

The effects of surface soil physico-chemical properties on the prevalence of helminths in Ogun State, Nigeria

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Key words: *Ascaris lumbricoides*, soil-transmitted helminths, physico-chemical properties.

(Received for publication on January 27, 2005. Accepted on June 28, 2005.)

ABSTRACT

This study examined the association between surface soil physico-chemical properties and the prevalence of *Ascaris lumbricoides* in Ogun State. A school-based prevalence survey was carried out among 1 800 school pupils randomly selected from five Local Government Areas (LGAs) representing the major soil-geological zones in relation to their parent rocks namely: Odeda LGA (Undifferentiated Basement Complex), Obafemi/Owode LGA (Sandstone-Abeokuta Formation), Ewekoro LGA (Upper Coal Measure-Ewekoro formation), Ado-odo/Otta LGA (Coastal Plain Sands I-Alfisol), and Ogun Waterside LGA (Coastal Plain Sands II-Utisol). Kato smear method was used to determine the indirect prevalence and intensity of infection while drug (Levamisole) administration was used to determine the direct prevalence and intensity of infection, in addition to analysis of the physico-chemical characteristics of the surface soil samples from the LGAs. The overall indirect prevalence of infection was *Ascaris lumbricoides* (Roundworms 72.5%), *Necator americanus* (Hookworms 8.5%) and *Trichuris trichiura* (Whipworms 6.0%). The direct prevalence for *A. lumbricoides* was 48.5%. The physico-chemical studies of surface soils (5cm depth) from the LGAs showed that sand/silt content and pH varied significantly among the soils. The total Nitrogen and exchangeable cations (Mg^{++} , Ca^{++} , Mn^{++} , K^+ , and Na^+) also vary significantly ($P < 0.05$). High prevalence of ascariasis was more correlated with decreasing amount of manganese in soils.

INTRODUCTION

Human parasitic nematodes exhibit varying degrees of complexity in their modes of transmission. For soil-transmitted helminths, development in the soil is of fundamental epidemiological significance (Mabaso *et al.*, 2004). This is particularly true for hookworms which have thin-shelled eggs and free-living larvae that are very sensitive to desiccation and cold temperatures; as it is for *Ascaris lumbricoides* and *Trichuris trichiura* which have no free living larval stages but rather thick-shelled eggs that allow for prolonged survival under harsh environmental conditions (Smyth, 1996).

Some studies have examined hookworm association with soil types (Udonsi *et al.*, 1980; Evans *et al.*, 1990; Appleton *et al.*, 1999; and Mabaso *et al.*, 2004), but information on the soil profile of *Ascaris lumbricoides* dominated communities or environment are non-existent in Nigeria. Understanding the soil nutrients and its effect on the biology of the parasites can improve our knowledge of epidemiology and in turn be a valuable aid in national control strategies. This study therefore examines the relationship between the physical and chemical properties of surface soils and *Ascaris lumbricoides* prevalence in Ogun State, Southwest Nigeria.

MATERIALS AND METHODS

Study area

Ogun State lies approximately between longitude 2°30'N and 4°30'NE and between latitudes 6°30'N and 8°N. It is predominantly populated by the Yoruba speaking tribes of Nigeria whose traditional occupations are agriculture and commerce. From the soil-geological description of Ogun State (Table 1 and Figure 1), a Local Government representing each demarcation was selected: Coastal Plains Sands I (Alfisols) – Ado-Odo/Otta Local Government; Coastal Plains Sands II (Utisols) – Ogun Waterside Local Government; Upper Coal Measure (Ewekoro formation) – Ewekoro Local Government; Sandstone (Abeokuta formation) – Obafemi-Owode Local Government; and Undifferentiated Basement Complex – Odeda Local Government.

Table 1: Soil-geological Description in Ogun State, Nigeria.

