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Physical Characterization of Different Licked- Soil Samples (Sudan)

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Abstract:

In this study physical properties of Geophagic soil samples from different areas in El-kuma locality were characterized to investigate the probable functions that attract Dorcas Gazelle species to visit Geophagic sites. The collected samples were divided into three categories, described as A, B, C and D. The fourth group (D) represents reference samples (control). One synthetic salt lick sample was also analyzed for comparison. The measured parameters include pH values, electrical conductivity, total soluble solids and soil color on dry and wet basis. The analysis showed considerable differences in pH values. Group (A) samples showed the highest EC values, whereas, Group (C) samples showed the lowest values. Samples of Group B had moderate EC values. Differences were also observed in total soluble solids contents.

Key words: Dorcas Gazelle, Clay minerals, Miedob Mountains, wildlife, geophagy

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1. INTRODUCTION

Geophaia is the desire that lead wild animals to frequently seek certain soil sites for licking and ingestion. In sometimes it is referred to the phenomena as salt hunger (Gibla Omer, 2001; Abbo et al, 2012). In Sudan Dorcas Gazelle species are the main wild animals that observed to lick certain types of soil (soil licks) known locally as "Kaddadah". The ingestion of soil (geophagy) is a regular activity of wild animals, especially those with frugivorous and herbivorous elementary requirements (Jones and Hanson, 1985; Kreulen, 1985; Nelson Beyer et al., 1994). Deliberate ingestion of soil by human beings is also referred to as geophagia, (Dimond 1999, Dominy et al., 2004, V. M. Ngole et al 2010). According to V. M. Nogle et al (2010), Geophagia as a practice has been reported in several countries across the continents including Africa, Asia and the Americas. The documented importance of soil licks makes their study and proper management, a matter of great interest in strategic conservation planning (E. Molina, 2013). According to Kreulen & Jaeger, (1984), Geophagia, or the deliberate ingestion of soil, has been classified as a form of pica. Geophagia in mammals has been associated with deficiencies of elements such as phosphorus, sodium, magnesium, sulphur, copper, cobalt and manganese (Kreulen, 1985; Johns & Duquette, 1991; Reid, 1992). Geophagia may also be an instinctive behavioral response to gastro-intestinal disturbances (Kreulen, 1985; Johns & Duquette, 1991; Reid, 1992).

Since 1850, geophagia has been at the centre of research and debate amongst scientists who question the usefulness, versus, the harmfulness of the practice of eating earthy substances. Research findings indicated that clays such as bentonite, and aluminum phillosilicate, acts as a digestive aid, whereas, kaolin acts as both a digestive aid and a base for some medicines; and attapulgite as an active ingredient in many anti-diarrheal medicines (J. S. Ogola; 2008).

Salt licks are key places for the ecological dynamics development of wildlife communities around the world and there are locations where animals develop geophaical behaviors (E. Molina 2013). Salt licks are well defined landscape elements that are present in both temperate and tropical ecosystems. In these locations, species with diets based on plant materials particularly birds and mammals, exhibit geophagical behaviors (Powell et al. 2009; Blake et al 2010). The frequent use of these places by wildlife has resulted in many studies. Most of these studies described salt licks properties, patterns of use, and explanations as to why these places are frequently visited (Knight and Mudge. 1967; Weeks. 1978; Tracy and McNautghton. 1995; Brightsmith. 2004; Pravo et al. 2008; Poole et al. 2010; Edwards et al. 2012; Panichev et al. 2012; Abbo et al. 2012). Most of the previous studies in this field gave a lot of interest to the chemical composition of the licked soils. Analyses are conducted, mainly, determine chemical or physicochemical properties. Pure or separate physical characteristics studies of lick soils are rare.

In this study some physical properties determination was performed for forty soil lick samples to identify the main parameters that distinguish licked soils from the surrounding non- licked soils in the same environment or ecosystem. The physical properties of soils ingested by wild animals may give more clear answers to why animals ingest earth or geophagic soil.

The measured parameters include pH values, electrical conductivity, total soluble materials (Solubility), and sample colour. pH values, may, determine the effect of the ingested soil in animal nutrition or the gastrointestinal function (Knezevich 1998; Vermeer and Ferrell 1985). One hypothesis of soil ingestion is neutralization of acidic Materials in gastric system

(Oates. 1978; Mahaney et al. 1999). Another hypothesis suggests enhancement of food digestion (Best and Gionfriddo, 1991). In these two cases the soil pH may play a significant role. On the other hand solubility of soil samples may give an indication to the amount of the total water exchangeable ions. High solubility may support the idea propose attraction of animals is to supplement some minerals deficiency in their diet e.g. Na, K, Mg, Fe (Jones and Hanson, 1985; Best and Gionfriddo, 1991; Powell et al, 2009) because soil solubility can easily release essential ions, making them readily available for absorption through gastrointestinal tract. Water insoluble materials from clay soils may bind, some, toxic or undesired components in animal feed (Oates. 1978; Gilardi et al.1999). Electrical conductivity of soil- water suspension may be a measure of how many free ions are available in the stomach for the mineral supplementation. Soil color is another parameter that gives easy indication of the expected geochemical composition of certain soil lick sites e.g. certain color may indicate the presence of iron compounds, and other may indicate e.g. the presence of calcium or magnesium compounds. White clay is composed largely of kaolin; while yellowish and reddish clays contain iron, which could be a source of iron supplement (Abrahams, P.W, 1997; Yount, K., 2005).

