

Original Research Article

Physico-chemical Parameters of Fallowing Farmland Soils as it Affects Geohelminthes in Isiodu, Emohua Local Government Area, Rivers State, Nigeria.

ABSTRACT

Background: This study was conducted to evaluate the physico-chemical parameters of soils in environments used for open defaecation as it affects the prevalence of geohelminthes in Isiodu Emohua, Rivers State, South South, Nigeria.

Methods: A total of 240 soil samples were collected randomly from soils found in fallowing Farmlands used for open defaecation in Isiodu Community in Emohua local Government Area, 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 geohelminthes.

Results: Evaluation after two variations gave an average of 74 (61.6%) of the soil samples as positive for geohelminthes as follows; 22 (18.3%), 46(38.3%) and 6 (5%) for sandy, loamy and clayey soils respectively, with a soil temperature mean of $27.3 \pm 1^\circ\text{C}$, pH $6.1 \pm .2$ and soil organic matter $12.9 \pm 3\%$. This was statistically significant ($P=.05$). Geohelminthes recovered from the samples were one hundred times; sandy: 38 (38%), Loamy: 54 (54%) and Clayey: 8 (8%). *Ascaris* spp 30 (30%), *Trichuris* spp. 16 (16%), *Ancylostoma duodenale* 11 (11%), *Strongyloidies* spp. 5 (5%), *Entrobis* spp. 2 (2%), *Trichostrongylus* spp. 2 (2%), *Meloidogyne* spp. 21 (21%), *Buracephalus* spp. 1(1%), *Bayliascaris* spp. 3 (3%), and *Toxocara* spp. 9 (9%).

Conclusion: Soil samples with higher physico-chemical parameters especially temperature and organic matter recorded high prevalence of the major human and plant geohelminthes in the area. Therefore direct dumping of human and other household waste to the soils at undesignated places should be discouraged.

Keywords: Isiodu; environments; geohelminthes; soils.

1. INTRODUCTION

Geohelminthes (soil-transmitted helminthes) are a group of nematode parasites with an essential phase of their asexual lifecycle in the soil. The infections are most prevalent in tropical and sub-tropical regions of the developing world, where adequate water and sanitation are lacking [1]. A report in March 2016 by World Health Organisation indicated that more than 1.5 billion people, or 24% of the world's population, are infected with soil-transmitted helminthes infections. Infections are widely distributed in tropical and subtropical areas, with the greatest numbers occurring in sub-Saharan Africa, the Americas, China and East Asia. The geohelminthes together present an enormous infection burden on humanity. Helminthiasis in humans are mostly caused by; *Ascaris lumbricoides* (the large roundworm), *Trichuris trichiura* (whipworm), and the blood-feeding hookworms (*Ancylostoma duodenale* and *Necator americanus*). Helminthes infections caused by soil-transmitted helminths (STHs) are among the most prevalent infections of humans who live in the developing world. The morbidity caused by STHs is most commonly associated with infections of heavy intensity. Approximately 300 million people with heavy helminthes infections suffer from severe morbidity that results in more than 150,000 deaths annually [2; 3]. In addition to their health effects, infections by helminthes also impair physical and mental growth in childhood, thwart educational

Comment [u1]: This manuscript is rather old, why are you trying to get it publish now. The work was done 5 to 6 years ago.

Comment [h2]: I understand, it was as a result of lack of funds for publication, besides some parts of this work has been published in two other journals. This is the third one.

Comment [u3]: You collected 240 soil samples and 74 were positive, then the percentage of positivity wouldn't be 61.6%.

Comment [h4]: 240 samples were collected during the study, but the results presented are averages of 2013 and 2014. 240 divided by 2 is 120, $74 \div 120 \times 100$ is 61.6%

Comment [u5]: report

Comment [h6]: ok thanks

Comment [u7]: Please check the grammar.

Comment [h8]: Sentence is rephrased.

49 advancement, and hinder economic development. Infection thrive in communities in need of better housing,
50 clean water, appropriate sanitation, better access to health care, education and decreased personal
51 earnings [4]. This is typical of most rural communities and urban slums in Nigeria, where most of the
52 inhabitants defecate in bushes and farmlands due to lack of or poor toilet facilities. Consequently during
53 rainfall, their feces are washed into streams and rivers which are used as source of water for household
54 and recreational activities [4; 5].

