IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 12, Issue 11 Ver. I (November. 2018), PP 31-38
www.iosrjournals.org

The Occurrence of Viable Helminthes Ova in Pit Latrine Faecal Sludge In Nakuru Sub County, Kenya

Maingi J.M[1*], Moturi W.N[1], Omondi S.O[2], Muchiri E.W[3]
[1.] *Department of Environmental Sciences, Egerton University.*
[2.] *Department of Biological Sciences, Egerton University.*
[3.] *Department of Civil and Environmental Engineering, Egerton University.*
Corresponding Author: Maingi J.M

Abstract: *Pit latrines eventually fill up and mostly have to be disludged for continued reuse of the facility. Disludging and disposal of pit latrine contents may expose the public and disludgersto harmful pathogens. Helminthes have been found to exist in faecal sludge and are the most resilient hence their elimination would render the faecal sludge safe upon exposure. Little is known on the occurrence of helminthes parasites and their magnitude in Kenya. It's on these facts that this research is based upon to find out the various helminthes species present in faecal sludge and their occurrences in regard to pit latrine depth. Thirty five pit latrines were selected purposively and sampled at various depths and analyzed for viable helminthes ova using the floatation method. One way analysis of variance was used to determine significant differences in the occurrence of various helminthes ova versus pit latrine depth. Where significant differences were found, a post hoc test (fishers exact and Tukey) was done to establish the exact depth at which the significance occurred. Results indicate that among the 128 samples collected, 23% were found to bear viable helminthes ova. Seven helminthes species were established; Ascaris lumbricoides, Trichuristrichiura, Schistosomahaematobium, Schistosomamansoni, Taeniasp, Enterobiusvermicularies and Necatoramericanus. A statistical significant difference in the occurrence of total viable helminthes ova was found to occur. A statistical significant difference in the occurrence of Ascaris ova in regard to pit latrine depth was also found to occur. Pit latrine sludge in Nakuru was thereforefound to contain numerous infective helminthes parasites and the fact that they exist even at deeper depths despite significant differences in their occurrence renders pit latrine sludge hazardous upon exposure to disludgers, public and the environment. Proper care should thus be ensured when handling and disposing raw sludge from pit latrines in Nakuru Sub County.*

Key words*: faecal sludge, helminthes ova, pit latrine*

Date of Submission: 17-11-2018 Date of acceptance: 03-12-2018

I. Introduction

The use of pit latrines is one of the most common forms of sanitation worldwide. Basic sanitation systems, safe drinking water and good hygiene practices are fundamental to the wellbeing and good health of the community (Itchon et al 2008). However, an approximately 2.6 billion people lack access to basic sanitation facilities such as pit latrines. Some of the places with the lowest sanitation coverage include southern Asia, sub-Saharan Africa of which Kenya is included and where two thirds of the total population lack access to improved sanitation facilities (JMP 2013). The WHO estimates show that eighty percent of all sicknesses and diseases are caused by polluted water, unavailability of water and inadequate sanitation (WEDC 1992). Improper disposal of faecal sludge can lead to contamination of water sources upon which waterborne diseases are transmitted. The inappropriate disposal of faecal sludge can be considered a point source of pollution in water and an environmental and public health hazard.

According to Muelleger and Langergraber (2005), human excreta contain large amounts ofpathogens. Proper management of human excreta plays a major role in the reduction of many water related and waterborne diseases (Warner, 1998). A major public and environmental health concern in developing countries is helminthes infections particularly among the poor communities with inadequate sanitation facilities (Navarro et al, 2009, Jimenez 2007). The incidence of helminthes infections under such conditions can reach up to 90% (Bratton and Nesse 1993). Faecal sludge may contain numerous parasites with the most prolific being *Ascaris lumbricoides*with 1.3 million infections globally. Ascaris is endemic in East Africa and Latin America where children and the poor are greatly affected (Jimenez 2007). Numerous helminthes species apart from Ascaris may also occur in faecal sludge where upon infection, heavy worm burdens may cause malnutrition, vomiting, stomach cramps, intestinal obstruction and diarrhea. All these may affect the growth, cognitive development and physical fitness more so in young children (Fripp 2004, Silva et al 1997).Pit latrines have been preferred over other forms of sanitation in developing countries because of several advantages attached to them such as; simple construction, low costs and easily acceptable by different communities globally. Despite these advantages, poor smell, flies, rapid fill up rates and public health risks while emptying and possible contamination of underground and surface water exists. The fact that every pit latrine will eventually fill up and require emptying especially in dense unplanned urban settlements poses a health hazard. In urban areas, space is always a limiting factor when one decides to relocate a filled up pit latrine and thus opts to empty it instead. Nakuru County is one of fastest growing urban community in Kenya where increased rural urban migration has led to increased demand for housing and proper sanitation leading to increased pit latrine fill up and emptying. This is rampant especially in the low income urban settlements and therefore a need to find solutions for safe emptying and disposal of faecal sludge to minimize chances of contamination to those handling the waste, the public and the environment.

