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Research Article

Preventive Measures against Transmission and Multiplication of COVID-19 Following the Simple Natural Laws with Soil, Clay, and Biodiversity

Bipin B Mishra*#, Richa Roy, Surendra K Singh***, Sanjeet Kr Sharma**, Bishun Deo Prasad*, Sanjay K Choudhary***, Ajay K Jha*** and Sangita Sahni******

**Bihar Agricultural University, Sabour, Bhagalpur, India*

***TM Bhagalpur University, Bhagalpur*

****ICAR-Central Coastal Research Institute, Ella Road, Goa*

*****Dr. Rajendra Prasad Central Agricultural University, Dholi, Pusa, Samastipur, Bihar, India*

***#Corresponding author:** Bipin B Mishra, Bihar Agricultural University, Sabour, Bhagalpur, India, Email: bbmsoil@rediffmail.com

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Abstract

A novel coronavirus (COVID-19 virus) outbreak has caused a global pandemic resulting in huge number of infections and thousands of deaths worldwide. The present review is an effort to establish the preventive measures based on biodegradability as well as adsorption of specific part of such viruses during clay-protein interactions in contact with soil surface. Even the biodegradability of many organic compounds and molecules is altered and the activity of enzymes is adversely affected upon their adsorption to the soil mineral surfaces and clays. Viruses have in general interconnection and interdependence within aboveground and underground biodiversity covering aerosol (gas), water (liquid) and soil or sediment (solid) and are subject to undergo biodegradation following the biogeochemical cycling. Available reports suggest that Covid-19 is by and large associated to certain RNA-viruses that may undergo structural distortion if they fall in direct contact with colloidal fraction of soil minerals preferably montmorillonite or bentonite as in Maharastra and other parts of India. Either aerosols or exposed surface soils in rural areas would delay transmission as well as multiplication of COVID-19. This review highlights on relevance of soil based natural preventive measures to slowdown the spread of COVID-19 following certain yardsticks. Such exploratory approach may help to eradicate such global pandemic.

Keywords: COVID-19; Biodegradability; Clay-organic interaction, Rural ecology; Montmorillonite clay; Natural preventive measures; Eradication

Introduction

Science works to discover the functioning of the universe. All theories and methods in science are intended for successful accomplishments of the human race. Science works virtually in a closed system by assumptions on defined model representing the truth and reality within some hypothetical yardsticks. But in reality, nothing is closed, and the concept of interconnection and interdependence are the basic framework that needs to be discovered jointly applying the most refined principles with Nexus Approach. If medical science is applying its role, for example, in accomplishment of the human race, relevance of other branches of science including environmental and soil science may not be overlooked, if fall in nexus concept. In fact, soil is a nexus tool that controls not only the surrounding environments but all other components like land, water, climate, ecosystem, food, and energy.

Humans are living at the lithosphere-hydrosphere-atmosphere interface of the Earth and interconnected with aboveground and belowground biodiversity, wherein interdependence is controlled by biogeochemical cycles. Man can survive for a week without food, for a few days without water but not beyond a few minutes without air. So, the Earth's atmosphere is vital to survival of everyone's life. This signifies the relevance of interconnection and its security for stability. Other living animals have by and large enriched the resources in their own ways, but being creative and aspirant, humans have damaged entire natural laws. Urbanization, for example, is one of the most disastrous human approaches intended to disconnect Earth's atmosphere and Earth's lithosphere (ground with soil and vegetation) wherein underground as well as aboveground biodiversity is virtually inactive. In fact, lithosphere is

the outer solid layer of the Earth's crust and the lowest boundary of atmosphere that includes rocks, unconsolidated parent materials and soils intending to interactions with sunlight, moisture and microbial communities including various viruses also [1].

Soil is the major environmental reservoir of many pathogenic viruses. Unfortunately, the soil biodiversity particularly in cities and metropolitan cities is virtually inactive as being virtually detached or weakly attached to Earth's atmosphere because of manmade compacted ground surface. Coronavirus (COVID 19) develops with a positive single stranded RNA genome [2]. The positively charged RNA lining over coronavirus indicated a clue to develop an association of such viruses with negatively charges soil clays preferably bentonite or montmorollonite clay atleast to slow down their spread [3,4]. The fact that many soil minerals react with and adsorb organic compounds or humic molecules is of great benefit to mankind [5,6]. In aligned to this is the biogeochemical cycles through which the specific chemical elements of the protoplasm circulate in the biosphere from environment to organism and back to the environment. Nitrogen and sulphur cycles, for example, consist of four parts [7]. The COVID 19 pandemic may be natural or manmade, but reports say that it is a group of viruses, originated from China. Its structure is almost established by world's virologists.

