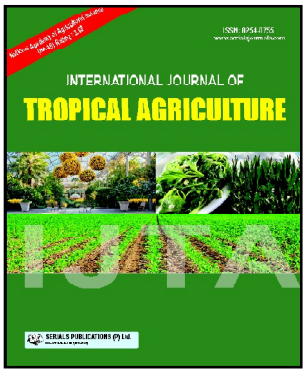

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Study of Physical and Mineralogical Properties of Soil from the Marathawada Region of Maharashtra

A.G. Dake[1], V.D. Patil[1] and P.H. Gourkhede[1*]

[1]Department of Soil Science and Agriculture Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani-431402 (M.S.)
[*]Corresponding auther. E-mail: pathrikar2012@gmail.com

Abstract: This study mainly focused on evaluation of different soils for their Geomedicinal values as "Study of physical and Mineralogical properties of soil from the Marathwada region of Maharashtra" was calculated during the year 2007-08 at Department of Soil Science and Agricultural Chemistry, College of Agriculture, Marathwada Agricultural University, Parbhani. In all 12 different soils from different locations were collected from evaluation of soil properties for medicinal values. The soil samples collected were : Soil from Sulphur Deposits-from village Unkeshwar, Dist. Nanded, Soil from Lonar Crater-from village Lonar, Dist. Buldhana, Soil of Gadhi-from village Daithana, Dist. Parbhani, Multani soil-from Local market of Parbhani, Dist. Parbhani, Soil form Ant's Living Home-from village Malsona, Dist Parbhani, Calcium Carbonate Rich soil-from M.A.U. Region, Dist. Parbhani, Red Soil-from village Daithana, Dist Parbhani, Soil from Janwal-Butte-from village Janwal-Wadwal Dist. Latur, High Clay Soil-from village Anglegaon, Dist. Parbhani, Forest Soil-from village Kinwat, Dist. Nanded, Soil Under Banyan Tree-from village Daithana, Dist. Parbhani, Normal Soil-from village Daithana, Dist. Parbhani. These soils were processed for the estimation of Iodine, Arsenic, and selenium . The result of research project revealed that the physical properties of soil *viz.* soil colour, soil texture, soil structure, bulk density, porosity was influenced due to nature of soil. Their study is essential to know the mineral makeup and influence of soil forming factors on soil genesis and nature of soil. Cultivated soil showed low concentration of Iodine, Arsenic and selenium.

Key words: Mineralogical properties, physical properties, evalution, Iodine, Arsenic and Selenium.

INTRODUCTION

Soil is a basic natural resource which supports life in all forms. Basically earth's crust composed of mineral matter which is made of various elements combined together to form compounds. Almost all elements present in the earth's crust like oxygen, silicon, iron, calcium are useful to human body. Each element in a combination with one or more other elements to form definite chemical compound. These compounds referred as minerals that combine to form rocks. Further these rocks crumbled into pieces and produce regolith/parent material. The various soil forming processes work under the umbrella of soil forming factors and parent material to get transformed into a 'true soil'.

The soil is indeed almost a perfect laboratory for creation of natural medicines. Soil contains an array of mineral matter, tiny microhabitats that create an enormous variation in the appearance and survival strategies of soil microbes. As time passes, soil get matured due to various physical and chemical processes. Biological oxidation of inorganic and organic compounds carried out by diverse group of microbes produce varied type of soils. The geological material observed in the form of rocks, minerals and soil particles which forms a backbone of earth's life. The relationship between geologic materials and human health has been known for centuries. Ancient Chinese, Egyptian, Hindues, Islamic and Greek texts describe the many therapeutic applications of various rocks and minerals and many health problems that they may cause. More than 2000 years ago Chinese texts describe 46 different minerals that were used for medicinal purposes. Arsenic minerals for example, Orphiment (As_2S_2) and Realgar (As_2S_3), were extensively featured in the material medica of ancient cultures. Health effects associated with the use of these minerals were described by Hippocrates (460-377 B.C.). There have been many pioneering collaborations on environmental health issues between geoscientists and medical scientists (Bencko and Vostal, 1999; Cronin and Sharp, 2002; Centeno *et al.*, 2002), but these studies have largely been driven by the interest and enthusiasm of individual scientists. Pedologist or soil scientist nobody have exception to these developments.