55 Losses incurred by farmers as a result of infections by these helminthes annually runs into billions of
56 dollars [6]. However, many farmers, particularly in developing nations, are not aware of the existence of
57 these nematodes, due to their usual small nature and most times losses from their nonspecific effects are
58 misunderstood to be from other pathogenic organisms or certain environmental factors [6; 7]. The infection
59 is promoted by poor hygienic habits such as indiscriminate disposal of human and animal faeces especially
60 in most parts of Nigeria, where large amount of human and animal waste is discharged into the soil daily
61 leading to the seeding of the soil with pathogenic organisms including geohelminthes eggs and larvae [7;
62 8]. The processes involved in geohelminths transmission are unique, as development and survival of eggs
63 and larval stages depend on the prevailing conditions such as soil moisture, temperature and relative
64 atmospheric humidity [9]. This study was conducted to evaluate the effects of physico-chemical parameters
65 of soils in fallowing farmlands used for open defecation as it affects geohelminthes.

Comment [u9]: Adult *Ascaris lumbricoides* can be seen with naked eyes, not all of them are small in nature.

Comment [h10]: *Ascaris lumbricoides* is not a plant geohelminth. Please go through the sentence again.

Comment [u11]: Reframe the sentence

Comment [h12]: Sentence has been reframed

Comment [u13]: You can state the aim in a better way.

67 2. MATERIALS AND METHODS

69 2.1 Study Area

70 The study was conducted in Isiodu, a town in Emohua Local Government Area of Rivers State Nigeria. It is
71 located at 6°51'72" North 4°53'77" East of the Greenwich. The area lies within the tropical rain forest
72 vegetation zone and inhabitants are mostly traders and farmers. Isiodu, Emohua features a tropical
73 monsoon climate with lengthy and heavy rainy seasons and very short dry seasons with an average
74 temperature range of 26°C. Samples were collected monthly from two fallowing farmlands used for open
75 defaecation between the months of January- June 2013 and 2014 respectively.

Comment [u14]: Any Reference to back he mentioned temperature?

Comment [u15]: What inform the choice of these months. Do you mean January- June 2013 and in the second year January-June 2014

Comment [h16]: It was how we structured the research

77 2.2 Ethical clearance for the study

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

84 2.3 Collection of Soil Samples

85 Sample collections were done in the morning from between 6 am – 12 noon when the larvae of
86 geohelminths are still active. A quadrat was thrown randomly at the defaecation sites and a sterile soil
87 auger was used to collect 100 g of 15 cm top soil from each quadrat point. The soil samples collected were
88 kept in sterile black polythene bags and taken to the Animal and Environmental Biology Laboratory University of Port Harcourt,
89 Nigeria which is about 5 kilometers away from the sites for analyses.

Comment [u17]: How do you know that geohelminths larvae are active in the morning? It is wrong to say eggs are active

Comment [h18]: Ok.

Comment [u19]: Reframe

Comment [u20]: How do you sterilize polythene bags?

Comment [h21]: Bags that has not been used at all from the factory are presumed to be sterile

91
92 **2.4 Examination of soil Samples**
93 **2.4.1 Temperature:**
94 The temperature of the soils was tested with thermometer during sample collection using ClimeMET
95 CM3011 Soil Thermometer, using a screwdriver, a pilot hole of about 5-6 inches deep was made, the
96 thermometer was gently inserted into the hole below the soil surface and after two minutes, the
97 thermometer was brought out and
98 reading was recorded [9, 10].

Comment [u22]: using

Comment [h23]: ok

99 **2.4.2 Soil texture**
100 The field method of using hand was employed to determine the soil texture according to [11, 12]. This was
101 used in identifying soil textures quickly. The procedure involves determining the sand content by rubbing a
102 small amount of soil in the palm of hand; to determine if the sand content is less than 50%, water was
103 added to create a soil that is wet enough to roll. The soil was squeezed and rolled between the thumb and
104 forefinger to make the longest possible ribbon. A loam soil formed only a short ribbon. Clay soils formed a
105 much longer ribbon [11].

Comment [u24]: Can you reference this procedure?

Comment [h25]: done

106 **2.4.3 Soil pH**
107 The reference electrode of a pocket size pH meter was inserted into the top 1cm of the moist soil surface.
108 The knob of the pH meter was switched on for about 30 seconds and the value of pH meter recorded.
109 Later, the reference electrode was rinsed with distilled water that was taken to the site from the laboratory
110 between each soil sample reading. After the reading, the knob of the pH meter was be switched off [9; 10].