According to Feachem et al 1983, Schonning and stenstrom 2004 and WHO 2006, any exposure to fresh or untreated faeces contributes to a human health risk. Survival of pathogens is an important factor in disease transmission especially while handling or emptying faecal sludge. The table below shows the survival times for different pathogens and parasites in faecal sludge under tropical and temperate conditions;

Table 1: Organism survival periods in faecal sludge.

Organism	**AV. Survival time (days) in the wet faecal sludge at ambient temperature**	
	Temperate Climate 10 - 15^{0}c	**Tropical Climate 20- 30^{0}c**
Viruses	<100	<20
Salmonellae	<100	<30
Cholera	<30	<5
Faecal coliforms	<150	<50
Amoebic cysts	<30	<15
Ascaris eggs	2-3 years	10-12 months
Tapeworm eggs	12 months	6 months
Trematodes	<30	<30

Source; Feachem et al 1983 and Strauss 1985

The pathogens excreted in faeces may include: Bacterial species e.g. *Aeromonasspp,Campylobacter jejuni*, pathogenic *E. Coli, Pleisiomonasspp, Shigellaspp, Vibrio Cholerae and Yersinia spp.* Viruses; include, Enteric adenovirus 40 and 41, Hepatitits A Virus, Hepatitis E, Polio virus and rotavirus. Protozoic species include *cryptosporidium pavum, entamoebahistolytica, Giardia intestinalis and* lastlyhelmintheswhich include *Ascaris Lumbricoides,* (roundworm),*TaeniaSolium/Saginata*(Tapeworm),*Trichuristrichiura*(Whipworm) the hook worm, *(Necatoramericanas) and shistosomaspp*(WHO 2006). According to Schonning and Stenstrom (2004), majorityof the above listed pathogens cause gastro-intestinal symptoms such as diarrhea, stomach cramps and vomiting. Pit latrine faecal sludge can contain high concentrations of excreted pathogens depending on the health status of those using it. Pathogens include bacteria, viruses, protozoa and helminthes (WHO 2006).