In India, soils were found to be used for various medicinal and cosmetic purposes which include washing the hairs by mud, use of mud face-pack to glow the skin, use of mud-paste during the headache and so on. Geologists are working with the medical community to address various health issues like use of soil for varied curative measures, exposure to toxic levels of trace elements such as arsenic and mercury; trace element deficiencies; exposure to natural dusts and to radioactivity; naturally occurring organic compounds in drinking water, etc. In addition to geological scientists and medical professionals, the role of soil scientists in the development of geomedicinal data-base will be lighting torch for the medical community. The medical geology (geomedicines) as a natural cure is not strictly an emerging discipline but rather a re-emerging discipline, in the present day context. It is a need of hour to correlate the myths of use of soil as a medicine with sound scientific base.

MATERIAL AND METHODS

Location, Geography and Climate of Selected Soil Sites

The twelve soil samples were collected from various locations of Maharashtra state. Soil samples *viz*, Ghadi's soil, calcium carbonate rich soil, red soil, Ant's living home soil, high clay soil, soil under banyan tree and normal soil belongs to Parbhani district, while soil under sulphur deposits and forest soil were collected from Nanded district. Soil of naturally grown medicinal plants (Janwal butte) belongs to Latur district and soil of Lonar crater belongs to Buldhana district. Multani soil was purchased from Parbhani local market.

General climate and geography of the districts from which soil samples are collected are given below.

Table 1
Locations of soil samples

Sr. No.	*Soil type*	*Village name*	*Tahsil*	*District*
1	Soil from Sulphur Deposits	Unkeshwar	Nanded	Nanded
2	Soil from Lonar Crater	Lonar	Buldhana	Buldhana
3	Soil of Gadhi	Daithana	Parbhani	Parbhani
4	Multani soil	Local market of Parbhani	Parbhani	Parbhani
5	Soil from Ant's Living Home	Malsona	Parbhani	Parbhani
6	Calcium Carbonate Rich Soil	M.A.U. Region	Parbhani	Parbhani
7	Red Soil	Daithana	Parbhani	Parbhani
8	Soil from Janwal-Butte	Janwal-Wadwal	Latur	Latur
9	High Clay Soil	Anglegaon	Parbhani	Parbhani
10	Forest Soil	Kinwat	Nanded	Nanded
11	Soil Under Banyan Tree	Daithana	Parbhani	Parbhani
12	Normal Soil	Daithana	Parbhani	Parbhani

Geography and Climate of Parbhani District

Geographically Parbhani is situated at 409 m above the mean sea level and spread over 19°16′ North latitude and 76°47′ East longitude in Marathwada region of Maharahstra state and has sub tropical climate. The regular monsoon started from 2nd week of June 2008. The rainfall was 925.30 mm distributted from June to October mean maximum temperature varied from 28.30°C to 43.1°C, whereas mean minimum temperature was between 7.4°C to 25.8°C. Relative humidity was observed 30 to 93 per cent during June 2008 to October 2008.

Geography and Climate of Nanded District

Geographically Nanded district is situated between 18°15′ to 19°55′ North latitude and 77°7′ to 78°15′ East longitude having an latitude of 362.24 m above mean sea-level. Nanded district is situated on the South-East portion and has extensive mountain range and barren areas. Godavari is the main river in Nanded district. It arrives from Western side and flows centrally of the district.

Geography and Climate of Latur District

Geographically Latur district is situated in the South-Eastern part of Maharashtra state at 19.7° latitude and 73.25° longitude on the Balaghat plateau at 540 m to 638 m above mean sea-level.

Geography and Climate of Buldhana District

Buldhana is a district in the State of Maharashtra situated in the Amravati division. The Tapi river and the Godavari river pass through the district. The Lonar crater, is the second largest hyper velocity meteorite crater in the world, is located in this district.

Table 2
Soil samples collected and their special kind of use

Sr. No.	*Soil*	*Use*
1.	Soil from sulphur deposits	As disinfectant in skin disease
2.	Soil from Lonar crater	As mud therapy during swelling
3.	Soil of Gadhi	Pregnant women eat it
4.	Multani soil	For face pack in cosmetic industry
5.	Soil from ant's living home	To wash the hairs
6.	Calcium carbonate rich soil	To wash clothes
7.	Red soil	Pregnant woman eat it
8.	Soil from Janwal Butte	Support medicinal plant's
9.	High clay soil	To wash hairs
10.	Forest soil	Support flora and fauna
11.	Soil under banyan tree	Used to improve quality of crop produce (organic farming)
12.	Normal soil	For comparison

Each soil sample is collected by using wooden peg up to the plough depth (20 cm).