Viruses vs Coronaviruses (COVID 19)

The virus is smallest in size among bacteria, algae, and fungi. The size of viruses ranges from a few tens to a few hundreds of nm, which is equal to 1/100 to 1/1000 of the normal cell of living organism. Viruses can infect bacteria as well. A virus is a section of DNA or RNA enclosed by a protein shell. The whole community is the integral part of biodiversity. The belowground communities are tightly linked to aboveground communities through trophic interactions, biogeochemical cycling, and plant-soil feedbacks, and these interactions ultimately govern ecosystem functioning [8,9]. However, our understanding of belowground communities is limited compared with our understanding of aboveground communities [8,10].

Rao [11] reported that the potential adsorbents found in marine water includes clays (montmorillonite, kaolinite, bentonite, illite), aquatic life forms (algae, bacteria), silts, and sediments, though the exact mechanism of increased virus survival due to adsorption to solids and sedimentary particulates is unknown. But they opined an approximately 10 to10000 fold higher concentration of virus in sediment than in the overlying water (Rao et al 1986). Viruses have been isolated from soils receiving domestic wastewater. Three different soil types containing 81%, 41% and 7.6% sand were examined for their ability. The great majority of viruses were detected within the first 15 cm of soil below the effluent application lines. Several isolates were found at a depth of 85 cm and single isolations at 100- 120 cm. Hurstetal [12] recovered 91% of seeded poliovirus from the top 2.5 cm of soil. Obviously, viruses have association with soil biodiversity Hopkins [13] being maximum around the soil surface.

Singh [14] reported in an exciting interview that four antiviral drugs inhibited replication of the coronavirus that causes COVID-19 and expected to have an imminent cure. Singh [14] explained, "We are developing what is called RNA polymerase inhibitors of coronavirus in our lab through a collaboration with the Karolinska Institute, Stockholm, Sweden. He added that RNA polymerase is an enzyme that is responsible for copying a DNA sequence into an RNA sequence, during the process of transcription. Covid-19 is an RNA virus "We have already identified a small molecule that inhibits RNA polymerase from SARS-CoV-2 that causes COVID-19. He opined that this small molecule or its derivative can be a drug against COVID-19. Singh [14] with his team at the University of Missouri examined whether four antiviral drugs- remdesivir, 5-fluorouracil, ribavirin and favipiravir could help in treating COVID-19 and found that all four block the virus's RNA proteins from making copies of the virus. If replication can be stopped or inhibited, the infection can be overcome. "When we said identified we meant that they can be effective against SARS-CoV-2 that is the causative agent of COVID-19."

Urbanization: Some Questions ?

Humans by virtue of reasoning power since their evolution captured the land according to availability and ownership. In doing so, they violate the natural laws and promote degradation of natural resources. The humans promoted urbanization. The urbanization and the resulting high-density population are exerting an increasing demand for environmental management, but it is not so easy. During urban development process, the most terrifying situation is the irreversible process of making the earth's surface compacted with concretion being made linked to concrete roads, seepage, buildings and play grounds in such a planned way that the earth's atmosphere is virtually got detached from lithospheric ground and soils virtually irreversibly (Figures 1&2). In fact, Earth's atmosphere is at risk especially due to urbanization. Herein, three vital disturbances do occur:

Figure 1: Municipal Corporation Area in Mumbai.

Figure 2: Connaught Place, New Delhi (Aerial view).

(i) Whole urban areas are virtually least interconnected to active biodiversity either with aboveground or underground biodiversity due to concrete packing. Any new microorganism or virus is transmitted by some means remains active following the uninterrupted high multiplication rate.

(ii) Urban areas have high population density and if mode of viral transmission is from man to man, such environment is the most positive in favoring the viral spread, COVID 19.

(iii) In metropolitan cities, the area is by and large filled or covered with concrete permanently. Such manmade planned activities lead virtually to disconnect Earth's atmosphere to its ground. This could be experienced in frequently occurring thunderstorms and lightening around city areas causing casualties too during recent days.