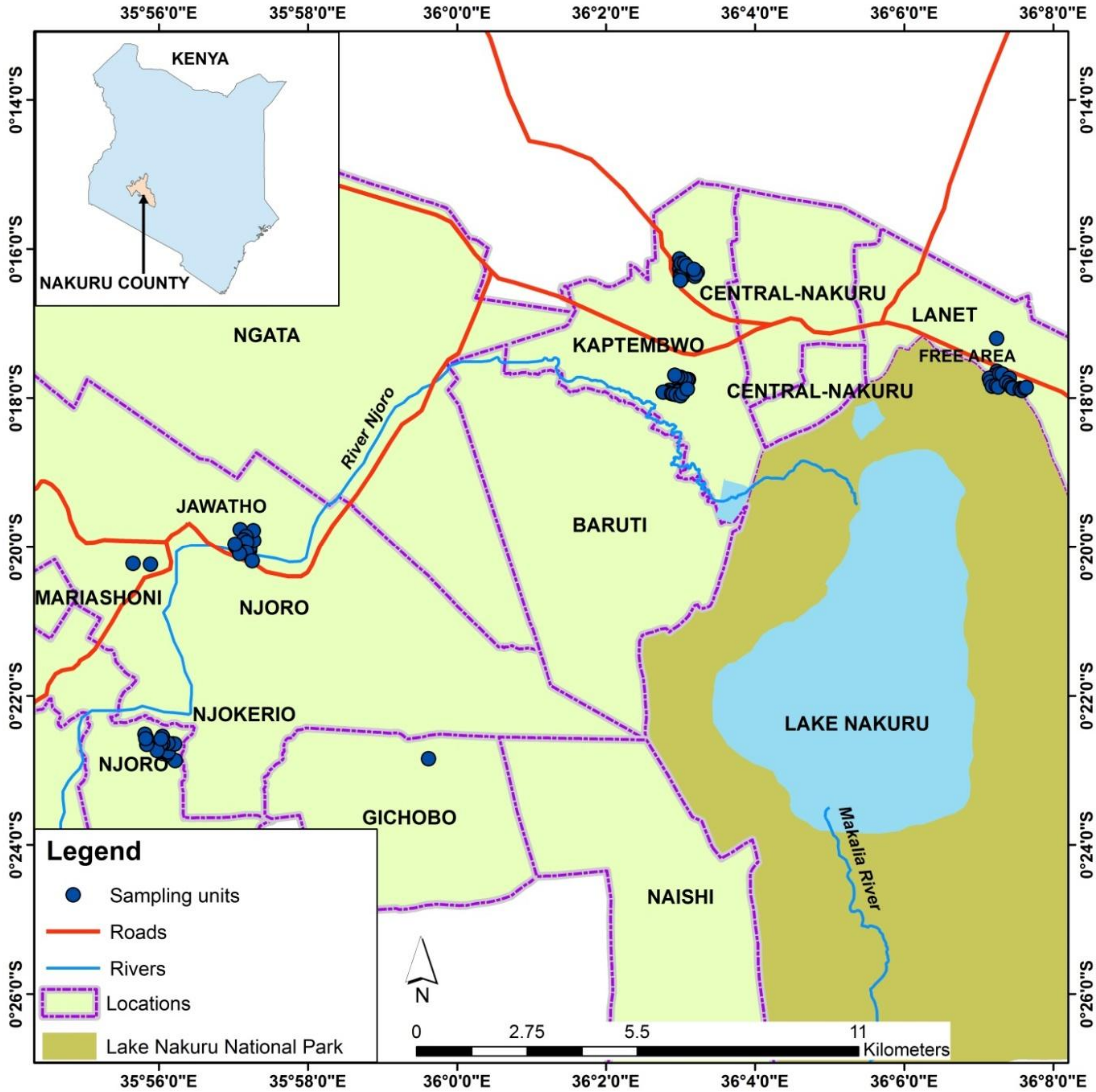
According to a research report by David Still and Kitty Foxon 2012, to the water research commission on tackling the challenges of full pit latrines, an investigation into helminthic and protozoan parasites in pit latrine faecal sludge in South Africa revealed the occurrence of *Ascaris* at a prevalence of 60% in all the samples collected followed by *Trichuris* at 50% then *Taenia* at 11%.

This research was therefore conducted purposely to create a knowledge base on the kinds of helminthes parasites present in faecal sludge found in pit latrines within Nakuru County and their magnitude. This information is thus useful in creating awareness on the hazards involved while emptying and disposing faecal waste among the disludging practitioners and upon poor transport and disposal and to the concerned authorities for regulatory and enforcement purposes since pit emptying is the most practiced way of ensuring the reuse of pit latrines in Nakuru county.

II. Materials And Methods

This study was carried out in Nakuru County, Kenya. Nakuru town is located at a distance of 160 Km North West of Nairobi and lies between the latitudes $0^0 10^1$ and $0^0 20^1$ south and longitude 36^0 and $36^0 10^1$ east. It is situated at an altitude of between 1520 and 1890 meters above sea level within the Great Rift Valley. Nakuru has a predictable weather pattern with temperatures ranging from between 10 degrees Celsius during the cold months (July and August) and 28 degrees Celsius during the hot months of January to march. Faecal samples were collected from thirty five pit latrines located in five regions within Nakuru County as shown in the map below;

MAP OF SUDY AREA



Source; Survey of Kenya Topographical Maps, Scale 1:50,000 using ILRI boundary shape files: GIS Arc GIS 10.2.