<i>Geology</i>	<i>Relief</i>	<i>Description</i>	<i>Local Govt Areas Covered</i>
Coastal Plain Sands – Alfisols	Nearly level plains	Very deep well drained soils, loamy sand, sandy loam or sandy clay. Loam surfaces over sandy clay loam, clay loam, sometimes gravelly sub soils	Ipokia, Ado-Odo/Otta, Ifo and Yewa South
Coastal Plain Sands II – Utisols	Nearly level plains	Very deep well drained soils, sandy, loamy sand, or loamy surfaces over loamy, sandy, loam or sandy clay, sometimes mottled sub soils	Ogun Waterside
Upper Coal Measure (Ewekoro Formation)	Nearly level plains	Very deep well drained and poorly drained soils. Sandy, loam, loam or loamy sand surfaces over clay loam, gravelly clay or sandy clay loam sub soils	Sagamu, Yewa North, Ikenne, Ewekoro and Odogbolu
Sandstone (Abeokuta Formation)	Gently undulating plains	Very deep well drained few shallow ferruginised and gravelly soils, sandy loam, loam over clay loam, sandy clay loam or sandy clay sub soils	Imeko-Afon, Obafemi/Owode and Ijebu-Ode
Undifferentiated Basement Complex	Generally undulating plains with scattered rocks outcrops and hills	Shallow and moderately deep to deep well drained and somewhat poorly to poorly drained soils, loamy sand to sand loamy and sometimes gravelly surfaces over sandy clay loam to sandy clay and sometimes gravelly sub soils	Abeokuta North, Abeokuta South, Odeda, Remo North, Ijebu East, Ijebu North and Ijebu North-East

Source: Federal Ministry of Agriculture (1985)

Four primary schools were selected from each of the Local Government Areas as follows:

Ado-Odo/Otta Local Government Area

St Michael's Primary School, Otta; St James Primary School, Otta; A.U.D. Primary School, Ado-Odo; and All Saints Anglican Primary School, Ado-Odo.

Ewekoro Local Government Area

Baptist Day Primary School, Ewekoro; All Saints Primary School, Itori; St Michael's Primary School, Wasimi; and Baptist Central Primary School, Wasimi.

Odeda Local Government Area

O.L.G. Primary School, Itesi-Ajgunle; Methodist Primary School, Odeda; African Church Primary School, Rogun Rogun; and O.L.G. Primary School, Obantoko.

