Investigation on Various Physico-chemical Parameters of Clays of Baksa District of Assam Used for Cosmetic Purposes

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A B S T R A C T

Clay has been used for millennia by many different civilizations. Clay is a type of soil with extraordinary physico-chemical properties that endow it to be one of the best detoxifier/purifier and versatile natural healing product available. It is a potent antiseptic, while responding the tissue on which it is applied, a wound-healer by stimulating the cellular regeneration and protecting the scar, a bleeding stopper, a cleaner and a sedative and relaxer. Clay has the shampoo like properties attracting dirt oil and impurities making it an excellent hair cleaner and can be used to cleanse oily hair and to clarify product build from hair. The action of clay is mostly due to its dual property of adsorption and absorption that are expressed at different degrees in different clays.

In the present experiment, a comparative study of seventeen important Physico-chemical parameters of the soil samples used for cosmetic purposes by the local people from three different places of Baksa District of Assam and one sample from the state of Jharkhand is performed. Parallel to it, an agricultural soil sample is also analysed. The soils used for cosmetic purposes are clay/ clay Loam in Texture with near neutral or slightly alkaline soil reaction having high content of nutrients. The soil of Jharkhand is rich in nutrients chloride, potassium, phosphate and organic carbon; the cosmetic clay of Assam is rich in sulphate and nitrate; and the agricultural soil is rich in calcium and magnesium. The total surface area of a given mass of clay is more than a thousand times than that of sand with same mass. The increase in surface area has an important implication in nutrient availability and therefore in cosmetic abilities.

Key Words:: *clay, cosmetic ability, clay loam, texture, specific surface area.*

Introduction:: The use of clays in medicinal and cosmetic applications has been widely studied by large number of researchers. According to these authors, such clays are widely used for, cleansing the hair, skin, emulsification, detoxification, adsorption, UV radiation protection, ion exchange with the skin, and trans-dermal nutrient supplementation of elements such as calcium, iron, magnesium and potassium. Clays have been used topically in mud spas in the form of ointments, pastes, creams and gels to adsorb toxins from skin and provide heat to stimulate circulation for rheumatism treatment [1, 2]. The ability of clays to perform these various functions is influenced by among others, their special properties such as extensive swelling in water and water absorption, colour, particle size, specific surface area i.e. surface area per unit volume or unit mass of the particles; and cation exchange capacity (CEC) i.e. the ability of clay colloids to attract and hold positively charged ions [3, 4]. Suitable consistency and appropriate viscosity are required for products to remain in contact with the application area until the objective is achieved. Cosmetic products must therefore be smooth, adhesive and without grittiness [5].

In many African communities, the traditional usage of clays for cosmetic purposes is a common practice [6]. The uses of clay soil for cosmetic purposes by the indigenous people of Baksa district of Assam have also been reported. 'Chanthali' community calls it "Nadka Hasa" which means hair washing (Nadka) soil (Hasa) [7]. This practice, which is based on indigenous knowledge has been going on for several years, and has been handed from one generation to another. Clays used as shampoo for cleaning and brightness of hairs in Iran and adjacent countries are also reported. Theses clays have special properties such as extensive swelling in water and water absorption. Similarities of such clays are found with bentonite clay [8].

Various types of clays are there in use for medicinal and cosmetic purposes. Bentonite clay, French Green clay and Rhassoul clay are used externally for skin conditions and for cosmetic purposes. French Green Clay also known as Illite Clay or Sea Clay is very absorbent, and literally "drinks" oils, toxic substances, and impurities from skin. Cosmetically, French Green clay is revered for its ability to stimulate blood and lymph circulation, remove dead skin cells, absorb impurities and fats, and tone and strengthen connective tissues. After using French Green clay, skin feels fresh, smooth, radiant, and soft. French Green Clay is also marvelous for helping to clear problem skin areas, and is gentle enough to use weekly, or even daily on problem spots. Rhassoul clay is very high in trace minerals such as silica, magnesium, iron, calcium, potassium and sodium, making it truly one of the finest treasures for pampering skin. Because of the high mineral content, astringent properties, and absorption properties, Rhassoul clay is wonderful and effective clay for cleansing, detoxification, and for general skin care treatments. In clinical tests, Rhassoul has been shown to be effective on skin elasticity, clogged pores, removes dead skin layers, removed surface oil from skin, improves skin clarity and appearance, and reduces flakiness and dryness of both the scalp and skin.

Clays come in a variety of colors such as red, green, white, gray, and can range in texture from coarse and heavy to fine and fluffy. The different colors of clays occur because of their natural mineral content. Clay soils actually tend to be very rich in minerals, but it can be difficult for plants to access those minerals due to the nature of the soil structure. Clay minerals possess powerful adsorptive and absorptive properties. Adsorption is the process of attraction, binding, and accumulation of molecules or particles to a solid surface in a condensed layer. Absorption results when a substance diffuses or penetrates into a liquid or solid forming a transition zone or layer, often with a new composition. Clay minerals are ubiquitous in nature and their adsorptive and absorptive capabilities have been exploited in a variety of cosmetics and pharmaceutical formulations [9].