Faecal samples were collected from pit latrines by use of a modified sampler, kept in an air tight container and placed in a cool box then transferred to the laboratory immediately for analysis. Laboratory analysis was performed to establish viable helminthes parasite ova present in faecal sludge and their occurrence at different depths. Floatation method (Bailinger) was used to recover helminthic ova in faecal sludge and establish their occurrence in relation to pit depth. (WHO, 2006). 5g of faecal sludge were weighed and diluted to 1 liter with tap water. Stirring was done to disintegrate the solid matter and left to sediment for 3 to 4 hours after which the balinger method was applied. Helminthes eggs identified were considered viable based on morphological characteristics. Viable eggs were those found to be embryonated and containing a motile larva, undeveloped or embryonated and containing an immotile larva. Those found to contain a necrotic larva and damaged cell wall were considered dead and therefore not viable (Hawksworth et al). One way analysis of variance (ANOVA) by the aid of Minitab version 16 research tool was used to establish significant differences in the occurrence of viable helminthes ova in relation to depths in the selected pit latrines. Where significant differences were found, a Post Hoc test was conducted (Tukey and Fisher's exact) to establish the exact depth at which the significant differences occurred. Graphs and tables have been used to present the data findings.

III. Results And Discussion

Thirty five pit latrines at different depths in the five locations were analyzed for viable parasitic helminthes ova. Out of the 35 pit latrines, 34% (12) were found to contain faecal sludge that had viable helminthes ova. 23% (30) of the total samples (N =128) were found to contain viable helminthes ova. Human

excreta and lack of adequate personal and domestic hygiene have been implicated in the transmission of many infectious diseases including cholera, typhoid, hepatitis, polio, cryptosporidiosis, Ascariasis and schistosomiasis. The WHO estimates that 2.2 million people die annually from diarrhoeal diseases and that 10% of the population of the developing world are severely infected with intestinal worms related to improper waste and excreta management. (Murray and Lopez, 1996)
Seven helminthes species were identified. These include; *Ascaris lumbricoides*, S*chistosomahaematobium, S. mansoni,Enterobiusvermicularis,Necatoramericanus,Trichuristrichiura and Taenia sp.* Their percentage occurrence in the investigated pit latrines is given in the table below;

Table 2: Occurrence of helminthic species ova in pit latrine sludge found in Nakuru, Kenya

Helminthes species	No of occurrences	Prevalence (%)
Ascaris lumbricoides	27	67.5
Necatoramericanus	6	15
Trichuristrichiura	3	7.5
Enterobiusvermicularis	1	2.5
Schistosomahaematobium	1	2.5
Schistosomamansoni	1	2.5
Taeniasp	1	2.5

The highest occurences as shown in the table above were those of the *Ascaris lumbriocoides*followed by *Necatoramericanus* and *Trichuristrichiura.* Only single occurences were observed for the other helminthes species.Pit latrine faecal sludge can contain high concentrations of pathogens depending on the health status of those using it. Such pathogens include bacteria, viruses, protozoa and helminthes (WHO 2006). David Still and Kitty Foxon (2012), found that the ova of *Ascaris* was the most prevalent at 60% followed by *Trichuris* at 50% then *Taenia* at 11%in an investigation into helminthic and protozoan parasites in pit latrine faecal sludge in South Africa.. This study gave almost similar results where Ascaris occurred in (**67.5% n=27**) of the total samples followed by hookworm at (**15% n=6**), then *Trichuris* at (**7.5% n= 3**) of the total samples analyzed. *Taeniaspp* was found to be least (**2.5% n=1**) of the total samples analyzed. Below are photos of some of the ova identified through microscopy and their identities.

a) *Ascaris* ova x40

b) *Schistosomahaematobium* ova x40

c) *Trichuristrichiura* species ova x40

d) *Schistosomamansoni* ova x40

Plate 1: Photos of some of the helminthes parasite's ova identified in pit latrine faecal sludge from the study area.

