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# Assessment of Physico-chemical Parameters of Soils in Fallowing Farmlands on the Abundance of Human Infecting Geohelminths in Mgbuitanwo Emohua, Rivers State, Nigeria

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Authors OO and GDBAW designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors IH and OO managed the analyses and literature searches. All authors read and approved the final manuscript.*

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## ABSTRACT

This study was conducted to determine the effects of soil physico-chemical parameters on the abundance of human infecting geohelminths in soils of environments used for open defaecation in Mgbuitanwo Emohua, Rivers State, Nigeria. A total of 240 soil samples were collected randomly from soils found in fallowing Farmlands used for open defaecation in Mgbuitanwo Community in Emohua local Government Area of Rivers State, between the months of January-June 2013 and 2014 respectively. The samples were analysed for temperature, pH, and organic content and Centrifugal flotation method was used to examine the samples for geohelminths. Evaluation after two variations gave an average of 60(50%) of the soil samples as positive for geohelminths as follows; 5 (4.2%), 40(33.3%) and 15(12.5%) for clayey, loamy and sandy soils respectively, with a soil temperature mean of 26.8± 1°C, pH 5.9 ± .5 and soil organic matter 12.4 ± 1%. The effects of

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these parameters on the geohelminths was statistically significant (*P*<.05). Eggs and larvae of human infecting geohelminths were recovered Eighty-eight times; *Ascaris* spp. 31(35.2%), *Trichuris* spp. 23 (26.1%), *Ancylostoma duodenale* 18 (20.5%), *Strongyloides* spp. 4 (4.5%), *Enterobius* spp. 8(9.1%), *Trichostrongylus* spp. 2(2.3%) and *Schistosoma mansoni* 2(2.3%). The high presence of human infecting geohelminths in soils of the study area portends a public health danger. Therefore, combination of sanitation and community health education is a necessary and effective control measure against geohelminths.

*Keywords: Physico-chemical parameters; soils; geohelminths; Mgbuitanwo; Nigeria.*

## 1. INTRODUCTION

The burden of intestinal helminthiasis remains a public health problem worldwide with *Ascaris lumbricoides, Trichuris trichiura*, hookworm and *Strongyloides stercoralis* being the commonest well known [1,2]. Geohelminths premature stages (eggs) require a period of development in the soil before they become infective [3]. Infections by Geohelminths are the second leading cause of mortality in children less than 6years of age after malaria [4,5]. About 1.45 billion people in the worldwide were infected with Soil-Transmitted Helminthes (STHs) and 5.19 million showed associated morbidity [6]. Out of 1.45 billion infections due to Soil Transmitted Helminths, 438.9 million were infected with hookworms (*Ancylostoma duodenale* and *Necator americanus*), 819 million with *Ascaris lumbricoides* and 464.6 million with *Trichuris trichiura* and 4.5 billion people at risk of infection with one of the three common soil-transmitted helminths above [7-9].

Geohelminths infections are most prevalent in tropical and sub-tropical regions of the developing world, where adequate water and sanitation are lacking [10]. In developing countries where the economy is poor, infections by geohelminths is enhanced by faecal pollution [11], contact with animals [12], poor hygienic practices [13] and improper disposal of human and animal waste [14].

Olaniyi et al. [15] reported that soil transmitted helminths of *Ascaris lumbricoides*, *Trichuris trichiura*, and the hookworm species are common infections in Nigeria, noting that the prevalence of these parasites especially *Ascaris* has not changed in the past 50 years and poly-parasitism with these nematodes is also a common occurrence. Eze et al. [16], reported a 70% prevalence of various intestinal helminths in Khana Local Government Area, Rivers State. These studies only looked at the prevalence of geohelminths in humans without considering factors that make them thrive in the environment thereby ensuring continuous spread among humans who are in constant contact with the environment especially the soil.