(iv) Soils or clays and their interactive association with organic matter including enzymes or proteins are least active and appreciated.

Earth Sciences, Northern Illinois University, USA on February 18, 2015 stated that compacted or metropolitan cities can spawn more thunderstorms based on their findings (Figure 3).Their research demonstrates that urbanization has led to more thunderstorm initiation events in Atlanta than would have occurred over natural vegetation. This is one example to pinpoint how urbanization is against nature as a whole. In India, the frequency followed by fatality around most of the cities due solely to intense thunderstorms is now regularly experienced during rains. Obviously, soil is a nexus tool to keep atmosphere and lithosphere interconnected, which is at risk due to urbanization.

Figure 3: Lightning over Atlanta. Credit: David Selby/Wikimedia Commons.

The atmosphere being the integral part of the Earth looks simply like an envelope surrounding the earth's lithosphere and hydrosphere, wherein six spectra are playing major roles in restoring the equilibrium for a climate. These are physical state and stability of the earth i.e. planetary physical spectrum, electromagnetic-nuclear spectrum besides chemical, biological, pedologic and anthropogenic spectra (Figure 4) as reported by Mishra & Richa [15]. In urban areas, all chemical, biological and pedogenic spectra are disturbed primary due to anthropogenic spectra and interconnection and interdependence among all six are at panic point of imbalance. Biodiversity is one that is also affected adversely primarily by anthropogenic factors.

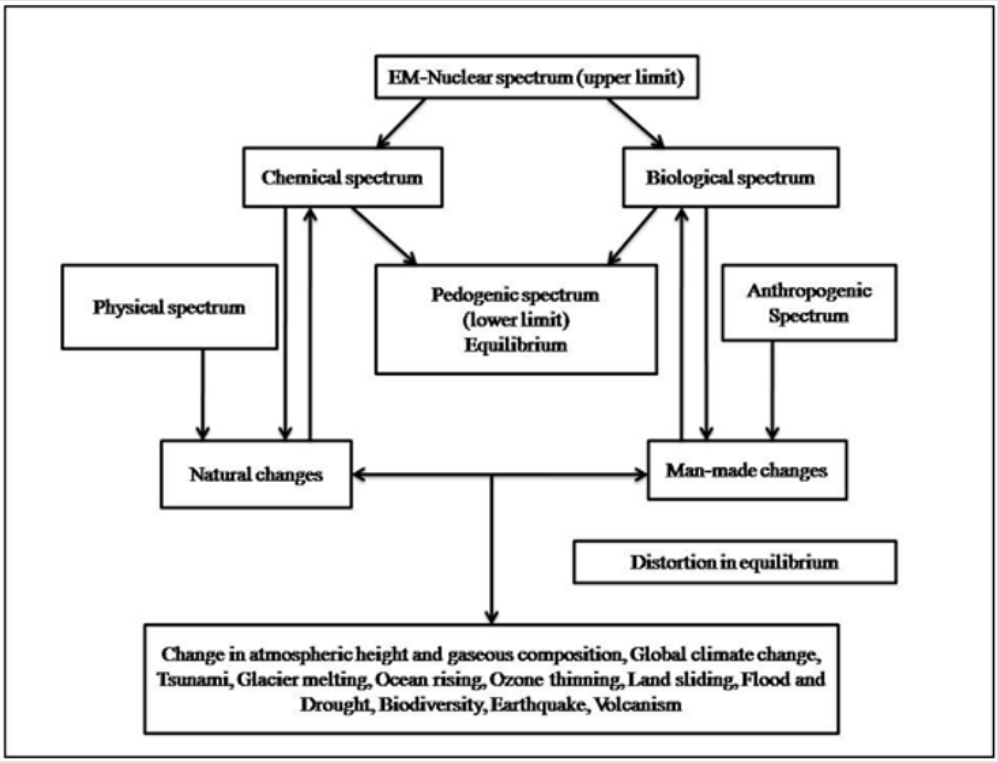

Figure 4: Principles of strategic planning to combat with challenges of climate change using integrated management inputs (Mishra and Richa 2014).

