traditional medicine.

2. Materials and Methods

The samples were taken from three locations in Boralesgamuwa in Colombo, Sri Lanka. About 500g of each sample was sun dried for 3 days, ground using mortar and pestle. A representative sample of 250g was taken for particle size analysis and another 250 g sample were used for chemical analysis.

Particle size analysis was conducted in the laboratory of Department of Agricultural and Plantation Engineering, Faculty of Engineering, The Open University of Sri Lanka. Particle size analysis was performed using hydrometer method (Gee and Or, 2002).

Chemical analyses were done in Soil and Plant Nutrition Laboratory of Tea Research institute, Talawakelle. Soil pH (H_2O) and electrical conductivity (EC) were measured using pH meter and conductivity meter in a 1:2.5 soil water ratio (VanReeuwijk, 1993 and Raina *et al.,* 2007). Total nitrogen was analyzed by the modified Kjeldahl oxidation method (Okalebo *et al.,* 2002). Available phosphorus was determined by Bray 1 method (Bray and Kurtz, 1945). Exchangeable Ca^{2+}, Mg^{2+}, Na^{+} and K^{+} were determined by extraction with 1 N NH4OAC. K^{+} and Na^{+} in the extract were determined with a flame photometer, while Ca^{2+} and Mg^{2+} were determined using an atomic absorption spectrophotometer following the procedures outlined by Udo *et al*. (2009).

The available Sulphur content was determined in the laboratory with the use of NH4OAc 0.5 mol L-1 in HOAc 0.25 mol L-1 (ammonium acetate in acetic acid - AMA) (Bardsley and Lancaster, 1960). Concentrations of zinc, copper, iron, and manganese (Zn, Cu, Fe, and Mn) were determined by combining a 10-gram scoop of air-dried of soil with 20 milliliters of DTPA (Diethylenetriamine-penta-acetic acid) extracting solution and shaken for two hours. The sample was then filtered, and the extract was analyzed via inductively coupled plasma optical emission spectrophotometer (ICP-OES). Results are reported as parts per million (ppm) of each metal in soil (FAO, 2022). All analyses were performed on samples with three replicates.

3. Results and Discussion

Physico chemical properties of Termite Mound Clay (*Humbas mati)*

Particle size analysis

Particle size analysis of the termite mound clay in this study revealed the presence of 86% clay, 8% silt and 6% sand. High clay content in termite mound clay enhances water storage capacity. Research conducted by Dhembare in 2013 found clay percentage in termite mound clay was as high as 70.5% compared to clay percentage in surrounding soil, meanwhile, research conducted by Lee and Wood in 1971 presented high percentages of Kaolin clay in African termite mounds. Results of both this research agree with the findings of the current study. Higher clay content enhances water storage and infiltration capacity and thus promotes microbial metabolism. Termites carry out a sequence of actions such as fetching, cementing mineral particles into mounds by using their salivary secretion. These actions can further increase the aggregate stability and soil porosity, which can enhance water retention (Lopez-Hernandez, 2011). Termite mound clay is usually made of clay whose plasticity has been further improved by the secretion from the termites while being used in building the mounds. According to Geiger *et al*., (2003) termites need to keep their body water content within narrow limits and therefore develop a close dependence on water holding capacity.

pH and electrical conductivity

The pH of termite mound clay varies from 3.6 to 3.8 and it is slightly acidic. Electrical conductivity was 10.74 µs/cm which showed that termite mound clay is mostly

saline. Abe and Wakatsuki (2011) reported a significantly higher soil electrical conductivity, which agrees with the results of the current study. This may be due to the higher bulk density caused by the fact that termites repack clay with their saliva to form hard protective layer against open air temperature fluctuation in the termite mounds.

Total nitrogen and available phosphorus

Chemical analysis of this study revealed that the total nitrogen in the termite mound clay was 15 percent. Nitrogen is a necessary macronutrient and key regulator of ecosystem processes. The termite mound clay with higher total nitrogen may be due to the higher organic matter content (De Silva *et al*., 2025). The increases in clay and organic carbon contents in termite mound clay were associated with significantly higher reserve of total nitrogen (Mthimkhula *et al*., 2018) which agrees with the results of the current study. Furthermore, available phosphorus in this study was as high as 42ppm. Lopez-Harnandez *et al*., (2006) reported higher available phosphorus in termite mound clay might be due to the incorporation of feces in the mound material which aligns with the current findings as well. Termites feed on organic material with clay minerals and the gut of termite is modified and adapted for changes in chemical and physical properties (Batjes, 1996). Oliverira *et al*., (2012) noted that the higher phosphorus is related to the higher amount clay organic matter in the mound construction, that prevents the loss of available phosphorus.

Exchangeable Base Cations

Analysis of termite mound clay of this study revealed that K^+, Ca^{2+}, Mg^{2+} and Na^+ are higher in as 45.8ppm, 151.7ppm, 9.7 ppm and 241.7ppm respectively. These results agree with research conducted by Ackreman *et al*., (2007) and Sileshi *et al*., 2010 suggesting the presence of higher contents of magnesium, sodium and calcium in termite mound clay. Reviews by Jayawardena and Molligoda (2020), showed that termite mounds are frequently enriched with changeable basic cations such as Ca^{2+}, Mg^{2+} and K^+ and $CaCO_3$ compared to the adjacent soil. Bouillon (1970) reported very high levels of sodium in the inner part of the Termite mound, probably due to the incorporation of saliva during construction. Above findings supports the evidence presented through the current study.