111 **2.4.4 Determination of organic matter in the soil**
112 The organic matter (carbon) was determined by ashing a 5 gram scoop of the soil sample at 360°C for
113 2hours in a muffle furnace. The loss by weight of the sample during this ignition was calculated as the
114 organic matter. Results were reported as percentage (%) organic matter by weight in the soil [13].

116 **2.5 Examination of soil samples for eggs and larvae of geohelminthes**

117 **2.5.1 Centrifugal flotation method**

118 The samples were labelled and taken to the Parasitology laboratory where they were left to dry at ambient
119 room temperature. After drying, the soil was sieved using a fine sieve (pore diameter 250 µm) in order to
120 remove larger particles but allow small size particles including sticky helminthes eggs to pass. From the
121 sieved portion, 2 g of soil was placed into a 10 mL test tube containing 3ml of 30% sodium hypochlorite
122 (NaOCl) solution. The tube was shaken intermittently for 1hour. Then 5ml of concentrated saccharine
123 solution (1000 g of white sugar in 900 mL of distilled water) was added and the tubes were shaken
124 thoroughly. The test tube was put in the centrifuge (model HW236) and set to centrifuge at 1500 rpm for 15
125 minutes. More sugar concentrate was added to the tube to raise the meniscus and float the eggs in order to
126 put cover glasses on the top of the tubes and wet them by the surface of the floating solution. After allowing
127 it to rest for 15 minutes, the cover glass was carefully removed from the top of the tubes and placed on
128 microscope slides, the slide was examined microscopically at 40x magnification for the presence of
129 helminthes eggs/ova [7]. The eggs and larvae of human helminthes were identified with reference to Atlas
130 of Parasitology [14]. Plant nematodes were identified using atlas on identification of plant parasitic
131 nematodes [15].

Comment [u26]: 250 µm

Comment [h27]: corrected

Comment [u28]: 2 g

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Comment [u30]: How can tubes contain 900 mL of distilled water?

Comment [h31]: The error has been corrected in the sentence

132 **2.6 Data analysis**

134 Results obtained from the samples were entered into Ms. Excel 2007 and analyzed using standard
135 deviation and one way analysis of variance (ANOVA) statistical tool was used to assess significant
136 differences in prevalence of geohelminthes. Descriptive statistics were calculated and presented in form of
137 tables [9; 16].

138 2. RESULTS

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141 An average total of 120 soil samples of different textural classes were examined during the study period
142 from the two sites for physico-chemical parameters and geohelminthes. Seventy-four (61.6%) of the soil
143 samples with 27.3±1, 6.1±2 and 12.9±3 for Temperature, pH and organic matter, were positive for
144 geohelminthes as follows; 22 (18.3%), 46 (38.3) and 6 (5%) for sandy, loamy and clayey soils respectively.
145 Sixteen (80%) of the soil samples with 26.6±1, 6.3±1 and 15.3±2 for Temperature, pH and organic matter
146 were positive for geohelminthes in the month of January as follows; 5 (25%), 10, (50%) and 1 (5%) for
147 Sandy, loamy and clayey soils respectively. Twelve (60%) of the soil samples with 28.3±1, 6.3±1 and
148 12.6±1 for Temperature, pH and organic matter were positive for geohelminthes in the month of February
149 as follows; 4 (20%), and 8(40%) for sandy and loamy soils. No geohelminthes was recovered from clayey
150 soils. Thirteen (65%) of the soil samples with 27.3±1, 6.2±1 and 16.5±2 for Temperature, pH and organic
151 matter were positive for geohelminthes in the month of March as follows; 3 (15%), 9(45%) and 1 (5%) for
152 sandy, loamy and clayey soils respectively. Twelve (60%) of the soil samples with 27.1±1, 5.9±5 and
153 12.1±1 for Temperature, pH and organic matter were positive for geohelminthes in the month of April as
154 follows; 4 (20%), 7(35%) and 1 (5%) for sandy, loamy and clayey respectively. Nine (45%) of the soil
155 samples with 27.6±1, 5.9±2 and 10±1 for Temperature, pH and organic matter were positive for
156 geohelminthes in the month of May as follows; 3 (15%), 5 (25%) and 1 (5) for sandy, loamy and clayey
157 soils respectively. Twelve (60%) of the soil samples with 27.3±1, 6.1±1 and 11±1 for Temperature, pH and
158 organic matter were positive for geohelminthes in the month of June as follows; 3 (15%), 7 (35%) and 2
159 (10%) for clay, loamy and sandy soils respectively See Table 1.