As a result of cumulative impacts, the COVID 19 viruses in cities are spreading very fast due to man to man transmission as well as multiplying with full momentum, since no proper check or restriction in cities are normally possible. Soil biodiversity refers simply to a huge laboratory of microorganisms which are often in association with viruses. Soil environment is a strange wherein clay types perform unique functions in attaining aboveground and underground biological stability due to their high surface

area, electrostatic features, biogeochemical cycling etc. Once COVID-19 is trapped by clay particles either kaolinite or most preferably bentonite, it is pathogenic features would be minimized, but it requires systematic investigation. In true sense, soil is least appreciated due solely to the fact that soil what we see is beneath our feet, but it is integral part of whole living systems. Not only survival and nourishment but our livelihood is directly controlled by soil. Soil in many respects is strange like "space", but it is full of wisdom that is being captured widely and most reliably. COVID 19 viruses in contact with soil and its clay fractions will be weakened and controlled naturally, if efforts are assured.

Adsorption of organic molecules and viruses on clay surface

Soil dust in environment or aerosol is primarily the clay particles. All surface soils have varying proportion of sand, silt, and clay wherein clay is the most active due to high surface area, surface charge distribution and interaction with organic molecules. Smectite especially montmorillonite or bentonite in particular is the most versatile group of catalysts being played in probiotic chemistry. Due to polarization of water molecules coordinated to intercalated cations, such minerals act as powerful Bronsted acids (Raman and Raman 1989). These clays may donate protons through transfer of a proton from an already protonated molecule in the exchange couple to another more basic molecule in solution. Raman & Mortland [16] reported several such proton transfer reactions. Caims-Smith (1982) forwarded a revolutionary fact involving clays as the initial genetic material in his book Genetic Takeover, in which he postulated that our first ancestor might be the inorganic clay genes and emphasized that our first ancestor might have been inorganic clay gene and DNA could not have been the first genetic material.

Clay minerals can take up a wide range and variety of organic molecules because of their extensive surface area, layer structure, and surface charge characteristics. Besides, clay minerals can shield these molecules from cosmic and ultraviolet radiation, and catalyze their polymerization [3,17]. The proposal that ribonucleic acid (RNA) can act as both a storehouse of genetic information and an enzyme-like catalyst in the primordial Earth, has stimulated research into the ability of clay minerals to catalyze the formation of RNA from its (activated) monomers. After outlining the probable role of clay minerals in chemical evolution and the origins of life, and summarizing clay minerals structures, we describe the interactions of clay minerals with nucleic acid bases, nucleosides, nucleotides, polynucleotides, and nucleic acids [3].

van der Waals forces often act in adsorption of viruses (phages) to colloid materials. Rao [11] reported that the potential adsorbents found in marine water includes clays (montmorillonite, kaolinite, bentonite, illite), aquatic life forms (algae, bacteria), silts, and sediments, though the exact mechanism of increased virus survival due to adsorption to solids and sedimentary particulates is unknown. But they opined an approximately 10 to10000 fold higher concentration of virus in sediment than in the overlying water at sites in both Texas and Florida [11] .

Fate of COVID 19 in rural areas

As against cities, the rural areas are not so populated, and houses are specious and not built closely. The soils and landscapes are open for agriculture, forestry, plantation, and pasture purposes, wherein biodiversity is active. Both aboveground biodiversity because of windblown dust (clay size) in aerosol and underground biodiversity in the soil environment are active depending on soil environment, organic matter decomposition and microbial communities in soil. The day temperature in major parts of India, for example, is more than 40 degree C which makes better environment for biogeochemical cycling as well as clay-organic interactions, wherein RNA of COVID 19 might be adsorbed and partly distorted. Dry land appears as a relevant environment, since in such conditions,dehydration-hydration cycles that allow the polymerization of nucleotides occur [18]. Clay minerals have a strong affinity for organic molecules and can catalyze their reactions [19]. Pedreira-Segade [20] reviewed on how the nucleotides would, the building blocks of RNA and DNA have interacted with phyllosilicates (clays) under various physic-chemical conditions. The binding of DNA and RNA onto mica in presence of transition metals is widely acknowledged [21]. As the recent review by Yu Chen and colleagues from China in the Journal of Medical Virology points out (https://doi.org/10.1002/jmv.25681), COVID19 has RNA-based genomes and subgenomes in its polyprotein sequence. The link between non-enzymatic RNA polymerization and RNA self-replication is a key step towards the "RNA world" and still far from being solved, despite extensive research. Clay minerals, lipids and, more recently, peptides were found to catalyze the non-enzymatic synthesis of RNA oligomers [22]. Herein, a review of the main models for the formation of the first RNA polymers is presented in such a way as to emphasize the cooperation between life's building blocks in their emergence and evolution. A logical outcome of the previous results is a combination of these models, in which RNA polymerization might have been catalyzed cooperatively by clays, lipids and peptides in one multi-component prebiotic soup. The resulting RNAs and oligopeptides might have mutualistically evolved towards functional RNAs and catalytic peptides, preceding the first RNA replication, thus supporting an RNA-peptide world. The investigation of such a system is a formidable challenge, given its complexity deriving from a tremendously large number of reactants and innumerable products. A rudimentary experimental design is outlined, which could be used in an initial attempt to study a quaternary component system.

