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Physicochemical Parameters and Abundance of Pathogenic Protozoans and Helminths in Abattoirs within Minna Metropolis, Niger State, Nigeria

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ABSTRACT: Protozoans and helminthes are parasites. Protozoans are single-celled organisms, while helminthes are multicellular animals. These parasites feed off on other living organisms and cause diseases. The objective of this paper therefore was to investigate the physicochemical parameters and abundance of pathogenic protozoans and helminths in abattoirs within Minna Metropolis, Niger State, Nigeria using appropriate standard techniques.The parasites identified in the abattoirs wastewater samples in the three study locations were: *Entamoeba histolytica, Giardia lamblia, Ascaris lumbricoides, Trichuris trichiuria,* Hookworm, *Hymenolepis nana, Schistosoma mansoni, Strongyloides stercoralis, Toxocara vitulorum,* and *Fasciola hepatica*. With Hookworm having the highest occurrence in Chanchaga wastewater with 20.7%, Tayi wastewater 21.2% and in Maikunkele 19.3%. Similar organisms were also observed to be present in the soil samples of the three study locations. Chanchaga with *Schistosoma Mansoni* having the highest occurrence of 25.4%, Tayi had high occurrence of *Strongyloides stercoralis* with 29.4%, and Maikunkele had high occurrence of Hookworm with 19.8%. The physicochemical parameters evaluated in the study areas shows that the colour and odour were different from the control with high level of clay, sand, Total Organic Carbon, Magnesium, Salinity, Nitrate and Sulphate in samples than the control ($p<0.05$),but in Maikunkele abattoir, Electricity Conductivity, Chloride, Phosphate, Sulphate were higher in the control than the samples. Therefore, conducting educational campaigns and raising awareness among the local population about the risks associated with contaminated water and soil in abattoirs is essential. Providing information on proper hygiene practices, including hand-washing and safe food preparation, can help prevent the ingestion of parasite eggs or cysts and minimize the spread of infections.

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Parasites related to human gastrointestinal tracts are major causes of health concerns in many nations especially in the developing world. These can be categorized into two groups; protozoa and helminths. The most common are Soil-Transmitted Helminthes (STH) which include; *Ascaris lumbricoides*, hookworms *(Ancylostoma duodenale* and *Necator americanus)*, *Trichuris trichiura, Strongyloides stercoralis* and *Enterobius vermicularis* (Hatam nahavandi *et al.,* 2023). The helminthes are multicellular organisms that are associated with depletion of nutrient of the host for their own nutrition.They are so called because humans become infected through contact with soil that has become contaminated with parasites through poor human behavior of excrete disposal. Protozoans are

unicellular parasites that are associated with damage of intestinal mucosa resulting in mal-absorption of nutrients leading to diarrhoea and dysentery.The most common pathogenic protozoans are *Giardia lamblia*, *Entamoeba histolytica*, *Balantidium coli*, and *Cryptosporidium* (Mahmud *et al*., 2017). Protozoans are mainly transmitted to human through protozoa-contaminated and insufficiently prepared food and water.There are many other non-pathogenic protozoa that are found in intestinal canal whose presence indicates faecal-oral contamination in poor sanitary environment and poor hygiene practices.Other protozoans such as *Cryptosporidium* spp. and *Isopora* spp. are becoming important in causing prolonged diarrhoea in immuno-compromised patients. It is estimated that between 500 million and 1 billon people worldwide are infected by nematode species such as *Ascaris lumbricoides*, *Trichuris trichiura* and hookworms (Mahmud *et al*., 2017). Hence, the objective of this paper was to investigate the physicochemical parameters and abundance of pathogenic protozoans and helminthes in abattoirs within Minna metropolis, Niger State, Nigeria.

MATERIALS AND METHODS

Study Area: This study was carried out in abattoirs located in Minna, the capital city of Niger State which is located in the North Central region of Nigeria, Latitude: 9.62. Longitude: 6.55 with an estimated population of 479 ,000 in 2022 (United nations world population prospect). It comprises of various ethnic groups such as Nupe, Gwari, Hausa, Igbo, Yoruba and Fulanis. Their occupation ranges from peasant farmers, traders, civil servants etc.