160
161 An average total of 120 soil samples made up of sandy, loamy and clayey collected during the study period
162 from the two sites had physico-chemical parameters as follows; 27.4±4.0°C, 6.0±2 and 12.8±2 for
163 temperature, pH and %organic matter with a total of 100 geohelminthes recovered from the samples as
164 follows; *Ascaris* spp. 30 (30%), *Trichiuris* spp. 16 (16%), *Ancylostoma duodenale* 11 (11%), *Strongyloides*
165 *spp.* 5 (5%), *Enterobius* spp. 2 (2%), *Trichostrongylus* spp. 2 (2%) *Meloidogyne* spp. 21 (21%),
166 *Buracephalus* spp. 1(1%), *Bayliascaris* spp. 3 (3%), and *Toxocara* spp. 9 (9%). Physico-chemical
167 parameters of sandy soils were 27.8⁰C±1, 6.0±1, and 12.6±2% for temperature, pH and %organic matter
168 with a total of 38 (38%) geohelminthes recovered as follows; *Ascaris* spp. 9 (23.7%), *Trichiuris* spp. 9
169 (23.7%), *Ancylostoma duodenale* 4 (10.5%), *Strongyloides* spp. 2 (5.3%), *Meloidogyne* spp. 8 (21%),
170 *Buracephalus* spp. 1(2.6%), and *Toxocara* spp. 5 (13.2%). Physico-chemical parameters of loam soils were
171 28±1⁰C, 6.3±4, and 15±1% for temperature, pH and %organic matter with a total of 54 (54%)
172 geohelminthes recovered as follows; *Ascaris lumbricoides* 18 (33.3%), *Trichiuris* spp. 5 (9.3%),
173 *Ancylostoma duodenale* 7 (13%), *Strongyloides* spp. 3 (5.5%), *Enterobius* spp 2 (3.7%), *Trichostrongylus*
174 spp. 4 (3.7%), *Meloidogyne* spp. 11 (20.3%), *Bayliascaris* spp. 3 (5.6%), and *Toxocara* spp. 3(5.6%), while
175 Physico-chemical parameters of clayey soils were 27±.1⁰C, 5.6±.1, and 11.4±2% for temperature, pH and

Comment [u32]: You started with 240 samples, why 120 in Results

Comment [h33]: The results are averages of what was recorded between 2013 and 2014.

Comment [u34]: Did you find eggs/ova of *Ascaris lumbricoides* in soil?

Comment [h35]: yes

Comment [u36]: How do you differentiate larva of Hookworm from that of *Strongyloides*?

Comment [h37]: Eggs of *Strongyloides* were not found in the samples

176 %organic matter with a total of 8 (8%) as follows; *Ascaris lumbricoides* 3 (37.5%), *Trichiuris* spp. 2
177 (25%), *Meloidogyne* spp. 2 (25%), and *Toxocara* spp. 1 (12.5%) See table 2.