Raman and Mortland [23] presented several proton transfer reactions in which smectite/montmorillonite may donate protons through transfer of a proton from an already protonated

molecule in the exchange couple to another more basic molecule in solution. Raman and Raman (1989) reviewed details on role of montmorillonite as catalysts, while Ghosh and Mishra [24] summarized the mode of clay organic interactions highlighting polarity in adsorption. Preventing the spread of the COVID 19 from urban to rural areas where majority of the population in India, for example, shelter is a key concern, in which one must follow strictly the practice of social/physical distancing (at least 1 m apart), wearing of face masks and frequent hand hygiene and sanitizing to control the infection and its spread as per WHO (World Health Organization).

Towards slowing down transmission and multiplication

The whole mechanism of COVID-19 for transmission, spread and multiplication within a short time is yet a mystery. However, it is advocated that transmission of COVID -19 follows three modes, namely contact (direct or indirect), droplet spray for short range transmission and aerosol in long-range transmission (airborne transmission). Although the main vehicle for its spread is contact but the other modes (droplet spray and aerosol) could not be ruled out. Recent report published in The New England Journal of Medicine indicates the viability of COVID 19 in aerosols for at least 3 hrs [25]. Even six feet of distance barrier are not sufficient to stop its spread through aerosol. However, the gravity and air flow causing most virus droplets to float, spread, and adsorbed to the air dust, soil and clays or ground. Plastered, cemented or plastic covered floor or ground is virtually inert to COVID-19 being transmitted in any mode. Importantly, the soil particles containing clays preferably bentonite with appreciable amount of organic matter seems to be preventive to COVID-19. Following any mode of transmission, once this virus comes in contact with soil dust (clay particles) or soil surface, adsorption of viruses becomes possible following the suitable principles for clay-protien or clay-enzyme interactions [16]&[23,24]. The extent of adsorption of COVID 19 by soil or clay or bentonite needs to be studied and validated. A plethora of reports indicates that the RNA decomposed very quickly if COVID-19 lost its coat (capsid). The protonated montmorillonite, titrated to pH 6–7, serves as a catalyst for the formation of RNA oligomers [26].

It is well documented that bentonite or montmorillonite clays adsorb the pathogenic viruses including human viruses [27-29]. The Black cotton Vertisols occurring widely in Maharastra are rich in montmorillonite and other parts of India including Tal land soils of Bihar. Besides other clay types like kaolinite and illite may also serve the purpose for adsorption depending upon ionic strength [28].In vitro study indicates that clay particles adsorb bovine coronavirus [30]. Based on above finding we hypothesized that the spike proteins found on the surface of COVID-19serves as the attachment protein with other surface including bentonite clay's interlayers. Further the binding or adsorption of COVID-19 may inhibit their multiplication as well as further spread (Figures 5 & 6). As such, soil and clay may slow down the speculated fast multiplication of COVID-19 and spread in any mode.