Experimental:: Three soil samples used for cosmetic purposes by local people of Baksa Districts of Assam ($89^0 42^/$E to 96^0E Longitude and from $24^0 8^/$ N to $28^0 2^/$N Latitude) bordering Bhutan along with an agricultural sample are drawn by quartering process [10]. These collected samples of soil are from near a rivulet and represent the type of soil studied in this experiment. These are used by the local indigenous people for cleaning hair etc. Similarly a representative sample used for same purposes in the state of Jharkhand is also collected. Soils are then air dried and sieved to get fine particles/powder and numbered as shown in Table-1. The seventeen parameters selected for study are Texture, Electrical Conductivity (EC), Water Holding Capacity (WHC), Bulk Density (BD), Particle Density (PD), Porosity, Hydraulic Conductivity (HC), pH, Soil Organic Carbon (SOC), Total Organic Carbon (TOC), Nitrate Nitrogen, Phosphorous, Potassium, Chloride, Sulphate, Calcium, and Magnesium. All theses parameters are determined by standard methods as listed in Table-2 [11, 12].

Result and Discussion:: The final results of the parameters determined are as follows [Table-3]. It has been found that the test soil samples II, III and V are of Textural class Clay and IV is of Clay Loam i.e. soils which are used for cosmetic purposes have higher percentage of clay than the agricultural soil I. The total surface area of a given mass of clay is more than a thousand times the total surface area of sand particles with the same mass. This increase in surface area has an important implication in nutrient management and also in the water holding capacity. The WHC of clay and clay loam are higher than sandy clay. Thus the cosmetic ability is greatly influenced by particle size of the clays. Besides this, the samples being clay i.e. the particle diameter less than 0.002 mm in size will give pleasant sensation when it is applied to the skin. Credit goes to the pleasant sensation perhaps for which clays have also been used by mammals and birds in the wild all over the world.

The usual values of Bulk density, Particle Density and Porosity for a good agricultural soil are 1.3 $g.cm^{-3}$, 2.6$g.cm^{-3}$ and hence 50% respectively. The experimental cosmetic soil samples of Assam i.e. samples III, IV and V possess porosity around 50%. On the other hand, Jharkhand soil is more porous but the agricultural soil is less porous. Porosity around 50% is more desirable in connection with retention of soil air and soil water.

Clay soils used for cosmetic purposes have lower hydraulic conductivity due to their small pore throat radii but also have very high porosities due to the structured nature of clay minerals, which means clays can hold a large volume of water per volume of bulk material, but they do not release water rapidly and therefore have low hydraulic conductivity. The clay and clay loam samples under examination follow this trend. The soils used for cosmetic purposes have lower value of Hydraulic Conductivity than that for agricultural soil.

Electrical conductivity of a soil sample is influenced by the metal content, porosity, clay particle content, permeability, and degree of pore saturation. A metal ion has a large conductivity. Clays are hydrated minerals with high porosities and low permeability. The minerals themselves may not be very conductive, but their surfaces cause an excess of cations in the pore fluid immediately adjacent to the clay surfaces. The result is high conductivity near the clay surfaces [13]. The EC value of 0.8208 $m.S.cm^{-1}$ in the Jharkhand soil indicates a high metal content in it. This is followed by the clays of the study areas i.e. 0.3534, 0.3534 and 0.2964 $m.S.cm^{-1}$ which are also rich in metal content.

Matike and his co-workers, after analyzing 40 samples used for cosmetic purposes in South Africa, reported the pH values ranged between 4.53 and 9.57 [14]. In this experiment the clay samples used for cosmetic purposes are mostly slightly alkaline or near neutral in soil reaction, pH ranged between 6.9 and 7.9. Soil pH is the most important chemical parameter that determines the availability of nutrients in a particular soil sample. Most of the essential nutrients are readily available at near neutral pH. For example, in a neutral soil, the exchangeable cations such as Ca^{++}, Mg^{++}, K^{+}, Na^{+} dominate the exchange capacity and therefore they come to the soil solution in large quantity. In other words, such cations become easily available at neutral pH. From this point of view, the experimental soils seem to be proper in respect of its capability to make the chemical elements available to the spot of application.

For a usual soil sample, some of the cations and anions generally exist in the following quantities. In mg/Kg (i.e. ppm) of dry soil Chloride 10 to 350, Sulphate 25 to 500, Calcium 2 to 200, Magnessium 1 to 120 and potassium 1 to 25. Phosphorous in soil usually ranges from 0.01 to 0.3%, but only a small fraction of it may be available, the rests being in the form of fixed phosphorous [11]. The experimental soil samples are seemed to be usual with respect to Chloride, Sulphate, Calcium, Magnessium, and Potassium. Calcium and magnesium salt ingredients are important in clay. Clay like ingredients such as Calcium, and Magnesium Silicates; Magnesium Trisilicate and many other calcium and magnesium mixed silicates with other metals are used in commercial cosmetic formulations. Typical cosmetic uses of silicates include abrasive, opacifying agent, viscosity-increasing agent, anticaking agent, emulsion stabilizer, binder, and suspending agent. Topical application of Magnesium Aluminum Silicate to human skin daily for 1 week produced no adverse effects [15].