4.9.1 The occurrence of total viable helminthes parasite ova across pit latrine depths in Nakuru County.

Majority of helminthes ova were found at the top as opposed to the other depths respectively. *Ascaris lumbricoides* ova were the most occurring across all the depths and across all the pit latrines sampled. There was a significant difference in the occurrence of total viable helminthes ova versus pit depth ($F=10.86$, $\rho = 0.00$) and upon conducting a post hoc test, a statistical difference was found to occur between the top layer and all the other depths respectively and not within the second, third and fourth depths. This was due to the diverse occurrence of various helminthes species at the top layer where all the seven species identified were present. Another fact is that the faecal sludge at the top was relatively fresh and of recent deposition compared to the other depths and therefore many parasites including the short lived ones are likely to be present before they die off by the time of sample collection. The fact that Ascaris ova was found to occur in large numbers at the top could also have led to the significant difference in the occurrence of these parasite ova between the top layer and all the other depths respectively. The figure below shows a representation in the occurrence of total helminthes ova present in faecal sludge in relation to pit latrine depth;

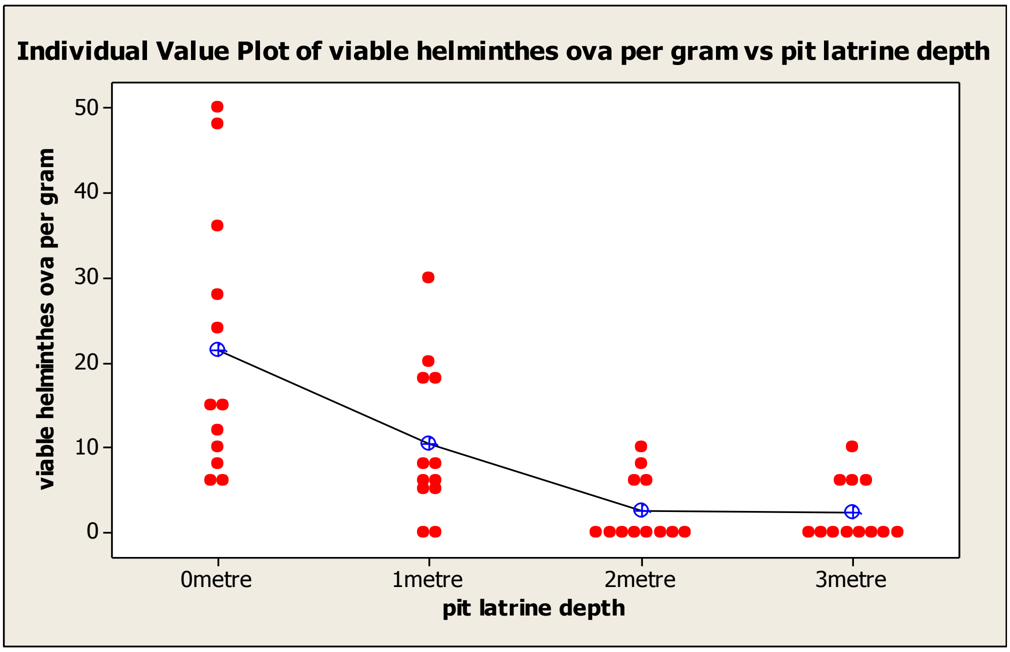


Figure 1: Trends in the occurrence of viable helminthes ova versus pit depth in the various sampling sites

From the figure above on the occurrence of viable helminthes ova versus pit depth, the highest occurrences per pit latrines sampled occurred at the top and gradually reduced as samples were taken lower down the pit latrine depth. Significant differences occurred only between the top layer and all the other depths respectively but not within the second (1m), third (2m) and fourth depths (3m) and therefore the top most layers were concluded to be the most hazardous upon exposure to disludgers and the public.

4.9.2 The occurrence of Ascaris ova in pit latrine faecal sludge versus depth

*Ascaris lubricoides*ova occurred at all the four depths of a pit latrine right from the top to the bottom. The mean occurrences are shown in the table below (table 3)

Table 3: Individual means in occurrences of Ascaris ova versus pit depth

Level	N	Mean	SD
0 meter	9	21.000	14.335
1 meter	10	11.000	7.832
2 meters	4	7.500	1.915
3 meters	4	7.000	2.000

The Ascaris has been referred to as a bio marker in the establishment of pathogen free faecal sludge since it's the hardiest and most persistent helminthes parasite and thus its elimination would render the sludge safe for disposal or reuse (Jimenez 2007). In this particular research *Ascaris* was found to occur in all depths and even dominated at depths three (2meters) and four (3 meters) respectively. This means that faecal sludge is still infective even at such depths especially with *Ascaris* and thus unsafe upon exposure to human. The fact that the sludge mostly spills on the ground while disludging and that most practitioners don't wear PPEs exposes the public and the practitioners to these harmful parasites. When the contaminated soil is washed through surface run off, it may also contaminate sources of water for domestic use hence enhancing exposure to the various hazards identified.