Sample Collection: The study was carried out between the periods of January to June of 2022, January to April in Niger State is a dry season and from the month of May to June we have little occational rainfall. A total number of 200 effluent and soil samples were collected randomly from different Abbatoirs in Minna, Niger State.50 samples of each were collected at random positions from each of the three abattoirs,(Chanchaga, Tayi, Maikunkele),Soil samples were kept in a sterile polythene bag. The effluents were collected in a thoroughly washed and sterile 5 litres plastic container (30litres from Tayi abattoir, 10 from Chanchaga and Maikunkele abattoirs) and the samples were taken in an ice box to Microbiology Laboratory, Federal University of Technology Minna, Niger State, for analysis within 6 hours of collection. Samples werepreserved by refrigeration at 4°C without any preliminary treatment. Wastewater samples for Chemical Oxygen Demand (COD) and Total Nitrogen (TN) tests werepreserved by using sulphuric acid at pH of 2; those for parasitological analysis preserved by using 10 % formaldehyde

Examination of Wet Preparation: A drop of suspended sediment in saline was placed on the center of clean grease-free slide and covered with a cover slip. The preparation then examined using x10 and x40 objectives lenses of the microscope with the iris diaphragm closed and condenser lowered.

Iodine Preparation: Iodine mount was prepared by the addition of a drop of iodine to a drop of the deposit placed on a clean grease free slide. The preparation then covered with cover slip and examined using x10 and x40 objectives lenses of the microscope, with the iris diaphragm closed and condenser covered.

Formol Ether Concentration Technique: Seven mLs of formol ether was added into screw cap bottle. One gram of well-mixed Sample emulsified into the tube and filtered by passing through a wet gauze into a centrifuge tube. Three mLs of diethyl ether was centrifuged at 3000rpm for 1minute. The debris layer was loosened using an applicator stick and the whole supernatant discarded into disinfectant jar. The deposit was loosened by tapping the tube between the fingers and a drop of the sediment was placed on the centre of a clean grease free glass slide and a cover slip applied gently to avoid air bubbles and over flooding. The preparation was examined with x10 and x40 objectives.

Modified Ziehl Neelsen (ZN) Method: A smear was prepared from the sediment obtained by the formol-ether concentration technique. The smear was allowed to air-dry. The smear was fixed with methanol for 3 minutes; the smear then stained with unheated carbol-fuchsin for 15minutes. The smear then washed off with water and decolourised with 1% acid alcohol for 10 seconds. The smear was washed, counterstained with 0.5% methylene blue for 30 seconds. The smear was washed off with water and the slide allowed to air-dry. The smear was examined microscopically for oocysts using X10 and X40.

Determination of Physicochemical Properties of Abattoir Effluent Sample: pH: The pH of the samples was determined by dipping a pH tester (Unicam 9450, Orion Model No 91.20 PH) into the sample in a 250 mL conical flask and allowed to equilibrate for 3 minutes. The pH meter read and recorded accordingly. *Electrical conductivity (EC):* The electrical conductivity was determined using Lenore et al. (2005) method. The conductivity and temperature probe wasplugged in to the unit. The metre calibrated according to the manufacturer's specification for the

equipment. The display set to read 0C and µS/cm respectively by the use of MODE keypad. The probe immersed in to the textile effluent and the electrical conductance in micro second per centimetre (µS/cm) recorded.

Temperature: The temperature of the effluent was determined on the field by lowering a mercury thermometer into the sample and allowed to equilibrate for four minutes and the reading was taken to the nearest degree Celsius (0C) (USEPA, 1998).

Total Suspended Solid (TSS): Hundred milliliters (100 mL) of the sample of effluent was taken into a conical flask with a pipette. It was filtered in funnel fitted with glass fibre which has been pre-dried at 103 - 1050C and weighed. The glass was fibre carefully removed from the funnel and dried to a constant weight at 103-1050C and the weight subtracted from the weight of the filter paper to obtain the weight of the suspended solids (APHA, 2005).

Total Solids (TS): A crucible petri dish was dried at 102 – 105^0C in an oven to a constant weight. One hundred millilitres (100 mL) of thoroughly mixed effluent was then accurately pipetted into a crucible petri dish, weighed and evaporated to dryness on a steam bath. The residue dried in an oven for 1h at 103 - 105^0C and re-weighed after cooling to 28^0C±3. The cooling was done until the weight of the dish plus residue remains constant to within 0.05 mg. The weight of the dish thensubtractedto obtain the weight of the total solids (APHA, 2005).