178 An average total of 60 soil samples made up of clayey, loam and sand collected during the study period in
179 site 1 had physico-chemical properties as follows; $27\pm 2^{\circ}\text{C}$, 6.2 ± 1 and $12.8\pm 2\%$ for temperature, pH and
180 %organic matter with total of 47 geohelminthes recovered as follows; *Ascaris* spp. 15 (31.9%), *Trichuris*
181 spp. 7 (14.9%), *Ancylostoma duodenale* 4 (8.5%), *Strongyloides* spp. 3 (6.4%), *Enterobius* spp. 2 (4.3%),
182 *Trichostrongylus* spp. 2 (4.3%), *Meloidogyne* spp 8 (17%) and *Toxocara* spp. 6 (12.8%). Physico-chemical
183 parameters of clayey soils were $26.8\pm 4^{\circ}\text{C}$, 6.1 ± 1 , and $11.5\pm 2\%$ for temperature, pH and %organic matter
184 with 4 (8.5%) geohelminthes recovered as follows; *Ascaris lumbricoides* 1 (25%), *Trichuris* spp. 1 (25%),
185 *Meloidogyne* spp. 1 (25%) and *Toxocara* spp. 1(25%). Physico-chemical parameters of loam soils were
186 $26.9\pm 1^{\circ}\text{C}$, 6.3 ± 3 , and $15\pm 3\%$ for temperature, pH and %organic matter with 20 (42%) of the
187 geohelminthes recovered as follows; *Ascaris* spp. 7 (35%), *Trichuris* spp. 2 (10%), *Ancylostoma*
188 *duodenale* 1 (5%), *Strongyloides* spp. 2(10%), *Enterobius* spp. 2 (10%), *Meloidogyne* spp. 3(15%) and
189 *Toxocara* spp. 1 (5%).While Physico-chemical parameters of sandy soils were $27.3\pm 1^{\circ}\text{C}$, 6.2 ± 1 , and
190 $12.5\pm 3\%$ for temperature, pH and %organic matter with 23 (48.9%) of the geohelminthes recovered as
191 follows; *Ascaris lumbricoides* 7 (30.4%), *Trichuris* spp. 4 (17.4%), *Ancylostoma duodenale* 3 (13%),
192 *Strongyloides* spp 1 (4.3%), *Meloidogyne* spp. 4 (17.4%), and *Toxocara* spp. 4 (17.4%), See table 3.

193 An average total of 60 soil samples made up of clayey, loam and sand collected during the study period in
194 Site 2 had physico-chemical properties as follows; $27.9\pm 1^{\circ}\text{C}$, 5.7 ± 1 and $12.8\pm 1\%$ for temperature, pH and
195 %organic matter with total of 53 geohelminthes recovered as follows; *Ascaris* spp. 15 (28.3%), *Trichuris*
196 spp. 9 (17%), *Ancylostoma duodenale* 7 (13.2%), *Strongyloides* spp. 2 (3.8%), *Meloidogyne* spp. 13
197 (24.5%), *Bayliascaris* spp 3 (5.7%) and *Toxocara* spp. 3 (5.7%) and *Buracephalus* spp. 1 (1.9%). Physico-
198 chemical parameters of clayey soils were $27\pm 1^{\circ}\text{C}$, 5.1 ± 1 , and $11.3\pm 4\%$ for temperature, pH and %organic
199 matter with 4 (7.5%) of the geohelminthes recovered as follows; *Ascaris lumbricoides* 2 (50%), *Trichuris* spp.
200 1 (25) and *Meloidogyne* spp. 1 (25%). Physico-chemical parameters of loam soils were $28.4\pm 1^{\circ}\text{C}$, 6.2 ± 4 ,
201 and $14.5\pm 2\%$ for temperature, pH and %organic matter with 34 (64.2%) of the geohelminthes recovered as
202 follows; *Ascaris* spp. 11 (32.3%), *Trichuris* spp. 3 (8.8%), *Ancylostoma duodenale* 6 (17.6%),
203 *Strongyloides* spp. 1(2.9%), *Meloidogyne* spp. 8(23.5%), *Bayliascaris* spp. 3 (8.8%) and *Toxocara* spp. 2
204 (5.9%).While Physico-chemical parameters of sandy soils were $28.2\pm 1^{\circ}\text{C}$, 5.7 ± 1 , and $12.6\pm 3\%$ for
205 temperature, pH and %organic matter with 15 (28.3%) of the geohelminthes were recovered as follows;
206 *Ascaris* spp. 2 (13.3%), *Trichuris* spp. 5 (33.3%), *Ancylostoma duodenale* 1 (6.6%), *Strongyloides* spp. 1
207 (6.6%), *Meloidogyne* spp. 4 (26.6%), *Buracephalus* spp. 1 (6.6%) and *Toxocara* spp. 1 (6.6%) See Table 4.

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215 Table 1: Monthly Soil Physico-chemical parameters as it affects prevalence of geohelminthes in the soils
216 of Isiodu.