Significant test using one way analysis of variance at 95% CL

A p-value of 0.049 was established by one way ANOVA and therefore a significant difference in the occurrence of viable *Ascaris* ova versus pit latrine depth. A Post hoc test to establish the exact level of significance (fisher's exact test) found that significant differences exist between the occurrence of viable *Ascaris* ova at the top and occurrences in all the other depths but not between the depths of 1m, 2m and 3m meaning that the top most layer had huge occurrences of viable ova compared to the other depths.

Viable Ascaris ova per gram of faecal sludge versus pit latrine depth

Viable Ascaris ova was found to occur in large numbers at the top and gradually reducing as you go deeper in a pit latrine as shown in the figure below;

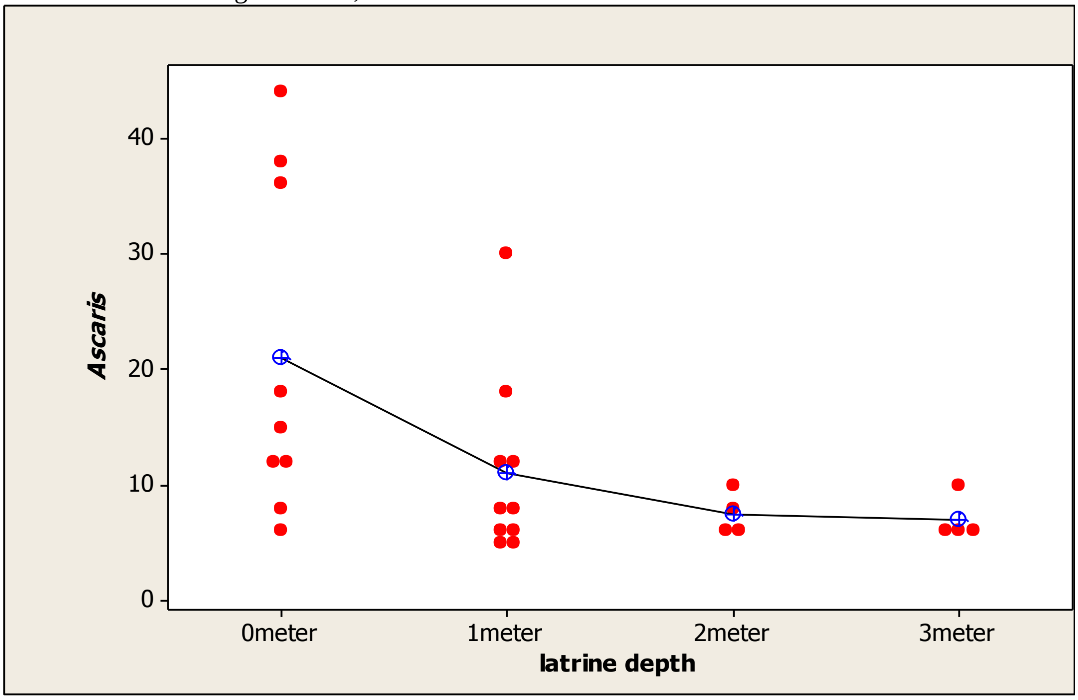


Figure 2: Viable ascaris ova per gram of faecal sludge versus pit latrine depth

The figure above illustrates mean proportions of Ascaris ova identified versus pit latrine depth, most of the ova identified occurred at the top and gradually reducing as you go deeper in depths sampled. Ascaris occurred in all the depths sampled meaning that sludge from such depths was still hazardous upon exposure to the environment and humans.

A significant difference was also found in the occurrence of viable Ascaris ova versus pit latrine depth (F=3.04, ρ= 0.049). The *A. lumbricoides* ova have a thick cell wall that makes them resistant to adverse environmental conditions and therefore a long life span and thus of an interest (Fripp, 2004). The difference occurred between the top layer and all the other depths respectively but not within 1m, 2 m and 3m. This again can be explained by the fact that the faecal samples at the top where deposited recently and therefore a large number of viable Ascaris ova could be present as opposed to the other depths where there has been a retention time and thus gradual die off. These findings are slightly different from the ones reported by Foxon and Still (2012) on the occurrence of viable Ascaris ova in VIP waste at 3 depths in S. Africa where there was no significant difference in the number of viable *Ascaris* ova in regard to pit latrine depth. This could be due to the fact that the depths in Kenya were at intervals of 1 meter while those of S. Africa were at intervals of 0.5 meter and thus not comparable since we took samples far much deeper in a pit latrine and at different intervals.