Chemical Oxygen Demand (COD): Fifty (50 mL) of the effluent sample was taken into a refluxing flask and several boiling stones added. Then 0.1 g mercury sulphate ($HgSO_4$) added to the solution and 5 mL of concentrated $H_2SO_4$was also added to the solution. To ensure that $HgSO_4$ dissolved completely, the solution was swirled slowly while adding Sulphuric acid, then 0.1g of$2SO_4$was added to this solution and finally Potassium dichromate was added. Thorough mixing of the solution was ensured by swirling the flask in a water bath to prevent any volatile substances that may have escaped from the liquid state. The flask then attached to a condenser and further cooling carried out and 20 mL of sulphuric acid added to the solution in the flask continuing cooling and swirling to mix the solution. The solution was refluxed for 1 hour. A blank run (using 50 mL distilled water instead of sample) was simultaneously conducted with the same procedure after cooling; the solution then transferred to an Erlenmeyer flask. The reflux flask was rinsed thrice, pouring the rinsing water to the Erlenmeyer flask. The solution was then diluted to 300 mL, 8 drops of phenanthroline ferrous sulphate was then added to the solution as an indicator. The solution was titrated against the Mohr's salt. The titre volume required for the colour change from blue-green to reddish blue was noted. The procedure then repeated for the blank run.

The formula below wasused to calculate COD (APHA, 2005)

$$\text{COD} = \frac{8000 \times (\text{Vbl} - \text{Vs})m}{\text{original volume of sample taken in mg/l}}$$

Where, Vbl = Titre volume for the blank; Vs = Titre volume for the sample; m = Molarity of Mohr's solution.

Determination of Biochemical Oxygen Demand (BOD): Biochemical Oxygen Demand (BOD-5) was determined using dissolved oxygen (DO) HI9146 (Winkler) method of DO determination, Microprocessor Dissolved Oxygen Meter. The amount of sample to be analysed was be measured, clean calibrated thermometer placed into the sample; temperature stabilized at 20°C ±1°C in the refrigerator. DO meter was turned on for 30-60 minutes. After aeration, 1 ml each of the potassium phosphate, magnesium sulphate, calcium chloride, was diluted according to manufacturer's instruction. Dilution was placed at constant temperature to maintain the initial temperature until sample dilutions for analyses began. The initial and final (after 5 days ± 4 hours) DO concentration measured as (D1) of each sample. Temperature checked using air incubator with laboratory thermometer to ensure that the temperature was maintained. At the end of 5 days ± 4 hours, BOD bottle removed from incubator. The sample poured off the water seal and ground-glass stopper. The final DO concentration (D2) was then measured.

The formula below was used to calculate BOD (APHA, 2005):

$$\text{BOD}_5(mg/l) = \frac{D1 - D2}{P}$$

Where, D1= DO diluted sample immediately after preparation (in mg/L); D2= DO diluted sample after 5 day of incubation at 20°C ±1 (in mg/L); P= decimal volumetric fraction of sample used.

Dissolved Oxygen (DO): The dissolved oxygen was determined using Winkler's method (APHA, 2005), A 250 ml stopper bottle immersed beneath the water surface, the stopperwas not removed until the bottle was filled and then the stopper was tightly sealed under the water to exclude air bubbles. The dissolved oxygen then fixed by adding 1 ml of winklers solution A (Manganese (II) sulphate) followed by 1 mL of

solution B (Potassium iodide). After winkler's solution A and B was added to the water, the stoppered bottle was inverted several times to mix the sample and the reagents. The potassium iodide in solution B reacts with Manganese in solution A to form a brown precipitate of Manganase iodide. The precipitate is allowed to settle completely for 15 minutes, the precipitate settle in the lower half of the bottle leaving clear solution above. The precipitate was then dissolved with 1 mL of concentrated tetraoxosulphate (VI) acid (H_2SO_4). 100mL of the treated water sample was titrated against 0.025N Sodium thiosulphate solution (Na2S2O3) to a pale yellow colour. At this point 2 drops of starch indicator were added and swirled to mix, the titration was continued until the colour changed from blue black to colourless. The volume of the sodium thiosulphate used was recorded.

$$\mathrm{DO} = \frac{V_{(D)} \times N_{(D)} \times 1000}{Volume\ of\ sample\ (ml)}$$

Where; DO = dissolved oxygen; V (D) = Volume of Na2S2O3 used in titration; N (D) = Normality of the titrants; Results expressed in mg/L

Chloride: The Chloride (Cl-) was determined by Mohr's titration. Twenty millilitre of sample placed in a conical flask and pH adjusted to between 6 - 8 with small amount of (0.1M) calcium carbonate solution. One millilitre of potassium chromate solution prepared by dissolving 50 g of potassium chromate in a minimum of distilled water added and the solution titrated with (0.0141 M) silver nitrate solution with constant stirring (APHA, 2005).