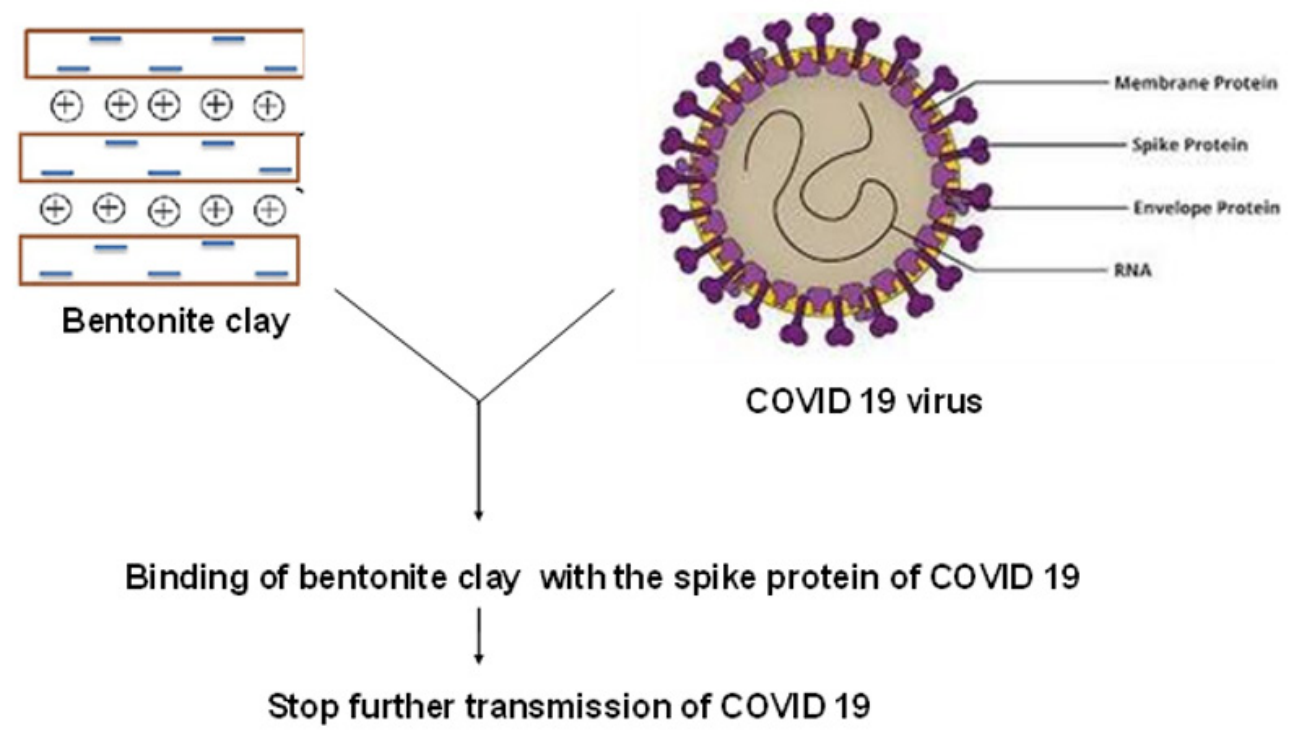

Figure 5: Flow diagram showing adsorption of COVID 19 virus on bentonite clay.

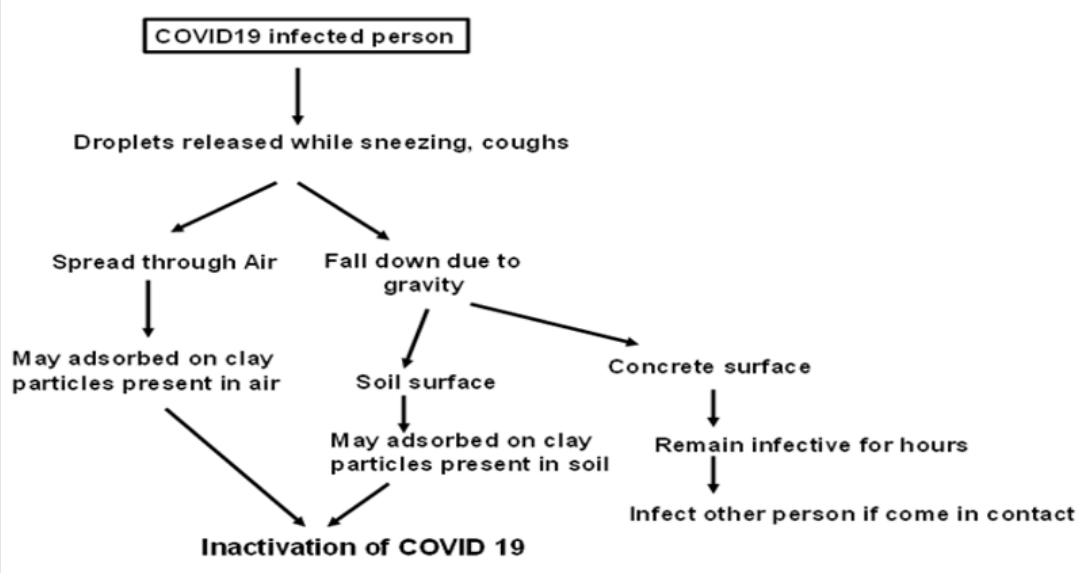

Figure 6: Possible benefits of clay present in air and soil for inactivation of COVID19.