The unique process involved in geohelminths transmission, such as free-living stages and survival depend on the prevailing conditions, therefore, free-living infective stages present in the environment develop and die at temperature – dependent rates [17]. Hence the study to determine the effects of soil physico-chemical parameters on the abundance of human infecting geohelminths.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

The study was conducted in Mgbuitanwo, a town in Emohua Local Government Area of Rivers State Nigeria. It is located at 6°53′07″ North 6°52′94″ East of the Greenwich. The area lies within the tropical rain forest vegetation zone and inhabitants are mostly traders and farmers. Mgbuitanwo, Emohua features a tropical monsoon climate with lengthy and heavy rainy seasons and very short dry seasons with an average temperature range of 26°C. Samples were collected monthly from two fallowing farmlands between the months of January- June 2013 and 2014, respectively. The farmlands were about 100 to 200 meters away from residential areas and were selected based on their being used by majority of the inhabitants as toilets. The sites have many shrubs, grasses and few economic trees.

### 2.2 Ethical Clearance for the Study

Permission to conduct the study was got from the community heads. During routine visits to the community heads, the relevance of the study which was to determine the effects of soil physico-chemical parameters on the prevalence and possible transmission of human infecting geohelminths in soils of environments used for open defaecation was explained. The community heads further assembled their subjects and explained same to them.

## 2.3 Collection of Soil Samples

Sample collections were done in the morning from between 6 am – 12 noon when the larvae and eggs of geohelminths are still active. A quadrat was thrown randomly at the defaecation sites and a sterile soil auger was used to collect 15 cm top soil from each quadrat point. The soil samples collected were kept in sterile black polythene bags and taken to the Animal and Environmental Biology Laboratory University of Port Harcourt, Nigeria which is about 5 kilometers away from the sites for analyses.

## 2.4 Examination of Soil Samples

### 2.4.1 Temperature

The temperature of the soils was tested with thermometer during sample collection using ClimeMET CM3011 Soil Thermometer, Using a screwdriver, a pilot hole of about 5-6 inches deep was made, the thermometer was gently inserted into the hole below the soil surface and after two minutes, the thermometer was brought out and reading was recorded [17,18].

### 2.4.2 Soil texture

The field method of using hand was employed to determine the soil texture according to [19]. This was used in identifying soil textures quickly. The procedure involves determining the sand content by rubbing a small amount of soil in the palm of hand; to determine if the sand content is less than 50%, water was added to create a soil that is wet enough to roll. The soil was squeezed and rolled between the thumb and forefinger to make the longest possible ribbon. A loam soil formed only a short ribbon. Clay soils formed a much longer ribbon.

### 2.4.3 Soil pH

The reference electrode of a pocket size pH meter was inserted into the top 1cm of the moist soil surface. The knob of the pH meter was switched on for about 30 seconds and the value of pH meter recorded. Later, the reference electrode was rinsed with distilled water that was taken to the site from the laboratory between each soil sample reading. After the reading, the knob of the pH meter was be switched off [17].

### 2.4.4 Determination of organic matter in the soil

The organic matter (carbon) was determined by ashing a 5 gram scoop of the soil sample at 360°C for 2hours in a muffle furnace. The loss by weight of the sample during this ignition was calculated as the organic matter. Results were reported as percentage (%) organic matter by weight in the soil [20].

## 2.5 Examination of Soil Samples for Eggs and Larvae of Geohelminths

### 2.5.1 Centrifugal flotation method

The samples were labelled and taken to the Parasitology laboratory where they were left to dry at ambient room temperature. After drying, the soil was sieved using a fine sieve (pore diameter 250 μm) in order to remove larger particles but allow small size particles including sticky helminthes eggs to pass. From the sieved portion, 2 g of soil was placed into a 10ml test tube containing 3 ml of 30% sodium hypochloride (NaOCl) solution. The tube was shaken intermittently for 1 hour. Then 5 ml of concentrated saccharine solution (1000 gm of white sugar in 900 ml of distilled water was added and the tubes were shaken thoroughly). The tubes were then centrifuged at 1500rpm for 15 mins. More sugar concentrate was added to the tube to raise the meniscus and float the eggs in order to put cover glasses on the top of the tubes and wet them by the surface of the floating solution after allowing resting for 15min. The cover glasses was carefully removed from the top of the tubes and placed on microscope slides, the slides were examined microscopically at 40x magnification for the presence of helminthes eggs/ova [21]. The eggs and larvae of human geohelminths were identified with reference to Atlas of Parasitology [2].