Nitrate (phenol disulphonic acid method): Twenty-five milliliter (25 mL) of the effluent sample was taken into a porcelain basin and evaporate it to dryness on a hot water bath. 0.5 mL of phenol disulphonic acid added to the residue and dissolved the latter with the help of a glass spatula. 5ml of distilled water and 1.5mL of potassium hydroxide solution was added and the mixture thorough mixed. The yellow coloured supernatant absorbance read on a spectrophotometer at 410 nm, distilled water used as a blank. A standard nitrate solution of the range of 0.0 – 1.0 mg/L NO^{-3} was prepared and the absorbance recorded for each. A standard curve between absorbance (S) and concentrations of various nitrate solutions was plotted and the value of nitrate in the effluent sample deduced. The result recorded in mg NO^{-3} N/L.

Sulphates (turbidimetric method): The effluent sample was filtered through filter paper (whatman No.1) and 50 mL of filtrate transferred into an Erlenmeyer flask. 10ml of NaCl_HCl solution, 10 mL of glycerol ethanol solution, and 0.15 g of Barium chloride (reagent C) added to the filtrate and stirred with the help of a magnetic stirrer for about an hour. The absorbance (S) against a distilled water blank at 420 nm was measured using spectrophotometer. A standard solutions of different strength (reagent D) (0.0 – 40.0) was prepared in similar way and then record the absorbance for each taken. A standard graph plotted from these values putting strengths (mg/L) on one axis and absorbance on the other. The sulphate content of the sample deduced by comparing the absorbance of samples (S) with standard curve.

Total Phosphorous: Twenty-five milliliter of the effluent sample was taken into an Erlenmeyer flask and evaporated to dryness, the residue allowed to cool and dissolved in 1mL of per chloric acid, the flask gently heated until the contents becomes colourless. 10 mL of distilled water and 2 drops of phenolphthalein indicator added to the cooled colourless content. The mixture titrated against NaOH solution until the appearance of slight pink colour and distilled water added to make up the volume to 25 mL. Additional 1mL of ammonium molybdate solution and 3 drops of stannous chloride solution was added, a blue colour appears. The mixture then allowed to stay for about 10 minutes while the absorbance would be taken on a spectrophotometer (UV-Visible spectrophotometer) at 690 nm. A standard phosphorous solution of the range of 0.0 – 1.0 mg/L NO^{-3} prepared and the absorbance recorded for each. A standard curve between absorbance (S) and concentrations of various phosphorous solutions plotted and the value of phosphorous in the effluent sample deduced. The total phosphorous in mg /L is recorded.

Determination of Physicochemical Properties of Abattoir Soil Sample: Total Organic Carbon: Total organic carbon was analyzed by placing approximately 0.350 g of dried, ground and homogenized sample into a clean, carbon-free combustion boat. Each sample boat treated with phosphoric acid drop by drop until the sample stops "bubbling" and the sample is completely moist with acid. The sample is placed into an oven set at 40°C for24 hours and then transferred to an oven set at 105°C. Once the sample got dry, the boat was placed on the auto sampler rack assembly and loaded onto the LECO carbon analyzer.

Note: All reagents used were verified to be contaminant free. All equipment and glassware usedto analyze samples was verified to be carbon-free or are combusted at 400°C for a minimum of 4 hours. The calibration and accuracy of balances, weights, pipettors and thermometers were checked daily.

Determination of Clay/Silt/Sand Content: Using a measuring cup 1/2 cup of soil sample was placed in the jar. And 1.5 cups of distilled water was added, covered and shaken for 5minutes and left the jar on the desk ,allowed it to settle for 24 hours. After 24 hours, the depth of the settled soil using the metric system was measured. All soil particles had settled. This is known as the TOTAL DEPTH. It was recorded and labeled as the total depth of soil. The jar was shaken for another 5 minutes. Allowed to stand 30seconds. This enables the sand to settle. Measured the depth of the settled soil using the metric system, and recorded as SAND DEPTH. Didn't shake the jar again. Left to stand for another 30 minutes. Measured the depth by subtracting the sand depth to determine the SILT DEPTH. Recorded and labeled the data. Shaken the jar for another 5minutes. After three hours, the remaining unsettled particles were clay. Calculated the CLAY DEPTH by subtracting the silt and sand depth from total depth. Then calculated the percentage of each soil texture using these formulas:

Sand Depth

$$\%\, Sand = \frac{sand\ depth}{total\ dept} * 100$$

Silt Depth

$$\%\, Silt = \frac{silt\ depth}{total\ dept} * 100$$

Clay Depth

$$\%\ \text{Clay} = \frac{clay\ depth}{total\ dept} * 100$$

Determination of Magnesium: Took 25 mL of sample in 100 mL of conical flask and diluted the content by adding about 25 mL of distilled water. Added 4 mL of NH4Cl + NH4OH buffer (see note). Warmed it to about 60^{o}c. Added a pinch of EBT indicator and titrated with 0.01 N EDTA to a pure turquoise blue without any traces of red. This titer value was considered as "A". Before carrying out a batch of determinations, I titrated 20 mL 0.01N magnesium chloride with 0.01N EDTA in order to check the EDTA concentration and provided a pure blue standard for use in the subsequent titration.