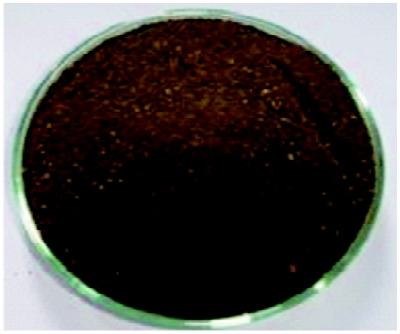
Soil from sulphur deposits

Soil from ant's living home

High clay soil

Soil from lonar crater

Calcium carbonate rich soil



Forest soil

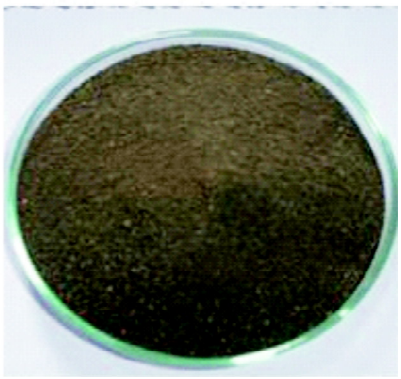
Soil from Gadhi

Red soil

Soil under banyan tree

Multani soil

Soil from Janwal butte



Normal soil

Plate 1: Different soils collected from various locations

Survey and Collection of Soil Samples

Our body is made up of Panchmahabhutas (Earth, Air, Water, Fire and Akash). Earth is our primary life support system supplying materials like minerals, water and air. Ancient history says that the people use special soils to cure various diseases and physiological disorders. Even today some acts are practiced. Keeping this in mind it was decided to collect the soils of varied nature which has special kind of use and study these soils scientifically. Therefore twelve different kinds of surface soils were collected from various location. The details of locations are presented in Table 1. and the reason of particular soil samples are given in Table 2.

Processing of Soil Samples for Soil Properties and Nutrient Content

The soil samples were also analyzed for the estimation of Soil colour, structure, texture, heavy and light minerals, Iodine, selenium and arsenic. Collected soil samples were dried, pounded in wooden mortar and pastel and were passed through 2 mm sieve. Each sample was thoroughly mixed to make it homogeneous and preserved in properly labeled polythene bags for a laboratory analysis (for free $CaCO_3$ soil samples were retained before pounding the soil).

The heavy and light mineral fraction of soil was determined by using Bromoform (Sp. Gr. 2.85) in separating funnel.

Iodine content was determined by sodium thiosulphate titration method (AOAC, 1984).

It was determined by the Molybdenum Blue colorimetric method which was given by AOAC (1984).

Selenium in soil was determined by Fluorometric Method using Microkjeldhal's flasks. The colour intensity was measured at 525 nm wavelength. It is given by AOAC (1984).

RESULT AND DISCUSSION

In this project the main object was to find out and survey those soils and their important soil properties in relation to medicinal uses. Since, these type of investigations are not available in a project "Study of Physical and Mineralogical properties of soil from Marathawada region of Maharashtra" was planned

Physical Properties of Soils

Soil physical properties have a great impact on its use and behavior towards medicinal value. The data on some of the important properties of soil *viz.*, soil colour, bulk density, porosity, soil structure and soil texture are presented in Table 3.

The soils under present investigation varied in colour and ranged from yellow to red. Soil from sulphur deposits was very dark grayish brown, Lonar crater soil was whitish yellow, Gadhi's soil was white while Multani soil was yellow. Soil from ant's living home found to be dark black and calcium carbonate rich soil was light grey, soil supporting medicinal plant from Janwalbute recorded dark yellow brown munsellcolour and high clay soil and normal soil was balck. Forest soil and soil collected under banian tree was light black and black brown, respectively.A variability in soil colour is governed by mineralogical and organic makeup of soil. Hue of colour is a expression of dominant wavelength reflected by the mineralogy of soil. Further minerals in complexation with organic material *i.e.* humus alter the colour vibrations. It is observed that humus complex impart dark colour. Soil colour has its importance in qualitative identification of mineral make up of soil.