Supporting Facts and Survey

Soil is a reservoir of genetic diversity and key players in geochemical processes. Soil viruses are of great importance as they may influence the ecology of soil biological communities through both an ability to transfer genes from host to host and as a potential cause of microbial mortality. Consequently, viruses are major players in global geochemical cycles, influencing the turnover and concentration of nutrients and gases [12,31]. In fact, environmental virology deals with the study of viruses that are transmitted through environmental factors like air, water, soil, or susceptible surface or even food. However, certain nonenveloped enteric pathogenic viruses enter the environment through the discharge of cough and waste materials from infected individuals and get transmitted to susceptible individuals and thus continue the cycle of infection. SARS being an emerging disease is severe acute respiratory syndrome (SARS) as experienced in November 2002 [32]. The mode of transmission of SARS coronavirus is the direct mucous membrane contact with infectious respiratory droplets.

The RNA-dependent RNA polymerase (RdRp, also named nsp12) is the central component of coronaviral replication/transcription machinery and appears to be a primary target for the antiviral drug [33].The "body" of COVID-19 is basically a genome enveloped in glycoproteins, with a smear of fat and bearing the crown of spikes that inspired the name "coronavirus." The genome is a single strand of RNA that is termed "positive-sense." That means that the infected cell treats the viral genome as if its own messenger RNA (mRNA), translating it into proteins [34].

With relaxation in lockdown in India, rural areas expect to see greater benefits compared to urban India, since fewer covid-19 cases are only detected in rural areas so far [35]. Urban residents are more at risk for person-to-person spread of the COVID 19, but those in rural areas are safe [36]. The novel corona virus can spread through direct transmission, contact transmission, or aerosol transmission. Aerosol transmission refers to the mixing of the virus with droplets in the air to form aerosols, which causes infection after inhalation [37].Based on observations, Anuradha [38] reported that use of soap or ash for washing hands before feeding the child reduced hand contamination significantly. Bloomfield and Nath [39] also studied the use of ash and soil for handwashing. The Sree Chitra Thirunal Institute of Medical Sciences and Technology, one of the leading medical institutes in Kerala, recently unveiled a testing kit, the Chitra Gene LAMP-N for COVID-19, produced by its team [40]. It is to believe that burial of COVID 19 victims in soil being potentially active for microbial decomposition would distort the viral structure with time [7]&[41-43]. By and large, the biogeochemical cycling in soil-clay-microorganism/biodiversity-water-environment-sunlight nexus works naturally. Importantly, based on WHO report, respiratory infections may be transmitted through droplets of different sizes: when the droplet particles are >5-10 μm in diameter they are referred to as respiratory droplets, and when they are <5μm in diameter, they are referred to as droplet nuclei. According to current evidence, COVID-19 virus is primarily transmitted between people through respiratory droplets and contact routes [44].

Till date there is no published report on air mediated transfer of COVID-19 or overlooked [45]. Study on two Wuhan hospitals in China during the COVID-19 outbreak in February and March 2020, detected SARS-CoV-2 RNA in aerosols of crowding prone areas [46]. Some medical studies also speculated the spread of COVID-19 RNA in air samples (aerosol). The existence of positively charged single stranded RNA (+ssRNA) in COVID 19 virus is well documented.

A plethora of reports indicates the formation of nucleic acid-clay complexes (Franchi et al., 2013; Beall et al., 2009) [47,48]. Therefore, we hypothesize that the clays already existing in air interact with positive strand RNA of COVID 19 virus and form the complex and so the COVID 19 virus gradually may appear inactive.

Preventive measures (COVID-19): Recommendations

Until now, no vaccination or medical treatment for COVID 19 is confirmed [49]. In India too, the situation is disastrous particularly in Maharastra, Madhya Pradesh and Gujarat. Maharastra is very rich in black cotton soils (Vertisols) with very high amount of montmorillonite or bentonite clays as depicted in map Figure 7. Although other clay types are also capable of interactions with organic molecules, bentonite is the most suitable and may be efficient to curb the normal structure of COVID 19. Accordingly, the following action plan is being forwarded to test under some trials in rural area particularly in Maharastra, India.