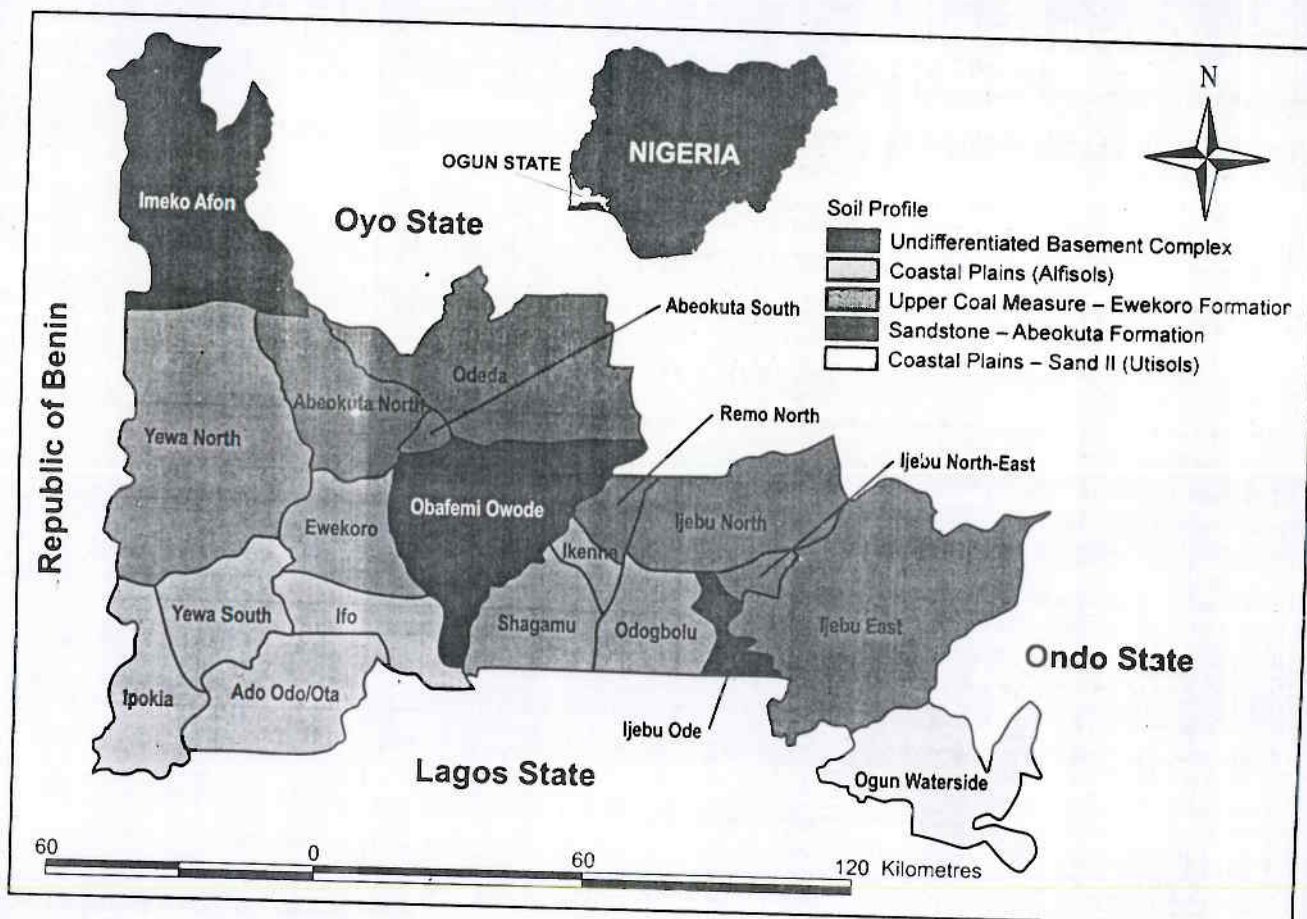
Obafemi/Owode Local Government Area

Anglican Primary School, Obafemi; All Saints Primary School I, Owode; All Saints Primary School II, Owode; and N.U.D. Primary School, Owode.

Ogun Waterside Local Government Area

St Thomas Anglican Primary School, Abigi; Moslem Primary School, Abigi; St Michael's Anglican Primary School, Ibiade; and L.G. Primary School, Makun-omi.

Figure 1: The Local Government Areas and their different soil-geological zones (Inset- Map of Nigeria showing the location of Ogun State).



Field and Laboratory Methods

Properly labelled plastic containers with tight lids containing the name and sex of each pupil were provided to each pupil, with the instruction to provide a small quantity of fresh stool and bring to school the following day. Faecal samples were collected from 200 (7-10 years old) pupils (100 per sex) randomly selected from each school. The specimens collected were preserved with 10% Formalin and taken to the Parasitology Laboratory in the Department of Biological Sciences.

University of Agriculture, Abeokuta, for microscopic examination. Kato smear method (Martin and Beaver, 1968) as modified by Nawalinski (1978) was employed in the indirect prevalence and intensity studies.

Drug (Levamisole) administration was used to determine direct prevalence and intensity. Faecal samples were collected from 1 600 pupils (52% males and 48% females), and examined over 48 hrs for *Ascaris* worms by flushing with running water through a sieve.

Soil Analysis

Using a spade to scoop soil from the surface horizon (0-50mm depth), 200g samples were taken very close to defaecation areas in the school used for the prevalence and intensity studies. Each soil sample was transferred to a separate container, and taken to the laboratory for soil analysis. Using Jenway 3150 pH meter method, the pH values of the soil samples were taken. Particle size determination was carried out using the Pipette method (Lambe, 1960). Total Nitrogen was determined by Macro-Kjeldahl method. Determination of exchangeable Calcium, Magnesium and Manganese was done by Atomic Absorption Spectrometer, while Potassium and Sodium cations were determined using the Flame photometry method (Black, 1965).