Months	Average No. Soil Sampled	Soil Physico-chemical parameters			% No. Soil Samples Positive for Geohelminthes			% Total
		Temperature (⁰ C)	pH	(%) Organic Matter	Sandy	Loam	Clay	
January	20	26.6±1	6.3±1	15.3±2	5 (25)	10 (50)	1 (5)	16 (80)
February	20	28.3±1	6.3±1	12.6±1	4 (20)	8 (40)	-	12 (60)
March	20	27.3±1	6.2±1	16.5±2	3 (15)	9 (45)	1 (5)	13 (65)
April	20	27.1±1	5.9±.5	12.1±1	4 (20)	7 (35)	1 (5)	12(60)
May	20	27.6±1	5.9±2	10±1	3 (15)	5 (25)	1 (5)	9 (45)
June	20	27.3±1	6.2±1	11±1	3 (15)	7 (35)	2 (10)	12 (60)
% Total	120	27.3±1	6.1±.2	12.9±3	22 (18.3)	46 (38.3)	6 (5)	74 (61.6)

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222 Table 2: Prevalence of geohelminthes in Relation to Physico-chemical parameters of soils in Isiodu during the study.
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Soil Physico-chemical parameters				% No. Geohelminthes										%Total
Soil Types	Temperature (°C)	pH	(%) Organic Matter	<i>Ascaris</i> spp.	<i>Trichuris</i> spp.	<i>Ancylostoma duodenale</i>	<i>Strongyloides</i> spp.	<i>Enterobius</i> spp.	<i>Trichostrongylus</i> spp.	<i>Meloidogyne</i> spp.	<i>Buracephalus</i> spp.	<i>Bayliascaris</i> spp.	<i>Toxocara</i> spp.	
Sand	27.8±1	6.0±1	12.6±2	9 (23.7)	9 (23.7)	4 (10.5)	2 (5.3)	0	0	8 (21)	1 (2.6)	0	5 (13.2)	38 (38)
Loam	28±1	6.3±.4	15±1	18(33.3)	5 (9.3)	7(13)	3 (5.5)	2 (3.7)	2 (3.7)	11 (20.3)	0	3 (5.6)	3 (5.6)	54 (54)
Clay	27±1	5.6±1	11.4±2	3 (37.5)	2(25)	0	0	0	0	2 (25)	0	0	1 (12.5)	8 (8)
%Total	27.5 ±1	6.0±.2	12.8±2	30 (30)	16 (16)	11 (11)	5 (5)	2(2)	2 (2)	21(21)	1 (1)	3 (3)	9 (9)	100

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Table 3: Prevalence of Geohelminthes in Relation to Physico-Chemical Parameters of Soils in Site 1 during the study.

Soil Physico-Chemical Parameters				(%) Types of Geohelminthes Recovered								(%) Total
Soil Types	Temperature (°C)	pH	(%) Organic Matter	<i>Ascaris</i> spp.	<i>Trichuris</i> spp.	<i>Ancylostoma duodenale</i>	<i>Strongyloides</i> spp.	<i>Enterobius</i> spp.	<i>Trichostrongylus</i> spp.	<i>Meloidogyne</i> spp.	<i>Toxocara</i> spp.	
Clay	26.8±.4	6.1±1	11.5±2	1 (25)	1(25)	0	0	0	0	1 (25)	1 (25)	4 (8.5)
Loam	26.9±.1	6.3±.3	15±3	7(35)	2(10)	1 (5)	2 (10)	2 (10)	2 (10)	3 (15)	1 (5)	20(42.6)
Sand	27.3±1	6.2±1	12.5±3	7(30.4)	4 (17.4)	3 (13)	1 (4.3)	0	0	4 (17.4)	4 (17.4)	23 (48.9)
(%)Total	27±.2	6.2±1	12.8±2	15 (31.9)	7 (14.9)	4 (8.5)	3 (6.4)	2 (4.3)	2 (4.3)	8(17)	6 (12.8)	47

232 Table 4: Prevalence of Geohelminthes in Relation to Physico-Chemical Parameters of Soils in Site 2 during the study.

Soil Types	Soil Physico-Chemical Parameters			(%) Types of Geohelminthes Recovered								(%) Total
	Temperature (°C)	pH	(%) Organic Matter	<i>Ascaris</i> spp.	<i>Trichuris</i> spp.	<i>Ancylostoma duodenale</i>	<i>Strongyloides</i> spp.	<i>Meloidogyne</i> spp.	<i>Buracephalus</i> spp.	<i>Bayliascaris</i> spp.	<i>Toxocara</i> spp.	
Clay	27±1	5.1±1	11.3±4	2 (50)	1(25)	0	0	1 (25)	0	0	0	4 (7.5)
Loam	28.4±1	6.2±.4	14.5±2	11(32.3)	3(8.8)	6 (17.6)	1 (2.9)	8 (23.5)	0	3(8.8)	2(5.9)	34 (64.2)
Sand	28.2±1	5.7±1	12.6±3	2(13.3)	5(33.3)	1 (6.6)	1(6.6)	4 (26.6)	1 (6.6)	0	1 (6.6)	15(28.3)
(%)Total	27.9±1	5.7±1	12.8±1	15(28.3)	9 (17)	7(13.2)	2 (3.8)	13(24.5)	1(1.9)	3 (5.7)	3 (5.7)	53