## 2.6 Data Analysis

Results obtained from the samples were entered into Ms. Excel 2007 and analyzed using standard deviation and one way analysis of variance (ANOVA) statistical tool was used to assess significant differences in prevalence of geohelminths. Descriptive statistics were calculated and presented in form of tables [9,22].

## 3. RESULTS AND DISCUSSION

An average total of 120 soil samples of different textural classes were examined during the study period for physico-chemical parameters and human infecting geohelminths. 60 of the 120 soil samples with 26.8±1°C, 5.9±.5 and 12.4±1% for Temperature, pH and organic matter were positive for human infecting geohelminths as follows; 5 (4.2%), 40, (33.3%) and 15 (12.5%) for clay, loamy and sandy soils respectively. Twelve (60%) of the 20 soil samples with 25.6±1°C, 5.8±.5 and 14.3±1% for Temperature, pH and organic matter were positive for human infecting geohelminths in the month of January as follows; 1 (5%), 8, (40%) and 3 (15%) for clay, loamy and sandy soils respectively. Nine (45%) of the 20 soil samples with 26.8±1°C, 5.1±1 and 13.8±1% for Temperature, pH and organic matter were positive for human infecting geohelminths in the month of February as follows; 1 (5%), 6(30%) and 2 (10%) for clay, loamy and sandy soils respectively. Eleven (55%) of the 20 soil samples with 27.3±.5°C, 5.9±1 and 11.8±1% for Temperature, pH and organic matter were positive for human infecting geohelminths in the month of March as follows; 1 (5%), 8(40%) and 2 (10%) for clay, loamy and sandy soils respectively. Seven (35%) of the 20 soil samples with 26.8±1°C, 6.8±.4 and 12.3±1% for Temperature, pH and organic matter were positive for human infecting geohelminths in the month of April as follows; 1 (5%) and 6(30%) and 2 (10%) for clay, loamy soils no geohelminths was recovered from sandy soils. Eleven (55%) of the 20 soil samples with 27.7±1°C, 5.7±1 and 11.6±1% for Temperature, pH and organic matter were positive for human infecting geohelminths in the month of May as follows; 6(30%) and 5 (25%) for loamy and sandy soils no geohelminthes was recovered from clay soils. Ten (50%) of the 20 soil samples with 26.7±.5°C, 6.3±1 and 11.1±1% for Temperature, pH and organic matter were positive for human infecting geohelminths in the month of June as follows; 1 (5%), 6, (30%) and 3 (15%) for clay, loamy and sandy soils respectively (Table 1).