In the top 10 cm, Soil organic Carbon's usual range is 1 to 3% in dry soil [16]. The experimental soil samples I, III and IV are deficient in Organic Carbon and hence in Soil Organic Matters. Clay soils used for cosmetic purposes which have high clay content have higher percentage of organic carbon and hence the total organic compound. Clay offers chemical protection to organic matter through adsorption onto clay surfaces. Soils with high clay content therefore tend to have higher SOC than soils with low clay content.

The clay and clay loam samples under examination also are rich in minerals. It indicates their suitability of being cosmetic clays. The cosmetic capabilities of clays are being exploited by many beauty spas around the world. In these spas, the colour of the clays also determines their use besides the other physico-chemical parameters [17]. Some more works in the said sample of clays deserve attention.

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Table-1:: Samles and their numbers.

Sample No	I	II	III	IV	V
Particulars	Agri. Soil	Jharkhand Soil	Soil of Fitikajan, Baksa District, Assam	Soil of Daimabari, Baksa District, Assam	Soil of Paharpur, Baksa District, Assam

Table-2:: Parameters and their methods of determination

Parameters	Name of the method	Particulars
Texture	Bouyoucos Hydrometer Method	Based on Stoke's Law
pH	Digital pH meter Method	Using Glass Electrode
EC(m.S.cm^{-1})	Conductivity meter Method	Using standard KCl solution
SOC (%)	Titration Method, Walkey and Black, 1934	Oxidising Agent- Chromic acid
TOC (%)	Calculation Method, Van Bemmelen factor	SOC X 1.723
WHC (%)	Wet Soil, Dry Soil mass determination	WHC = (WS-DS)X100/DS
BD(ρ_b) g.cm^{-3}	Mass and Bulk Volume Determination	ρb = mass / Bulk Volume
PD(ρ_p) g.cm^{-3}	Mass and Particle Volume Determination	ρ_p = mass / Particle Volume
Porosity (%)	Calculation Method	Formula - $100(1-\rho_{b/}\rho_p)$
HC (cm.sec^{-1})	Bower and Jackson Method	HC = QL/HAt
NO_3^- N (ppm)	Spectrophotometric Method-420 nm	Extractant - $CuSO_4$ & $AgSO_4$
P (ppm)	Bray's P-I method, Bray & Kurtz, 1945	Extractant – $NaHCO_3$
K (ppm)	F Photometry, Hanway & Heidet, 1953	Extractant –Ammonium Acetate
Cl^{-1} (g.L^{-1})	Titration Method	Using $AgNO_3$-K_2CrO_4 Solution
$SO_4^{=}$ (g.L^{-1})	Gravimetric Method	Using $BaCl_2$ reagent
Ca^{++} (g.L^{-1})	Titration Method	Using Versenate reagent
Mg^{++} (g.L^{-1})	Titration Method	Using Versenate reagent

Table-3:: Results of the parameters determined

Parameters	Sample-I	Sample-II	Sample-III	Sample-IV	Sample-V
Texture	Sandy Clay	Clay	Clay	Clay Loam	Clay
WHC (%)	13.41	41.66	23.64	30.07	21.74
HC (cm^3s^{-1})	13.6×10^{-3}	4.54×10^{-3}	11.1×10^{-3}	6.21×10^{-3}	8.63×10^{-3}
BD(ρ_b) $g.cm^{-3}$	2.85	2.05	2.52	2.68	2.45
PD(ρ_p) $g.cm^{-3}$	4.61	4.98	5.10	5.06	5.13
Porosity (%)	38.2	58.8	50.6	47.0	52.3
EC($m.S.cm^{-1}$)	0.1368	0.8208	0.3534	0.3534	0.2964
pH	6.6	7.7	6.9	6.9	7.9
SOC (%)	0.62	1.03	0.77	0.98	1.01
TOC (%)	1.07	1.78	1.33	1.69	1.74
NO_3^-N (ppm)	1.98	3.05	0.54	4.19	4.61
Avail. P (ppm)	0.170	0.288	0.123	0.272	0.064
K (ppm)	1.0	1.67	1.24	1.19	1.31
Cl^{-1} ($mg.Kg^{-1}$)	36	178	106	106	142
$SO_4^{=}$($mg.Kg^{-1}$)	106	168	160	164	180
Ca^{++}($mg.Kg^{-1}$)	8	4.8	3.2	3.2	4.6
Mg^{++}($mgKg^{-1}$)	22	6	14	10	8

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