In the present investigation the colour vibrations recorded starts from yellow to red which cover a complete spectrum of Munsell soil colour chart. Black to brown colour in these soil is due to the basaltic parent material rich in ferromagnesium and titaniferous compounds formed complex with humus. Red colour vibrations are might be due to dominance of oxidized iron bearing minerals. While

Table 3
Physical properties of selected soil samples

Sr. No.	*Sample name*	*Soil colour*	*Soil structure*	*Soil texture*	*Bulk density (Mg m^{-3})*	*Porosity (%)*
1.	Soil from sulphur deposits	Very dark grayish black	ND	Silty loam	1.42	47.00
2.	Soil from Lonar Crater	Whitish yellow	ND	Silty loam	1.28	52.00
3.	Soil from Gadhi	White	AB	Clay loam	1.31	51.00
4.	Multani soil	Yellow	ND	Clay loam	1.35	49.10
5.	Soil from Ant's living home	Dark black	Granular	Silty loam	1.12	58.00
6.	Calcium carbonate rich soil	Light grey	SAB	Sandy loam	1.35	49.10
7.	Red soil	Red	Platy	Clay loam	1.38	48.00
8.	Soil from JanwalBute	Dark yellow brown	Platy	Silty loam	1.40	47.2
9.	High clay soil	Black	SAB	Clay	1.38	48.00
10.	Forest soil	Light black	Granular	Silty loam	1.10	88.50
11.	Soil under Banian tree	Black brown	Granular	Silty loam	1.15	56.70
12.	Normal soil	Black	SAB	Clay	1.30	51.70

AB = Angular Blocky, SAB = Sub-Angular Blocky, ND = Not Determined.

yellow colour of Multani soil was might be due to hydrated haematite *i.e.* limonite. As these soils are located at varied physiographic positions having different climatic conditions, it is obvious that soil forming factors working together will produce regional soil. The soils formed are therefore are of varied in colour.

The soil structure recorded in the selected soil sample was Angular blocky in Gadhi's soil and forest soil, crumby to granular in ant's living home soil and soil under banian tree, sub-angular blocky in calcium carbonate rich soil, high clay soil and normal soil. Where as platy structure noticed in red soil and Janwal bute's soil.

The variations in soil structure might be related to the organic matter variations and cementing agents available for structure formation. Two cultivated soil samples *i.e.* high clay soil and normal soil shown sub-angular blocky while soil under banian tree and ant's living home were granular. In the later soils, due to more organic carbon content and faunal activity the structure developed might be a granular one. Red soil and Janwalbute's soil showed platy structure. The platy structure generally develops under impeded drainage. However, in this case the process of laterization might have worked to form platy structure.

The column third of Table 3 indicate the USDA textural class of soils which was determined by feel method. The texture varied from sandy loam to clayey. Except calcium carbonate rich soil no other soil recorded sand soil separate. Soil from sulphur deposits, Lonar crater, ant's living home, Janwalbute, forest and soil under banian tree were silty loam and rest were clay loam except high normal and clay soil which were clayey in texture. Texture of soil has profound influence on the pattern of heavy metal accumulation. Light textured soils accumulated lower levels of heavy metals than heavy soils under similar condition (Jaya Daskaran and Sriramulu, 1996). This indicates soil texture is one of the important properties that decides the medicinal value as it also influences the movements of pathogens and parasites in soil. Clay soils restrict the movement whereas sandy soils promote it (Abu Ashor *et al.*, 1994; Sinton, 1986).

The data on bulk density and porosity of soil are presented in column No. 6 and 7 of Table 4. The bulk density of soil ranged between 1.10 Mg m^{-3} to 1.42 Mg m^{-3} and porosity from 58.50 to 47.00 per cent. Soil from sulphur deposits and Janwalbutes showed maximum bulk density and lowest porosity followed by red soil, high clay soil (1.38 Mg m^{-3}) Multani soil and calcium carbonate rich soil (1.35 Mg m^{-3}). The bulk density of soil and their respective porosity found to have inverse relationship, which was recorded in this investigation.

Heavy and Light Mineral Fraction

The soil samples collected from various locations of Marathwada region and Lonar crater were analysed for heavy mineral and light mineral fraction of soil by using Bromoform. In general, it is evidenced that heavy mineral content found relatively in higher amount than light mineral content. The rocks are the assembledge of heavy and light minerals. Generally the heavy mineral fraction is present in the hard rocks. The basaltic trap rocks that contains relatively higher amount of ferromagnesium minerals and quartz, might have attributed to the heavy mineral fraction of soil. The young parent material which is not exposed for longer pedological time, inherits heavy minerals.