The figure below shows mean occurrences of various species identified in faecal sludge in pit latrines within Nakuru County;

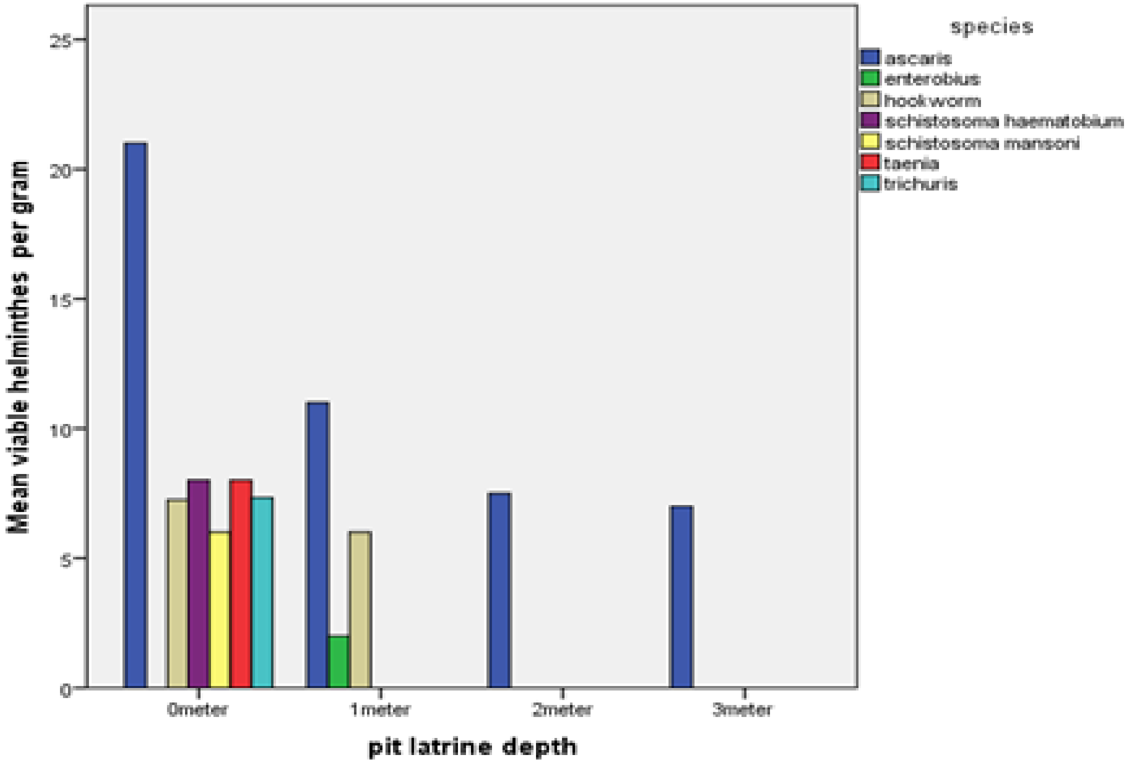


Figure 3: Mean proportions of the occurrence of various helminthes species identified versus pit latrine depth.

As presented, most of the helminthes species identified occurred at the top and one meter respectively while only the *Ascaris lumbricoides*occurred in all the depths from which sludge was sampled. This explains the hardy and persistent nature of the *Ascaris lumbricoides* in the environment and in faecal sludge. The reduction in the concentration of the other parasites as one goes deeper explains their die off rates in regard to time and therefore with enough retention time, faecal sludge can be safe from these parasites as they die off over time. Further research on the actual die offs of this helminthes parasites is recommended to find out the retention time at which pit latrine faecal sludge is safe for disludging and disposal.