Determination of Chloride: Transferred 25 mL of water sample to a 150 mL of conical flask. Added 0.01N H2SO4 with methyl orange to neutralize the amount of carbonate and bicarbonate and provided 1 mL in excess. Added 5-6 drops of potassium chromate indicator making it dark yellow. Titrated the contents against 0.02N AgNO3 solution with continuous stirring till the first brick red tinge appears. Notedthe volume of the AgNO3 required (mL.) Ran a blank of 25 mL of distilled water and subtract from the titer value to avoid error due to any impurity of chemicals. Determined the normality of AgNO3 by standardizing it against NaCl solution.

Determination of Phosphate: A 2.5-gram sample of air-dried soil was placed in a 125-milliliter Erlenmeyer flask. Fifty milliliters of the phosphorus extracting solution was added to the soil sample. The soil sample and extracting solution were agitated for 15 minutes on an automatic shaking machine. The soil suspension was filtered through Whatman No. 12 folded paper, and the extract was collected in a 50-milliliter Erlenmeyer flask. A 3-milliliter aliquot of the solution extract was transferred to a 125-milliliter Erlenmeyer flask. Thirty-seven milliliters of distilled water and 10 milliliters of the ammonium molybdate-sulphuric acid-boric acid solution were added to the 3-milliliter aliquot. Seven phosphorus standard reference solutions containing 0.0, 0.1, 0.2, 0.4, 0.6, 0.8, and 1.0 part per million were prepared by measuring 0, 1, 2, 4, 6, 8, and 10 milliliters of a solution containing 5 parts per millions of phosphorus and transferring these to 50-milliliter volumetric flasks. Twenty milliliters of distilled water, 3 milliliters of the phosphorus extracting solution, and 10 milliliters of the ammonium molybdate-sulphuric acid-boric acid solution was added to each of the seven phosphorus standard solutions. The standards were diluted to a volume of 50 milliliters with distilled water. Three drops of the stannous chloride solution were added to the phosphorus standards and to the aliquot of the soil solution extract. Ten minutes was allowed after the addition of the stannous chloride for complete chemical reaction which results in maximum color development. The optical density of the phosphorus solution was recorded by means of a Spectrophotometer. A red filter and a wave length of 650 mill microns used to measure the phosphorus concentration in the phosphorus standard reference solutions and in the soil solution extract. The amount of phosphorus present in the soil solution extract was determined by reference to a calibration curve obtained by plotting the optical density readings against the phosphorus concentration in the seven standard reference solutions.

Determination of salinity: 50-gram sample of soil was placed in a 250-milliliter Erlenmeyer flask. One hundred and twenty-five milliliters of distilled water were also added, and the soil and water suspension was agitated for 30 minutes on a mechanical shaking machine. The suspension was allowed to stand overnight and filtered through a Pasteur-Chamberlain filter. A 50-milliliter aliquot of the filtrate was placed in a porcelain or platinum evaporating dish that has

been previously heated, cooled in a desiccator, and weighed. The evaporating dish containing the filtrate was placed in an oven and allowed to dry. The residue was then ignited with a Fisher Burner at a very low heat to remove the organic matter. The evaporating dish containing the soluble salts was cooled and placed in a desiccator and weighed. The difference between the weight of the dish and the weight of the dish plus the ignited residue was then the weight of the salts that has been extracted from 20 grams of soil.

Determination of pH: Approximately 35 grams of air-dried soil were placed into a 4i4-ounce paper cup and 35 milliliters of distilled water was added with a filamatic vial filler. The force of delivery is sufficient to thoroughly mix the soil and water. After 24 hours the suspension was agitated with an electric stirrer and the soil reaction (pH) was determined by inserting the electrodes into the suspension. A Leeds and Northrup No. 7401 pH-meter lias proved to be very satisfactory for soil analysis. The pH-meter was standardized by using buffer solutions adjusted to pH 4.0 and pH 7.0.

RESULTS AND DISCUSSION

Occurrence of Protozoan and Helminthes in wastewater samples for chanchaga Abattoir: Table 1 show the occurrence of protozoan and helminths in abattoir wastewater in Chanchaga. It was observed that both protozoans and helminthes were present in all the abattoir waste water. The organisms observed in the waste water samples.include: *Entamoeba histolytica, Giardia lamblia, Ascaris lumbricoides, Trichuris trichiura,* Hookworm, *Hymenolepis nana, Schistosoma mansoni, Strongyloides stercoralis, Toxocara vitulorum,* and *Fasciola hepatica*.