Statistical Analysis

SPSS version 10 employing simple percentiles, paired and sample t-tests techniques were used in analysing the prevalence and intensity of infections, in addition to comparing infections with the soil parameters in the different soil zones. Correlation coefficient was used to determine the relationship between infection patterns and soil micronutrients.

RESULTS

Results from the indirect analysis revealed that male and female pupils had overall prevalence of 75% and 70% respectively for *Ascaris lumbricoides* infection. The prevalence of helminths examined is presented in Table 2 for all the different study areas. The results also showed that the

Table 2: Prevalence of Helminths by Eggs in the different soil geological zones of Ogun State

Soil Geological Zones	<i>Ascaris lumbricoides</i> %	<i>Necator americanus</i> %	<i>Trichuris trichiura</i> %
Sandstone - Abeokuta formation Obafemi/Owode LGA	97.5	22.5	0
Undifferentiated basement Complex Odeda LGA	55	20	7.5
Upper Coal Measure (Ewekoro Formation) Ewekoro LGA	55	0	0
Coastal Plain Sands I - (Alfisols) Ado-Odo/Otta LGA	67.5	0	0
Coastal Plains Sands II- (Udisols) 87.5 Ogun Waterside LGA	0	22.5	

Overall prevalence by egg for: *A. Lumbricoides* = 72.5%
Necator americanus = 8.5%
Trichuris trichiura = 6.0%

Table 3: Prevalence and intensity of *Ascaris lumbricoides* by sex in the study area.

Local Government Area	School	Number examined		Number (%) Infected		No. of worms voided /mean		Total mean No. of worms voided/mean
		Male	Female	Male	Female	Male	Female	
Obafemi/Owode	NUD School, Owode	24	38	15 (62.5)	23 (60.5)	79 (3.3)	97 (2.5)	176 (2.8)
	All Saints Anglican School I, Owode	29	26	18 (62.1)	13 (50)	106 (3.6)	43 (1.6)	149 (2.7)
	All Saints Anglican School II, Owode	42	35	19 (45.2)	20 (57.1)	85 (2.0)	105 (3.0)	190 (2.4)
	Anglican School, Obafemi	30	30	28 (93.3)	23 (76.7)	146 (4.8)	107 (3.6)	253 (4.2)
	Total	125	129	80 (64)	79 (61.2)	416 (3.3)	352 (2.7)	768 (3.0)
Odeda	Odeda LG School, Obantoko	7	8	2 (28.6)	3 (37.5)	17 (2.4)	12 (1.5)	29 (1.9)
	Odeda LG School, Itesi-Ajgunle	29	37	6 (20.7)	6 (16.2)	13 (0.4)	12 (0.3)	25 (0.3)
	African Church School, Rogunrogun	27	14	9 (33.3)	5 (35.7)	34 (1.2)	7 (0.5)	41 (1.0)
	Methodist School, Odeda	28	31	22 (78.6)	28 (90.3)	49 (1.7)	72 (2.3)	121 (2.0)
	Total	91	90	39 (42.8)	42 (46.7)	113 (1.2)	103 (1.1)	216 (2.7)
Ewekoro	St Michael Anglican School, Wasimi	33	31	14 (42.4)	4 (12.9)	28 (0.8)	4 (0.1)	32 (0.5)
	Baptist Central School, Wasimi	25	30	3 (27.6)	9 (30)	17 (0.5)	10 (0.3)	27 (0.4)
	All Saints Anglican School, Itori	20	16	8 (40)	5 (31.3)	38 (1.9)	16 (1.0)	54 (1.5)
	Baptist Day School, Ewekoro	17	20	9 (52.9)	10 (50)	22 (1.3)	17 (0.8)	39 (1.1)
	Total	99	97	39 (39.4)	28 (28.9)	105 (1.0)	47 (0.4)	152 (0.7)
Ado-Odo/Otta	St Michaels African School, Otta	9	15	4 (44.4)	4 (26.7)	5 (0.5)	8 (0.5)	13 (0.5)
	St James Anglican School, Otta	12	15	4 (33.3)	5 (33.3)	15 (1.2)	7 (0.4)	22 (0.8)
	All Saints Anglican School, Ado-Odo	23	22	4 (17.4)	4 (18.2)	5 (0.2)	7 (0.3)	12 (1.3)
	Aud School, Ado-Odo	11	10	3 (27.3)	2 (20)	4 (0.3)	4 (0.4)	8 (0.4)
	Total	55	62	15 (27.3)	15 (24.2)	29 (0.5)	26 (0.4)	55 (0.4)
Ogun Waterside	St Michael Anglican School, Ibiade	37	32	18 (48.6)	13 (40.6)	78 (2.1)	52 (1.6)	130 (1.8)
	St Thomas Anglican School, Abigi	27	23	15 (55.6)	8 (34.7)	41 (1.5)	22 (0.9)	63 (1.2)
	Moslem School, Abigi	28	33	17 (60.7)	18 (54.5)	41 (1.4)	58 (1.7)	99 (1.6)
	LG School, Makun-Omi	32	30	28 (87.5)	26 (86.7)	267 (8.3)	219 (7.3)	486 (7.8)
	Total	124	118	78 (62.9)	65 (55.1)	427 (3.4)	351 (2.9)	778 (3.2)