Furthermore, termite mound clay having higher clay and carbon contents, the higher cation exchange capacity would result from the greater negative charge contributed by clay particles consequently increasing the amounts of exchangeable cations (Ca, Mg, Na and K) retained on the termite mound clay (Mthimkhula *et al*., 2018).

Other essential nutrients

Chemical analysis of termite mound clay in this study revealed that it contains available Fe, Zn, Cu and Sulphur as 9.6 ppm, 1.1ppm, 0.11ppm and 48.3 ppm respectively. Furthermore, the termite mound clay soil in this study was red in color may be due to the higher content of iron oxide.

Dhembare, (2013) also found 6.2 ppm ferrous in termite mound clay whereas the surrounding soil has 5.42 ppm. According to Samad *et al*., (2021) red termite mound

clay is composed of chemical constituents such as silica, calcium oxide and aluminum oxide, magnesium oxide and other oxides like iron, potassium and sodium, however the red color is due to the presence of iron II oxide (Fe_2O_3) also the intensity of the color is depended on the percentage of the Ferric oxide. Foti (1994) reported higher concentration of bioavailable elements and soluble iron and ionizable iron were present in most termite mounds whereas not detected in the surrounding soils. Furthermore, Dhembare (2013) found 0.97 ppm Zinc in termite mound clay while 0.81 ppm in the periphery agrees with this study results. Zn is essential for production of auxins, activates enzyme for protein synthesis, regulation and consumption of sugars. Copper in the termite mound clay too was higher than the surrounding soil. Copper is a catalyst in several enzyme systems for carbohydrate and protein metabolism (Dhembare, (2013). These results agree with the results of this study that the termite mound clay has these essential nutrients.

Dhembare (2013) also found higher sulphur contents of 14.1ppm in the termite mound clay soil compared to the surrounding soil which agrees with this study results that termite mound clay has considerable amount of sulphur in it.

Scientific base for the Termite mound clay's healing ability in Traditional Medicine

Mud therapy for Joint disorders

Mud therapy since ancient times, has been used for various musculoskeletal and inflammatory joint diseases alone or in combination with other balneotherapy to relieve painful arthritic conditions (Chadzopulu *et al*., 2011). This includes conditions like osteoarthritis and rheumatoid arthritis. Furthermore, it is also used in the treatment of bursitis, tendonitis, sprains, strains and other musculoskeletal injuries and disorders (Chadzopulu *et al*., 2011).

Me**c**hanisms of actions of mud therapy in osteoarthritis are classified as specific and non-specific. Specific regarding the chemical and mineralogical features of the clay material. Non-specific regarding the overall hydrotherapeutic action (Mennuni *et al*., 2021). The benefits are associated with the thermal, chemical, biological, mechanical, neuroendocrine and immunological aspects (Mennuni *et al*., 2021).

The thermal effects include the increase in temperature of the skin, subcutaneous tissue, muscles, decrease in muscle tone and hyperemia in periarticular sites. This hyperemia leads to the removal of inflammatory cytokines and chemokines resulting in reduced pain (Fraioli *et al*., 2018) and a decrease in the chemical mediators of inflammation at the sites resulting in reduced inflammation (Mennuni *et al*., 2021). According to studies, the effects of mud therapy are mainly ascribed to heat and the ability of mud to maintain heat for a relatively longer period of time (Codish *et al*., 2005).

Regarding the chemical efficacy of mud therapy, antiseptic activity and the capacity to interchange substances are mainly due to the inorganic components of mud. Effects of mud therapy include, increase in membrane electrical conductance, absorption phenomena, hyperemia, activation of hydropoietic glands, enzymes and

hormones (Chadzopulu *et al*., 2011). The biological effects of mud bath therapy are secondary to the thermal and chemical effects of mud therapy (Fraioli *et al*., 2018).

According to Ayurveda Pharmacopeia, termite mound clay mixed with herbal material and thermal treatments have been done to increase curing ability or to remove toxic factors. Furthermore, termite mound clay, mustard powder, ginger power has been grinded with *Cinnamomum camphora* leaf juice and then boiled and applied for rheumatoid edema. Thus, it is clear that the termite mound clay used in traditional medicine in ancient times has similar properties such as enriched with cations to the other muds used in mud therapy at present time. Termite mound clay is widely used as major mineral ingredients in pharmaceutical science of *Rasashastra* (alchemy), *Samhita Grantha* and Ayurveda pharmacopeia of India and Sri Lanka. Therefore, the termite mound could be substituted with the present-day clay in mud therapy as the former has similar physicochemical properties enhancing its healing ability.