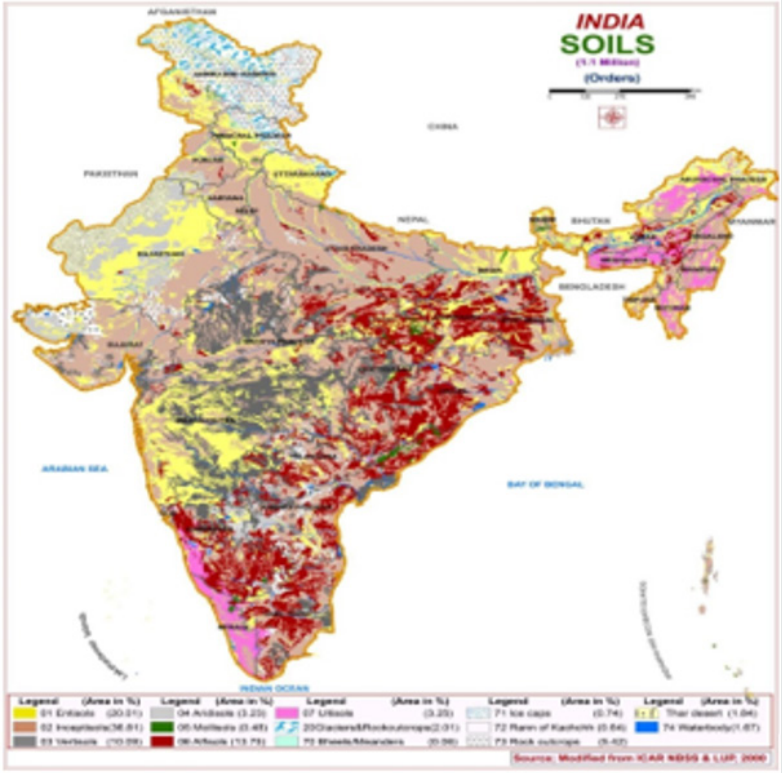

Figure 7: Different soil orders in India (Source: Anil Kumar et al. 2020).

(i) Selection of at least half acre of land undertilled bare soil in a remote rural area preferably under farming and declare it protected after fencing for all medical treatment of mild COVID 19 patients being shifted from compacted urban treatment centres from Mumbai and Pune.

(ii) The protected area may be disinfected with sodium hypochlorite (NaOCl) to kill the aboveground infectious microbes and viruses likely to be present in aerosol above the soil surface within the protected area.

(iii) Then transfer suitable number of mild COVID 19 patients, may be 100 or 200 in number, from Mumbai or Pune metropolitan cities to this protectedtreatment point while restoring all medical advisories.

(iv) Also, to continue all medical treatments as already prescribed to the mild patients maintaining physical distancing and others as recommended medically by WHO.

(v) Based on observations as outlined in this review, both transmission as well as multiplication of corona viruses in such new set of environments surrounded with soil and clay materials is likely to be slowed down and recovery will be faster.

(vi) In fact, the structure of COVID 19 will get gradually distorted during its interactions with clays and become inactive and COVID 19 is expected to be eradicated.

Sodium hypochlorite (NaOCl) is known to decompose even the resistant organic carbon in soil without affecting its inorganic constituents as well as mineral composition [50,51].Of course, the above points need to be tested or examined [52-61]. Even if the infection is transmitted through migration, it is expected for early recovery if the patients stay in village area surrounded with open or exposed soils [62,63]. Even in semi-urban area of Bhagalpur, one practice is being made common to till the soil in kitchen garden and lawn lying with residential house Figure 8.

Figure 8: Ploughing of 250 sq M lawn (residential house at Bhagalpur, India).

Conclusion

Conclusively, we prefer to encourage natural environment preferably in rural areas to get rid of this COVID-19, where specific clay rich soils are open and where Earth's ground-atmosphere connectivity is by and large optimal. Soil in its natural state is otherwise a nexus tool that remains interconnected as well as interdependent to all surrounding landform-hydrology-biodiversity-sunlight-climate-vegetation in order to restore livelihood security, wherein the contributions of soil biodiversity is vital. It is therefore presumed that the COVID-19 would not be so infectious if they are in contact with active soils rich in type specific clays and even with organic matter. In order to eradicate coronavirus (COVID 19), precautions may be taken to burn the dead body. However, such exploratory report needs to be validated systematically across the globe.

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