Table 1: Occurrence of Protozoan and Helminthes in abattoir water in Chanchaga abattoir

Samples	Wet Preparation		Iodine Preparation	Formol Ether	Ziehl Neilsen Method	Name Of Organism	Structure Observed
	X10	X40					
MPW1	+	+	_	_	++	*Entamoeba histolytica*	Ova
MPW2	+	+	++	+	+	*Giardia lamblia*	Ova
MPW3	+	+	+	+	_	*Ascaris lumbricoides*	Ova
MPW4	+	+	+	++	+	*Trichuris trichiura*	Ova
MPW5	+	+	-	++	+	Hookworm	Ova
MPW6	+	+	_	+	_	*Hymenolepis nana*	Ova
MPW7	_	+	+	+	+	*Schistosoma mansoni*	Larvae
MPW8	+	++	++	+	_	*Strongyloides stercoralis*	Larvae
MPW9	_	+	+	_	+	*Toxocara vitulorum*	Larvae
MPW10	+	++	+	++	+	*Fasciola hepatica*	Larvae

KEY: ++: good diagnostic value, +: low sensitivity, -: limited or no diagnostic value. MPW1-10= water samples.

Occurrence of Protozoans and Helminthes in wastewater samples for Tayi Abattoir: It was observed that both protozoans and helminthes were present in all the abattoir wastewater. The organisms observed in the waste water samples.include: *Entamoeba histolytica, Giardia lamblia, Ascaris lumbricoides, Trichuris trichiura,* Hookworm, *Hymenolepis nana, Schistosoma mansoni, Strongyloides stercoralis,* and *Toxocara vitulorum,*with*Giardia lamblia* having more occurence.

Table 2: Occurrence of Protozoan and Helminthes in abattoir water in Tayi abattoir

Samples	Wet Preparation		Iodine Preparation	Formol Ether	Ziehl Neilsen Method	Name Of Organism	Structure Observed
	X10	X40					
MPW1	+	+	+	+	++	*Entamoeba histolytica*	Cysts/ trophozoites
MPW2	+	+	+	_	+	*Giardia lamblia*	Cysts
MPW3	+	+	+	_	+	*Ascaris lumbricoides*	Ova
MPW4	+	+	+	+	+	*Trichuris trichiura*	Ova
MPW5	+	+	-	++	+	Hookworm	Ova
MPW6	+	+	_	+	+	*Hymenolepis nana*	Ova
MPW7	_	+	+	+	+	*Schistosoma mansoni*	Larvae
MPW8	+	++	+	+	_	*Strongyloides stercoralis*	Larvae
MPW9	_	+	+	_	+	*Toxocara vitulorum*	Larvae
MPW10	+	++	_	+	+	*Giardia lamblia*	Ova

KEY: ++: good diagnostic value, +: low sensitivity, -: limited or no diagnostic value. MPW1-10= water samples

Occurrence of Protozoans and Helminths in wastewater samples from Maikunkele Abattoir: Here both protozoans and helminthis were present in all the abattoir wastewater. The organisms observed in the wastewater samples.include: *Entamoeba histolytica, Giardia lamblia, Ascaris lumbricoides, Trichuris trichiura,* Hookworm, *Hymenolepis nana, Schistosomamansoni, Strongyloides stercoralis, Toxocara vitulorum,* and *Fasciola hepatica*.

Table 3: Occurrence of Protozoan and Helminthes in abattoir water in Maikunkele abattoir

Samples	Wet Preparation		Iodine Preparation	Formol Ether	Ziehl Neilsen Method	Name Of Organism	Structure Observed
	X10	X40					
MPW1	+	+	_	_	+	*Entamoeba histolytica*	Cysts/ trophozoites
MPW2	+	+	++	+	+	*Giardia lamblia*	Cysts
MPW3	+	+	+	+	_	*Ascaris lumbricoides*	Ova
MPW4	+	+	+	++	+	*Trichuris trichiura*	Ova
MPW5	+	+	-	+	+	Hookworm	Ova
MPW6	+	+	_	+	_	*Hymenolepis nana*	Ova
MPW7	_	+	+	+	+	*Schistosoma mansoni*	larvae
MPW8	+	++	+	+	_	*Strongyloides stercoralis*	Larvae
MPW9	_	+	+	_	+	*Toxocara vitulorum*	Larvae
MPW10	+	++	+	++	+	*Fasciola hepatica*	Larvae

KEY: ++: good diagnostic value, +: low sensitivity, -: limited or no diagnostic value. MPW1-10= water samples.