Mud therapy for face

Exposure of the skin to high heat can lead to the development of conditions like acne, blemishes, dark spots, early signs of ageing, skin allergies and rashes on the face. Mud therapy can be used to prevent and cure such damage. According to research, mud has an anti-ageing effect on the skin. Ions like $Ca^{2+,}$ $Zn^{2+,}$ $Mg^{2+,}$ Na^{+} present in the mud improves the activities of glutathione and superoxide dismutase, which can repair cells and reduce the damages caused by free radicals and reactive oxygen species like superoxide. These activities then result in improving skin elasticity, reducing skin pigmentation, skin wrinkling and exerting an overall anti-ageing effect on the facial skin (Tian *et al*., 2022). According to this study, termite mound clay has higher contents of ions $Ca^{2+,}$ $Zn^{2+,}$ $Mg^{2+,}$ Na^{+} and can cure skin related diseases like Tian *et al*., (2022) found in their studies. Minerals like Selenium, Zinc and Iron in the mud have the ability to promote energy circulation and keep skin cells active. Furthermore, they also contribute to nerve activity, regulation of cell permeability, and are also constituents of various enzymes and proteins that are essential for skin respiration, skin metabolism and normal growth of the cell (Tian *et al*., 2022). Especially, Dead Sea black mud, due to high salt content, sulfide concentrations and a low pH environment, possesses anti-acne effects (Tian *et al*., 2022). According to this study, termite mound clay has high salt content because the electrical conductivity is higher than 4 μs/cm and has shown higher Sulphide concentrations in low pH environment, possessing anti-acne effects. According to Drug represent in Ola leaf manuscript in Sri Lanka (Book series of *Talpate piliyam*) the paste of Sulfur (*Gandaka*), Cinnamon bark (*Kurundu pothu*) and termite mound clay obtain from top of the ant hill is used to cure different types of abscesses (*Talpate piliyam*, 1994). Therefore, the healing ability of termite mound clay agrees with scientific base of it according to this study.

Mud therapy for edema

According to research, mud packs are beneficial in reducing the swelling that affects any component of the body (Chadzopulu *et al*., 2011). Termite mound clay is considered to have high water retentive and high-water absorption properties. Due

to these reasons, they are considered beneficial in acute and chronic inflammatory diseases that can lead to edema (Lopez-Hernandez, 2011).

Furthermore, mud packs have been used traditionally to treat skin affected by cutaneous inflammation caused by UV radiation. This is characterized by erythema and edema. Certain chemical components of mud are found to be responsible for the reducing of erythema and edema. Moreover, the minerals in the mud were found to be the major components responsible for the anti-inflammatory properties of the mud (Kim *et al*., 2010). According to this study, the higher content of 2:1 type clay has higher water retention abilities and water absorption properties enhance the healing ability of termite mound clay in reducing swelling in any part of the body. Therefore, termite mound clay can be used as substitute to the other clay types used in mud therapy.

Treatment for pregnant mothers

In traditional medicine, women used to take termite mound clay during pregnancy as the termite mound clay has high amounts of iron and calcium. According to Foti's (1994) study on the possible nutritional/ medicinal value of some termite mounds used by Aboriginal communities of Nauiyu Nambiyu (Daly River) and Elliott of the Northern Territory, pregnant women used to eat a handful (20 to 30 g) at least 2-3 times a day when afflicted with upset stomach, vomiting and diarrhea or to stop the craving while pregnant. Termite mound pieces were used to give even to young children with diarrhea. Women reported that they used to eat "bits and pieces all day long during pregnancy". Furthermore, it was reported that women also used to eat it when they were hungry, when they had stayed in the bush for a long time, or after eating yam or meat (turtle, wallaby, goanna and porcupine). Termite mound clay was used by all men and children of the aboriginal communities as nutrient supplement from their childhood.

4. Conclusions

Mud therapy, based on their various modes of actions including thermal, chemical, biological and immunological effects, exerts beneficial action on local and general disorders. Termite mound clay is used in Traditional mud therapy in Sri Lanka. Therefore, comprehensive analysis of physicochemical parameters of Sri Lankan termite mound clay was done and the study reveals that termite mound clay has very high content of clay, low pH and above 4µs/cm of electrical conductivity therefore a saline condition. Chemical analysis proved that Termite mound clay has high contents of total nitrogen, available phosphorus, Na, Ca, Mg, K, Fe, Zn, Cu and Sulphur. Various components including minerals, trace elements and chemicals, consist of a variety of therapeutic properties including anti-inflammatory, antioxidant and immunomodulatory properties. Accordingly, Termite mound clay application is beneficial in joint disorders like osteoarthritis and rheumatoid arthritis to reduce pain and inflammation due to the reduction in chemokines and inflammatory cytokines responsible for these painful conditions. It is also beneficial to cure and prevent skin ailments like blemishes, acne, pigmentation due to the antioxidant nature and due to activities, that prevent and reduce the damage done by harmful free radicals. Furthermore, the minerals and chemicals in this Termite mound clay

also exhibit water retaining, water absorption and anti-inflammatory properties which are beneficial in edematous conditions affecting any part of the body. Therefore, Termite mound clay has all the necessary the physicochemical properties like the other clays used in mud therapy and it has the scientific base for its healing ability. Furthermore, termite mound clay could be used as a low-cost mud in mud therapy of the modern world.

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