prevalence of *A. lumbricoides* infection was generally high (55–97.5%) across the different soil geological zones.

Results obtained in the direct prevalence study (Table 3) revealed that 480 pupils (249 males and 231 females) of the 990 pupils who complied with faecal collection passed out worms directly. 51.9% male and 48.1% female pupils were infected with *A. lumbricoides*. Statistical analysis showed no significant difference between the infection rates in both sexes ($t = 2.60$, $p = 0.234$). The overall direct prevalence for *A. lumbricoides* was 48.5%.

Results of the physico-chemical analysis of the surface soils are presented in Table 4. The particle size classification indicated that the soil textures were sandy with sand concentration of

Table 4: Physico-chemical parameters of all soil samples analysed from the different soil-geological zones.

Location	Sand %	Silt %	Clay %	Texture	pH	OC	Total N ₂ (%)	Na cmolkg ⁻¹	K cmolkg ⁻¹	Mg cmolkg ⁻¹	Ca cmolkg ⁻¹	Mn mgkg ⁻¹
EWE1	87.2	10.4	2.4	Loamy sand	5.76	28	0.119	1.01	1.33	0.64	4.61	0.73
EWE2	90.4	4.8	4.8	Sand	5.98	31	0.101	0.55	0.64	0.13	0.06	1.05
OTA1	90.0	5.6	4.4	Sand	6.19	26	0.039	0.78	0.42	0.08	ND	0.71
OTA2	92.4	4.0	3.6	Sand	6.41	27	0.039	0.96	0.74	0.20	0.12	0.77
DED1	94.8	2.8	2.4	Sand	6.54	24	0.043	0.69	0.63	0.23	0.35	1.65
DED2	92.8	2.0	5.2	Sand	6.63	25	0.042	0.94	0.82	0.27	0.12	0.98
WDE1	93.2	2.0	4.8	Sand	6.33	24	0.032	0.96	1.10	0.31	0.52	0.85
WDE2	95.2	0.8	4.0	Sand	6.50	24	0.031	1.64	0.52	0.20	0.17	0.60
OGW1	83.6	6.4	10.0	Loamy Sand	6.38	30	0.102	0.32	1.68	0.32	0.61	0.34
OGW2	89.2	2.0	8.8	Loamy Sand	4.96	29	0.079	0.63	0.36	0.17	ND	0.03

Key: EWE1 & EWE2 – samples from Ewekoro LGA, OTA1 & OTA2 – samples from Ado-odo/Otta LGA, DED1 & DED2 – samples from Odeda LGA, WDE1 & WDE2 – samples from Obafemi/Owode LGA, OGW1 & OGW2 – samples from Ogun Waterside LGA

92.8–94.8%. However, Silt and Clay had concentrations of 2.0–2.8 and 2.4–5.2% respectively. The soils were acidic with pH range of 6.54–6.63. Potassium (0.58–0.99cmolkg⁻¹), and Sodium (0.44–1.3 cmolkg⁻¹) recorded higher values when compared with Magnesium, Calcium and Manganese. Total Nitrogen had lower levels (0.039–0.425%) in the soils analysed.