Occurrence of protozoan and helminths in Chanchaga abattoir soil: Similar organisms (*Entamoeba histolytica, Giardia lamblia, Ascaris lumbricoides, Trichuris trichiura,* Hookworm, *Hymenolepis nana, Schistosoma mansoni, Strongyloides stercoralis, Toxocara vitulorum*) were also observed to be present in the soil samples as shown in table 4, with *Schistososma mansoni* having more occurrence.

Occurrence of Protozoans and Helminths in Tayi Abattoir soil: In Tayi Abattoir,*Giardia lamblia, Ascaris lumbricoides, Trichuris trichiura,* Hookworm, *Hymenolepis nana, Schistosoma mansoni, Strongyloides stercoralis,* and *Toxocara vitulorum,*) were also observed to be present in the soil samples as shown in table 5,*Giardia lamlia* occurred more here.

Occurrence of Protozoans and Helminths in Maikunkele Abattoir Soil: In Table 6, *Giardia lamblia, Ascaris lumbricoides, Trichuris trichiura,* Hookworm, *Hymenolepis nana, Schistosoma mansoni, Strongyloides stercoralis,* and *Toxocara vitulorum,Entamoeba histolytica,Fasciola hapatica* were also observed to be present in the soil samples.

Table 4: Occurrence of protozoan and helminthes in abattoir soil in chanchaga abattoir

Samples	Wet Preparation		Iodine Preparation	Formol Ether	Ziehl Neilsen Method	Name Of Organism	Structure Observed
	X10	X40					
MPS1	_	+	+	_	+	*Entamoeba histolytica*	Cysts/ trophozoites
MPS2	+	+	++	+	+	*Giardia lamblia*	Cysts
MPS3	+	+	+	+	++	*Ascaris lumbricoides*	Ova
MPS4	+	+	+	++	+	*Trichuris trichiura*	Ova
MPS5	_	+	+	++	+	Hookworm	Ova
MPS6	+	+	_	+	_	*Hymenolepis nana*	Ova
MPS7	_		+	+	+	*Schistosoma mansoni*	Larvae
MPS8	+	++	++	+	_	*Strongyloides stercoralis*	Larvae
MPS9	_	+	+	++	+	*Toxocara vitulorum*	Larvae
MPS10	+	+	+	++	+	*Schistosoma mansoni*	Larvae

KEY: ++: good diagnostic value, +: low sensitivity, -: limited or no diagnostic value. MPS1-10= soil sample.

Table 5: Occurrence of protozoan and helminthes in Tayi abattoir soil

Samples	Wet Preparation		Iodine Preparation	Formol Ether	Ziehl Neilsen Method	Name Of Organism	Structure Observed
	X10	X40					
MPS1	_	+	+	_	_	*Strongyloides stercoralis*	Larvae
MPS2	+	+	++	+	+	*Giardia lamblia*	Cyst
MPS3	+	+	+	+	+	*Ascaris lumbricoides*	Ova
MPS4	+	+	+	++	+	*Trichuris trichiura*	Ova
MPS5	_	+	+	++	+	Hookworm	Ova
MPS6	+	+	_	+	_	*Hymenolepis nana*	Ova
MPS7	_		+	+	+	*Schistosoma mansoni*	Larvae
MPS8	+	++	++	+	_	*Strongyloides stercoralis*	Larvae
MPS9	_	+	+	_	+	*Toxocara vitulorum*	Larvae
MPS10	+	+	+	+	+	*Giardia lamblia*	Cyst

KEY: ++: good diagnostic value, +: low sensitivity, -: limited or no diagnostic value. MPS1-10= soil samples

Table 6: Occurrence of protozoan and helminths in abattoir soil in Maikunkele abattoir

Samples	Wet Preparation		Iodine Preparation	Formol Ether	Ziehl Neilsen Method	Name Of Organism	Structure Observed
	X10	X40					
MPS1	_	+	+	_	+	*Hymenolepis nana*	Ova
MPS2	+	+	++	+	+	*Giardia lamblia*	Cysts
MPS3	+	+	_	+	++	*Ascaris lumbricoides*	Ova
MPS4	+	+	+	_	+	*Trichuris trichiura*	Ova
MPS5	_	+	+	++	+	Hookworm	Ova
MPS6	+	+	_	+	_	*Entamoeba histolytica*	Cyst
MPS7	_		+	+	+	*Schistosoma mansoni*	Larvae
MPS8	+	++	+	+	_	*Strongyloides stercoralis*	Larvae
MPS9	_	+	+	++	+	*Toxocara vitulorum*	Larvae
MPS10	+	+	+	+	+	*Fasciola hepatica*	Larvae

KEY: ++: good diagnostic value, +: low sensitivity, -: limited or no diagnostic value. MPS1-10= soil samples