An average total of 120 soil samples made up of clayey, loam and sand collected during the study period in Mgbuitanwo had physico-chemical parameters as follows; 26.3±1°C, 5.9±.2 and 12.2±2% for temperature, pH and %organic matter with a total of 88 human infecting geohelminths recovered from the samples as follows; *Ascaris* spp. 31 (35.2%), *Trichuris* spp.23 (26.1%), *Ancylostoma duodenale* 18 (20.5%), *Strongyloides* spp. 4 (4.5%), *Enterobius* spp. 8 (9.1%), *Trichostrongylus* spp. 2 (2.3%) and *Schistosoma mansoni* 2 (2.3%). Physico-chemical parameters of clayey soils were 25.3°C±1, 6.2±.5, and 9.8±2% for temperature, pH and % organic matter with a total of 5 (5.7%) geohelminths recovered as follows; *Ascaris* spp. 2 (40%), *Trichuris* spp. 2 (40), *Ancylostoma duodenale* 1 (20%). Physico-chemical parameters of loam soils were 26.7±1°C, 5.8±1, and 14.2±2% for temperature, pH and %organic matter with a total geohelminths of 66 (75%) recovered as follows; *Ascaris* spp. 22 (33.3%), *Trichuris* spp. 17 (25.7%), *Ancylostoma duodenale* 12 (18.2%), *Strongyloides* spp. 4 (6.1%), *Enterobius* spp 7 (10.7%), *Trichostrongylus* spp. 2 (3.0%) and *Schistosoma mansoni* 2 (3.0%), while Physico-chemical parameters of sandy soils were 26.9±.1°C, 5.9±.5, and 12.3±1% for temperature, pH and % organic matter with a total of 17 (19.3%) as follows; *Ascaris* spp.7 (41.1%), *Trichuris* spp. 4(23.5%), *Ancylostoma duodenale* 5 (29.4%) and *Enterobius* spp. 1 (5.9) (Table 2).

**Table 1. Soil Physico-chemical parameters as it affect prevalence of geohelminths in the soils of Mgbuitanwo**

| Months | Average no. soil sampled | Soil physico-chemical parameters | | | % No. positive for human geohelminths | | | % Total |
|---|---|---|---|---|---|---|---|---|
| | | Temperature (°C) | pH | (%) organic matter | Clay | Loam | sandy | |
| January | 20 | 25.6±1 | 5.8±.5 | 14.3±1 | 1 (5) | 8 (40) | 3 (15) | 12 (60) |
| February | 20 | 26.8±1 | 5.1±1 | 13.8±1 | 1 (5) | 6 (30) | 2 (10) | 9 (45) |
| March | 20 | 27.3±.5 | 5.9±1 | 11.8±1 | 1 (5) | 8 (40) | 2 (10) | 11 (55) |
| April | 20 | 26.8±1 | 6.8±.4 | 12.3±1 | 1 (5) | 6 (30) | - | 7 (35) |
| May | 20 | 27.7±1 | 5.7±1 | 11.6±1 | - | 6 (30) | 5 (25) | 11 (55) |
| June | 20 | 26.7±.5 | 6.3±1 | 11.1±1 | 1 (5) | 6 (30) | 3 (15) | 10 (50) |
| % Total | 120 | 26.8±1 | 5.9±.5 | 12.4±1 | 5 (4.2) | 40 (33.3) | 15 (12.5) | 60 (50) |

**Table 2. Prevalence of geohelminths as affected by soil Physico-chemical parameters in Mgbuitanwo during the study.**

| Soil types | Soil physico-chemical parameters | | | % No. human geohelminths | | | | | | | %Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature (°C) | pH | (%) organic matter | *Ascaris* spp. | *Trichuris* spp. | *Ancylostoma duodenale* | *Strongyloides* spp. | *Enterobius* spp. | *Trichostrongylus* spp. | *Schistosoma mansoni* | |
| Clay | 25.3±1 | 6.2±.5 | 9.8±1 | 2 (40) | 2 (40) | 1 (20) | 0 | 0 | 0 | 0 | 5 (5.7) |
| Loam | 26.7±1 | 5.8±1 | 14.6±2 | 22 (33.3) | 17 (25.7) | 12 (18.2) | 4 (6.1) | 7 (10.6) | 2 (3) | 2 (3) | 66 (75) |
| Sand | 26.9±1 | 5.9±.3 | 12.3±1 | 7 (41.1) | 4 (23.5) | 5 (29.4) | 0 | 1 (5.9) | 0 | 0 | 17 (19.3) |
| %Total | 26.3 ±1 | 5.9±.2 | 12.2±2 | 31 (35.2) | 23 (26.1) | 18 (20.5) | 4 (4.5) | 8 (9.1) | 2 (2.3) | 2(2.3) | 88 |