In study performed by Olowoyo et al, (2013) in soil licks, The results showed that, the bioavailability of elements from geophagic soils depends largely on factors such as the soil pH, the pH of the stomach, the forms or chemical nature of the elements and the body weight of individuals consuming the geophagic samples (Kutalek, R., et al, 2010). Salt licks can be natural or artificial. Some people used artificial salt licks to attract wildlife such as deer and moose along with smaller creatures like squirrels. A wide variety of reasons have been proposed for why animals eat soil. The three most widely accepted theories are Grit for grinding food; mineral supplementation; or Adsorption of dietary toxins (Best & Gionfriddo 1991).

1.1 The Study area

This study was conducted within Alkuma locality (longitudes 26.0'0-29.0'0 and latitude 13.30'0- 14.30'0). Geologically Meidob volcanic mountains are important feature in northern Darfur. The volcanic field extends 100 km E–W and 50 km N–S. The Meidob volcanic field (MVF) forms part of the Darfur Volcanic Province and developed from 7 Ma to 5 ka as indicated by K/Ar, thermo-luminescence and ^{14}C ages. It is situated in an uplifted high of the Pan-African basement, which consists of greenstones, high-grade gneisses and granites, and covered by Cretaceous sandstone (Franz. G et al, 1997). The study area is directly south of meidob mountains series. The area extends from El-fasher in the west and Um-higailieg at the east. The samples were collected from different Geophagic sites, in three sub-areas within El-kuma locality with approximate distances from twenty to fifty Km from each other. These are Um-dodaly sites (A), Hagar sari sites (B), El-kuma sites (C), a fourth class of samples (D) was a control group collected from non-geophagic soil around the sites where licking practice was seemed to be most active.

2. MATERIALS AND METHODS

pH value of a well stirred soil in water mixture (1:2) was measured for each sample, using pH-meter- 3510-JENWAY. Conductivity meter (43200-JENWAY) was used for the determination of the electrical conductivity (EC) for each soil sample in a suspension form. For solubility determination, 20grams of each soil sample were dissolved in 100ml distilled water. The mixture was well stirred for 30 minutes using a magnetic stirrer and left overnight to settle. The clear aliquot was then filtered by decantation. The filtrate was evaporated to dryness. The solid residue weight was determined by weight difference. The soluble solid content for each sample was then calculated as percentage. Colours were determined using Munsell soil color chart for both dry and wet samples.

3. RESULTS AND DISCUSSION

Figure 3.1 shows that pH values. The pH values obtained for group A range from (6.33 - 8.2) with a mean value of (6.996). Group (B) samples showed pH values ranging from (5.95 - 9.15) with a mean value as (6.988). Some samples in this group (B) showed clear alkaline values (8.32, 8.68, 8.71, and 9.15); whereas some samples are slightly acidic (6.55, 6.18, 6.86, 6.69, and 5.95). Group (B) pH results may support the hypothesis of stomach fluids neutralization (anti acidic properties). The results of the studied samples in the four sections showed considerable variations in pH values. Group (C) have the lowest pH values ranging from (5.15- 7.567) with a mean (6.399).

All reference samples of section **D**, had almost neutral to slightly basic pH values (6.98- 7.51) with a mean of (7.4125). The pH of the Geophagic soil may affect its taste. Acidic soils are reported to have a sour taste (Abrahams and Parsons, 1997). The pH results obtained here are almost in the same range obtained by Hisashi Matsubayashi et al, (2006) and Olga Lucia Montenegroa, (2004). Alkalinity of lick soils may enhance the hypothesis of anti acid effect. According to Paula A. Pebworth et al, (2012), the highest rates of soil consumption occurred, when, soil was white, and therefore iron concentrations were low, indicating iron deficiency.

Figure 3.2 shows Electrical conductivity (EC) value for each group. The analyzed samples showed different electrical conductivity results. Group (C) shows the highest EC value and group (A) shows lowest values. Reference samples (D) showed the lowest results (The low salt content). Electrical conductivity values reported here are higher than that reported by V.M. Ngole et al. (2010). High electrical conductivity indicates a high amount of dissolved salts.

Figure 3.3 shows total soluble solid results. Total soluble solids results were different from section to the other. The results were in the order (C> B> A> D) with mean value of 4.794%, 1.743%, 3.33%, and 1.43% respectively. Reference samples show the lower total soluble solid contents, this may be enhanced by the low EC values for the soil water suspension of the control samples as a non-licked soils. The lower solubility for the control samples may suggests different chemical composition between the licked and non-licked soils.