Iodine, Arsenic and Selenium Content

Iodine, arsenic and selenium concentration in various soils are showed in Table 5. The Iodine content was found more in soil from sulphur deposits, Lonar crater's soil, soil from ant's living home, calcium carbonate rich soil, red soil and soil under banian tree (greater than 2 mg kg^{-1}) while rest of the soil showed low iodine content (lower than 2 mg kg^{-1}). It was interesting to know that the normal soil and high clay soil are under cultivation of crops and had lowest iodine content.

The iodine, even though is not essential for crops its requirement is necessary for human beings.

Table 4
Heavy and light minerals content of selected soil samples

Sr. No.	*Sample name*	*Heavy minerals (%)*	*Light minerals (%)*
1.	Soil from sulphur deposits	7.62	1.90
2.	Soil from Lonar Crater	7.95	1.72
3.	Soil from Gadhi	7.37	1.35
4.	Multani soil	8.37	1.21
5.	Soil from Ant's living home	8.73	1.35
6.	Calcium carbonate rich soil	9.18	1.23
7.	Red soil	7.12	1.13
8.	Soil from JanwalBute	7.31	1.24
9.	High clay soil	7.55	1.18
10.	Forest soil	8.21	2.01
11.	Soil under Banian tree	6.22	3.37
12.	Normal soil	7.20	1.15

Table 5
Iodine, Arsenic and Selenium content of selected soil samples

Sr. No.	*Sample name*	*Iodine (I) (mg kg^{-1})*	*Arsenic (As) (mg kg^{-1})*	*Selenium (Se) (mg kg^{-1})*
1.	Soil from sulphur deposits	2.539	0.601	7.60
2.	Soil from Lonar Crater	2.962	1.320	7.80
3.	Soil from Gadhi	0.423	1.021	7.80
4.	Multani soil	1.692	0.621	4.30
5.	Soil from Ant's living home	2.539	1.092	7.60
6.	Calcium carbonate rich soil	2.116	0.521	4.80
7.	Red soil	2.116	0.231	3.50
8.	Soil from Janwal Bute	1.481	1.031	7.90
9.	High clay soil	0.846	0.825	4.21
10.	Forest soil	1.904	1.023	7.21
11.	Soil under Banian tree	2.327	1.053	7.51
12.	Normal soil	1.058	0.921	1.90

It is required for thyroid harmones, temperature control, body growth and reproduction. Its deficiency causes abnormal growth of thyroid and sometimes may result into goiter. The lower content of iodine in normal and high clay soil may influence the above said functions and cause iodine deficiency in human beings. Generally it is observed that iodine from soil leach out under cultivation and under irrigated condition. Plants continuously pump out the iodine from soil and reduce the iodine concentration of soil. So the replenishment of iodine by some or other form to the soil media become essential activity. It is necessary to note that iodine must be included in food chain through soil.

Further scrutiny of data revealed that Se content was low in cultivated soils particularly normal and high clay soil (0.9 to 1 and 0.8 to 5 mg kg^{-1}, respectively). Cortacci in 2007 recorded that, use of sulphur rich fertilizers reduced the capacity of vegetable for assimilation of Se from soil and resulted into bad effects on animals and humans.

The arsenic content in these soils was ranged from 1.9 to 7.8 mg kg^{-1}. The As content could not show the consistency in the present soils investigation. The variability in the As content might be due to several factors like heterogeneity in the type of material added to soil, light and heavy texture and climate (heavy rainfall or low rainfall, extreme temperatures or moderate temperatures). It is to be noted that once this heavy metals enters into soil system, they may go under several changes depending upon physical, chemical and biological properties of soils. Bioavailability of these metals found to be an important one as this is a gateway of entry of heavy metals into a food chain. It is observed that heavy metals are immobile in soils. As a results these accumulate mainly in surface soils which are unfortunately the zone of prime root activity in crops. The permissible level of As in soils is not available and therefore its management in soils and plant become a crucial thing.

CONCLUSIONS

The physical properties of soil *viz*., soil color, soil texture, soil structure, bulk density, porosity was influenced due to nature of soil. Their study is essential to know the mineral makeup and influence of soil forming factors on soil genesis and nature of soil.

Cultivated soil showed low concentration of Iodine, Arsenic and Selenium and did not show consistency in results. This piece of research work is efforts made to link soil health properties to human health.

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