233 4. DISCUSSION

234 This study indicated a prevalence of (61.6%) of geohelminths in the soil samples of the study area with
235 Loamy soil having the highest prevalence of 38.3%. Equally, a temperature of 27.3 ± 1 C, pH of 6.1 ± 2 and
236 12.9 ± 3 organic matter were noted. [These findings agree with reports from studies by [5; 7; 10; 17] who
237 recorded geohelminthes eggs in soils with temperature ranges from $16 \pm 1^\circ\text{C}$ and $34 \pm 1^\circ\text{C}$ and as the
238 temperature increases within this range, the development of the egg is hastened. The pH and organic
239 contents of the samples were equally within the ranges recorded by [9; 18]. The physico-chemical
240 parameters of the soils during the study were almost at the same level. The high percentage of soil
241 samples in the study area positive for geohelminthes indicates a continuous deposition of human, plant and
242 animal wastes in the environment. The Soils in the months of January- March recorded the presence of
243 geohelminthes between 60-80% with the least prevalence of 45% occurring in the month of May. This
244 could be attributed to more outdoor activities like farming and gathering of firewood which takes place
245 these months and encourages open defaecation. The 38.3% of Loamy soils positive for geohelminthes had
246 a very high prevalence of 54% of the organisms while 5% clayey soils had the lowest prevalence of 8%,
247 this could be attributed to a higher organic content of Loamy soils and its ability to retain, humus, nutrients
248 and moisture while still allowing excess water to drain away thereby giving the geohelminthes access to
249 oxygen for survival in the soil [9; 19].

250 The high prevalence of *Ascaris* spp., *Meloidogyne* spp, *Trichuris* spp. in this study may be as a result of
251 their ability to tolerate different soil types and levels of physico-chemical parameters and persist longer in
252 the environment [7; 20]. Equally, high levels of *Ancylostoma duodenale*, and *Toxocara* spp were
253 recorded.

254 The parasites were observed 53 times in site 2 as against 47 in site 1 which could be as a result of
255 the slight difference in temperature and pH of the sites. The same number of *Ascaris* spp. was
256 observed in both sites while site 2 recorded higher number of *Meloidogyne* spp, *Trichuris* spp.

257 More organisms were recovered from sandy soils in site one while in site two loamy soils had more
258 of the geohelminthes this may be due to the observation of higher temperatures in these soils in the
259 two sites which confirms reports by [7;10; 19] that development geohelminthes stages is hastened
260 with increase in soil temperature.

261 5. CONCLUSION

262 Soil samples with higher physico-chemical parameters especially temperature and organic matter recorded
263 high prevalence of the major human and plant geohelminthes in the area. Therefore, open defaecation and
264 direct dumping of human and other household waste to the soils at undesignated places should be
265 discouraged.

267 6. RECOMMENDATIONS

268 Direct defaecation into soils should be discouraged.

269 The People should observe proper personal hygiene to reduce or eliminate the spread of *Ascaris* and
270 *Trichuris* species whose prevalence in the soil was high.
271

Comment [u38]: You cannot find egg of *Strongyloides stercoralis* in soil. Bring references that support these results.

Comment [h39]: I never said I did.

Comment [u40]: Hookworm has two species *Nectal americanus* and *Ancylostoma duodenale*? How are you sure the one you found is *A. duodenale* and not *N.americanus*?

Comment [h41]: The species in Nigeria is *Ancylostoma duodenale*. It cannot be *N americanus*

Comment [u42]: parasites

Comment [h43]: ok

Further studies should be carried out in the area to ascertain the level of geohelminthes prevalence in the inhabitants.

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Comment [u44]: Please check your references and make sure it conform to this Journal requirements

Comment [h45]: ok

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