Table 3.1 shows the Munsell soil color chart results, samples of group (A) showed reddish to Brownish color in the wet and dry form, samples No. (8 and 9) had a yellowish to brown in dry and wet form. Those of class (B) samples showed red to brownish but sample 13 had a pink color in the dry form. Most of class (C) Samples was Brownish in both wet and dry case, except sample (17) which showed yellowish red color. Most of the studied geophagic soils in this study had a hue of 2.5YR to 10YR. studies of Esraa. Omer et al (2016; 2014), had reported a high percentage of iron in some geophagic soils of the Sudan, that agree with V.N Ngole et al. (2010), which, reported clay soil color ranging from grey to red, that, may be corresponding to the color of hematite (Fe_2O_3) and goethite $FeO(OH)$, which, may support the hypothesis of using soil licks by animals for mineral supplementation. The synthetic salt-lick sample showed high solubility (96.722%), high Electrical conductivity value (78.40 ms/cm) and slightly alkaline value (7.21), that suggests the synthetic salts used for nutritional supplementations.

Table 3.1: Color of soils (wet and dry)

Samples sites	Sample No.	Dry samples		Wet samples	
		Hue value and chroma	Color of samples based on Munsell soil color charts	Hue value and chroma	Color of samples based on Munsell soil color charts
A	1	2.5YR 5/6	Red	2.5 YR 4/6	Red
	2	2.5YR 6/6	Light red	2.5 YR4/8	Red
	3	7.5YR 6/6	Reddish yellow	7.5 YR 5/6	Strong brown
	4	2.5YR 5/6	Red	2.5 YR 4/6	Red
	5	7.5YR 6/4	Light brown	7.5 YR 4/6	Strong brown
	6	2.5YR 5/6	Red	2.5 YR 4/6	Red
	7	7.5YR 5/6	Strong brown	2.5 YR 4/6	Strong brown
	8	10 YR 5/4	Yellowish brown	10YR 3/6	Dark yellowish brown
	9	10 YR 5/4	Yellowish brown	10 YR 3/6	Dark yellowish brown
B	10	5 YR 5/8	Yellowish red	5 YR 4/4	Reddish brown
	11	5YR 5/6	Yellowish red	5 YR 4/4	Reddish brown
	12	2.5YR 3/6	Dark red	2.5 YR 3/4	Dark reddish brown
	13	5YR 8/3	Pink	5 YR 6/4	Light reddish brown
	14	7.5YR 6/4	Light brown	7.5 YR 4/6	Strong brown
	15	7.5 YR 5/6	Strong brown	7.5 YR 3/4	Dark brown
C	16	2.5YR 4/4	Reddish brown	2.5 YR 4/6	Red brown
	17	5 YR 5/6	Yellowish red	5 YR 4/6	Yellowish red
	20	2.5 YR 4/4	Reddish brown	2.5 YR 4/6	Red brown

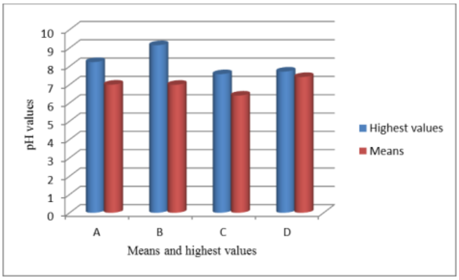

Figure (3.1): The highest and mean pH values in each group of samples

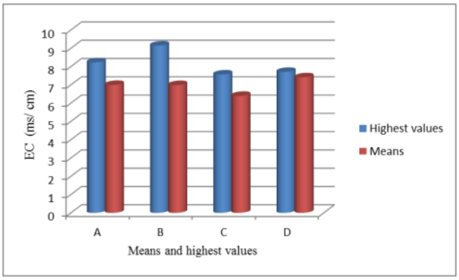

Figure (3.2): The highest and mean EC values in each group of samples

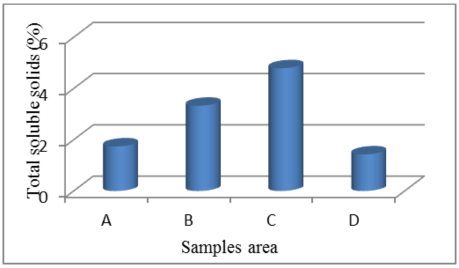

Figure (3.3): Total soluble solids percentage (means)

4. CONCLUSION

The obtained results may strongly agree with the suggestions that consider soil ingestion by animals as a desire to neutralize or reduce gastrointestinal acidity or to supplement some minerals deficiency in animals' diet. The low percentage of the soluble matter in control samples connected by the lower electrical conductivity values may be taken as a clear difference in physical properties between the licked and the non-licked soil samples. This may also indicate the presence of actual differences in chemical composition and soil texture in the two cases.

Many of the previous studies in this field considered sodium as a primary attractant for animals to visit geophagic sites frequently. Compounds dominated by sodium minerals are generally of high solubility in water. Sodium dominated minerals are rarely expected to be strongly coloured.

Colour measurements of the studied samples showed considerable presence of red, brown, dark reddish and yellowish chroma. These findings may strengthen the probability, that, expect wild animals ingestion of geophagic soils to be a seeking for iron, since iron minerals are normally coloured and less soluble especially when they are in the form of oxides.

Further research may need to be carried in the study area, and additional physical properties such as cation changing capacity, water retention capacity and soil texture may also need to be measured for more physical characterization.

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