Findings from this study indicated a prevalence of (50%) of human infecting geohelminths in the soil samples in the study area with Loamy soil having the highest prevalence of 33.3%. Equally, a temperature of 26.8±1°C, pH of 5.9±.5 and 12.4±1% organic matter was recorded. The prevalence in the samples was statistically significant as ($P$<.05). The temperature, pH and organic matter of the soils in the area were moderate and suitable for development thriving of infective stages of human geohelminthes, These findings agree with [17,23] who agreed that the optimum temperature for the embryonation of soil transmitted helminths eggs ranges from 16 ±1°C and 34 ± 1°C and as the temperature increases within this range, the development of the egg is hastened. The pH of the soil samples ranged between 5.1±1 – 6.8 ±.4 was lower than the pH of stool which is generally 7.0-7.5. These pH ranges fall within the tolerable ranges of geohelminths as studies has it that helminths ova tolerate a large range of pH. However, *Ascaris suum* eggs were said to have an arrested development when placed in an acidic environment. Hookworms, on the other hand, tolerate pH range of 4.6–9.4 and will still be able to hatch and infect [24]. The organic matter content of the soils during the study were between 11.1- 14.3 and should be adequate for the survival of the different geohelminths soil dwelling stages. Loamy soils which recorded 75% of the organisms equally had organic matter content of 14.6% which was the highest in the soil types. More of the geohelminths were recovered in soils with higher organic matte content. [9,25], revealed that there is a rise in the prevalence of geohelminths with the rise in the content of the organic matter [9]. Also noted that an increase in the physico-chemical parameters leads to increase in prevalence geohelminths in the soil types. The months of March and May recorded the highest prevalence of 55% with the least prevalence occurring in the month of April. This could be attributed to more of human waste being deposited in the soils these months since the physico-chemical parameters during the study were almost at the same level. Loamy soils had a very high prevalence of 75% of the organisms while clayey soils had the lowest prevalence of 19.3%, this could be attributed to a higher organic content of Loamy soils. Loamy soils also has the ability to retain, humus, nutrients and moisture while still allowing excess water to drain away thereby giving the geohelminthes access to oxygen for their survival [9,26,27]. *Ascaris* spp. had the highest prevalence value of 35.2%, *Trichuris* spp. 26.1%, *Ancylostom aduodenale* 20.5%, while *Trichostrongylus* spp. and *Schistosomam ansoni* had least prevalence of 2 (2.3%). High prevalence of *Ascaris lumbricoides* in this study is in line with findings of other studies in Rivers, Anambra and Delta states, southern Nigeria [4,9,24]. *Ascaris lumbricoides* can withstand harsh environmental conditions and can remain in the environment for longer period. The second most prevalent STH from this study was *Trichuris* spp. with prevalence value of 26.1%, *Ancylostoma duodenale* was the third most common parasite identified in this study, with prevalence value of 20.5%, this result is low compared with the values from other studies in various parts of Nigeria. Ngele, in Ubeyi Ebonyi state [28] recorded 58.3% and [29] in Mbaukwu Anambra state recorded 31.1%. The larva of hookworms are capable of vertical migration up and down in contaminated soil, depending on soil moisture and temperature and they remain in the soil until they come in contact with suitable host [17]. *Trichostrongylus* spp. and *Schistosoma* had the least prevalence with 2.3%. This is the first time a *Schistosoma* spp. is recorded in any study in the area as there has not been any record of *Schistosoma* spp. in the area.

## 4. CONCLUSION

The physico-chemical parameters of the soil samples had some effects on the abundance of human infecting geohelminths. Increase in the organic content of the soils especially loamy soils led to an increase in the prevalence of human infecting geohelminths in the study area. The ova and larvae of the geohelminths were found in soils with pH less than 7.0 which means possible transmission could occur, and portends a public health danger in the study area. Therefore, combination of sanitation by discouraging direct defaecation into soils and community health education are necessary and effective control measure against these geohelminths.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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