IV. Conclusions

1. Majority of the disludging practitioners in Nakuru Sub County use manual disludging methods upon which increased exposure to hazards related to faecal sludge may occur. This includes exposure from contact and inhalation since most of them have been found to not wear the appropriate PPEs at all times when disludging pit latrines.
2. Pit latrine faecal sludge in Nakuru County was found to contain numerous helminthic parasite species which include; *Ascaris lumbricoides, taeniasp, schistosomahaematobium, schistosomamansoni, trichuristrichiura, Necatorsp and Enterobiusvermicularis* which could potentially infect those disludging ,the public and the environment upon exposure due to poor disludging and disposal practices.
3. Viable and infective helminthes parasite ova and of different species were found in large numbers at the top most part of faecal sludge in pit latrines. This therefore was the most dangerous layer upon exposure during disludging and in instances where the pit latrines were literally full and still in use.
4. Viable helminthes ova especially the *Ascaris lumbricoides*was dominantin all pit latrines sampled and across all depths and therefore making faecal sludge at deeper depths still infectious. The fact that mix up may occur while disludging renders faecal sludge equally dangerous upon exposure regardless of the depth from which it is being extracted from and thus proper handling should be ensured while disludging.

References

[1]. Bratton, R. L., &Nesse, R. E. (1993). Ascariasis: An infection to watch for in immigrants. Postgraduate Medicine, 93(1), 171-178.
[2]. Feachem, R., Mara, D. D., & Bradley, D. J. (1983).Sanitation and disease. Washington DC, USA:: John Wiley & Sons.
[3]. Fripp, P. J. (1979). An introduction to human parasitology with reference to southern Africa. Macmillan South Africa Ltd.
[4]. Hawksworth, D., Archer, C., Rajcoomar, K., Buckley, C., &Stenström, T. A. (2010).The effect of temperature and relative humidity on the viability of Ascaris ova in urine diversion waste.cell, 72, 8033491.
[5]. Itchon, G. S., Tan, M. L. B., &Holmer, R. J. (2008). An observational study to determine the length of time necessary to eradicate parasitic ova and pathogenic bacteria in human excreta kept in the storage vaults of urine-diverting dehydration toilets in Cagayan de Oro City: A Preliminary Report. Faculty Working Series, (11).
[6]. Jiménez, B. (2007). Helminth ova control in sludge: A review. Water Science and Technology, 56(9), 147-155.
[7]. Jimenez B, 2007. Helminth ova removal from waste water for agriculture and aquaculture reuse.Water science and technology. 55,485-493.
[8]. Langergraber, G., &Muellegger, E. (2005). Ecological Sanitation—a way to solve global sanitation problems?.Environment international, 31(3), 433-444.
[9]. Murray, C. J., & Lopez, A. D. (1996). Evidence-based health policy--lessons from the Global Burden of Disease Study. Science, 274(5288), 740.
[10]. Navarro, I., Jiménez, B., Lucario, S., &Cifuentes, E. (2009). Application of helminth ova infection dose curve to estimate the risks associated with biosolid application on soil. Journal of Water and Health, 7(1), 31-44.
[11]. Stenström, T. A. (2004). Guidelines on the safe use of urine and faeces in ecological sanitation systems. EcoSanRes Programme.
[12]. De Silva, N. R., Chan, M. S., & Bundy, D. A. P. (1997). Morbidity and mortality due to ascariasis: re-estimation and sensitivity analysis of global numbers at risk. Tropical Medicine & International Health, 2(6), 513-518.
[13]. Still, D. A. (2002, May). After the pit latrine is full… What then? Effective options for pit latrine management.In WISA Biennial Conference (pp. 19-23).
[14]. World Health Organization, & UNICEF.(2013). Progress on sanitation and drinking-water.World Health Organization.
[15]. Warner, D. B. (1998, March).Drinking water supply and environmental sanitation for health.[Unpublished] 1998. Presented at the International Conference on Water and Sustainable Development Paris France March 19-21 1998..
[16]. World Health Organization. (2006). Guidelines for the Safe Use of Wastewater, Excreta and Greywater: Excreta and greywater use in agriculture (Vol. 4). World Health Organization.

Maingi J.M . " The Occurrence of Viable Helminthes Ova in Pit Latrine Faecal Sludge In Nakuru Sub County, Kenya" IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) 12.11 (2018): 31-38.