Analysis of the prevalence of *A. lumbricoides* with respect to mean values of the soil parameters measured in the different soils geological demarcations are presented in Table 5. The

Table 5: Mean values of the physico-chemical parameters and percentage prevalence of *Ascaris lumbricoides* in the different soil geological zones.

Soil Geological Zone	pH	Total N ₂ (%)	Na cmolkg ⁻¹	Kc molkg ⁻¹	Mg. cmolkg ⁻¹	Ca cmolkg ⁻¹	Mn mgkg ⁻¹	Prevalence (%)
Upper Coal Measure (Ewekoro Formation)	5.87	0.11	0.78	0.99	0.39	2.3	0.89	67 (13.9)
Undifferentiated Basement Complex	6.6	0.425	0.82	0.73	0.25	0.24	1.32	81 (16.9)
Sandstone (Abeokuta Formation)	6.42	0.315	1.3	0.81	0.26	0.345	0.725	159 (33.1)
Coastal Plains Sands – Alfisols	6.3	0.039	0.87	0.58	0.14	0.12	0.74	30 (6.3)
Coastal Plains Sands II – Utisols	5.70	0.0725	0.44	0.74	0.34	0.305	0.16	143 (29.8)

result suggests that pH of the soils; total Nitrogen, Sodium, and Calcium concentrations had no effect on the prevalence of the helminth parasite. It was observed that as concentrations of Potassium and Magnesium increased, prevalence of the helminth also increased whereas prevalence of *A. lumbricoides* increased with decreased Manganese concentrations. Statistical analysis showed no significant difference between the exchangeable cations and the prevalence of *A. lumbricoides*.

DISCUSSION

Analysis of the physico-chemical properties of the surface soils in the different soil geological zones of Ogun State revealed that the parameters measured are relatively within limits (FMA, 1985), except for Upper Coal Measure-Ewekoro Formation. The higher concentrations of calcium recorded in Upper Coal Measure could be due to the exploration and production of cement in that environment.

On the relative interaction and effect on the prevalence on *A. lumbricoides*, it was observed that when levels of Magnesium and Potassium were high, prevalence was also high, while prevalence also increased with decreased Manganese concentrations. Correlation coefficient revealed only a significant relationship between pH and the prevalence of *A. lumbricoides*, which is in consonance with the findings of Smyth (1996), that pH, oxygen and moisture are particular important factors in the hatching of nematode eggs. The study also observed that pH had a significant impact on the levels of Sodium and Manganese, while Nitrogen had effects on the percentage silt and sand levels, and a correlation between clay and sands in the soil zones.

There was a preponderance of *A. lumbricoides* eggs over those of *T. trichiura* in the soils. Smyth (1996) had observed in studies that the eggs of *T. trichiura* require a rain-soaked soil and a very warm, moist environment for embryonation. For soils to retain water, the percentage level of clay has to be high, which was not so in this study, where the textural class of the soils are within sand and loamy sand. Information on weather condition in Ogun State indicates that rainfalls are erratic, leading to high temperatures with dry soil texture (FMA, 1985).

ACKNOWLEDGEMENTS

The authors sincerely do appreciate the support and co-operation of Ogun State Primary Education Board, the head teachers, staff and pupils of the schools used for the study. Also the technical support received from Messrs S.O. Bankole, A. Akingbola (Chemistry laboratory) and O. Olapade (Soil Science laboratory) in the soil analysis.

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