Physicochemical Parameters of Abattoir Wastewater Chanchaga: Table 7 shows the physicochemical parameters of abattoir water samples in Chanchaga local government area. It was observed that the no significant difference ($p > 0.05$) in temperature of S1, S2, S3, and control. However, pH of the three samples were significantly different ($p < 0.05$) from that of the control whereas no significant difference was observed among the samples. The colour and odour of the samples were observed to be the same (light brown with offensive odour) and different from the control (dark brown with not specified odour). The turbidity and COD, TSS, DO, chloride, and sulphate of the three samples were significantly higher than control. Conversely, the TDS, BOD, nitrate, and phosphate of the samples were significantly lower ($p < 0.05$) than that of the control. No significant difference was observed in the EC of the samples and the control except for S3 that recorded lowest value.

Physiochemical Parameters of Abattoir Wastewater Samples Tayi: Table 8 shows the physicochemical parameters of abattoir water samples in Tayi, Similarly, no significant differences were observed temperature of the samples and the control, and the samples had the same colour and odour different from the control. Also, the turbidity, TSS, COD, DO, chloride and sulphate levels were higher in the samples than the control. Further, the EC of the samples showed no significant difference from the control except for S3. The control recorded higher levels of TDS, BOD, and phosphate than the samples as observed in chanchaga LGA. Contrarily, no significant differences were observed among the samples and the control in nitrate levels.

Physicochemical parameters of abattoir wastewater samples in Maikunkele: Here in Table 9, it was observed here that no significant differences ($p > 0.05$) were observed in the temperature and pH levels among the samples and control. Further, the turbidity, TSS, COD, EC, DO, nitrate, and sulphate levels of the samples were significantly higher ($p < 0.05$) than the control while the TDS, chloride, and phosphate levels of the control were observed to be significantly higher than the samples'.

Table 7: Physicochemical parameters of the Abattoir wastewater samples in Chanchaga

Parameter	**S1**	**S2**	**S3**	**Control**	**FME/WHO**
Temp ºC	29.12±2.32^a	26.20±1.89^a	27.21±1.76^a	28.40±1.62^a	Ambient
pH	7.70±0.30^b	7.50±0.30^b	7.90±0.20^b	6.90±0.20^a	6.8-8.5
Colour	Light brown	Light brown	Light brown	Dark brown	NS
Odour	Offensive	Offensive	Offensive	NS	NS
Turbidity (NTU)	7.45±0.25^b	7.23±0.30^b	8.20±0.21^c	5.8±0.34^a	5-25
TDS (mg/L)	46.27±1.10^b	40.30±2.31^a	41.22±1.98^a	400.00±3.48^c	500
TSS (mg/L)	900.00±5.86^b	1280.00±4.39^c	1850.00±6.17^d	680.00±7.12^a	500-1500
BOD (mg/L)	65.40±2.39^b	58.20±2.61^a	69.00±3.20^b	75.18±1.98^c	NS
COD (mg/L)	947.00±8.32^d	824.00±5.96^b	860.00±5.12^c	120.00±8.17^a	100
EC (µS/cm)	112.24±5.46^b	111.16±3.28^b	92.70±2.19^a	106.50±4.12^b	100
DO mg/l	13.89±0.64^b	13.23±0.87^b	13.50±0.42^b	4.82±0.89^a	100
Chloride (mg/L)	8.13±0.76^a	9.62±0.54^b	9.90±0.40^b	8.50±0.42^a	250
Nitrate (mg/L)	2.24±0.00^a	3.36±0.04^b	3.81±0.02^c	5.00±0.21^d	50
Sulphate (mg/L)	27.33±1.23^b	26.00±0.98^b	30.00±1.03^c	20.00±0.34^a	100
Phosphate (mg/L)	2.30±0.03^a	3.64±0.02^c	2.80±0.05^b	35.0±2.14^d	50-100

Values are presented as mean ± standard deviation of three replicates. Values with different superscripts in a row are significantly different at $p < 0.05$.

Key: *NS = not specified; WHO = world health organization; FME = Federal ministry of environment; TDS = total dissolved solids; TSS = total suspended solids; BOD = biological oxygen demand; COD = chemical oxygen demand: EC =Electrical Conductivity; DO = Dissolve Oxygen.*

Table 8: Physicochemical parameters of the Abattoir wastewater samples in Tayi abattoir

Parameter	S1	S2	S3	Control	FME/WHO
Temp ºC	27.10±2.19^{a}	25.20±1.96^{a}	27.21±2.13^{a}	28.45±2.15^{a}	Ambient
pH	7.70±0.30^{b}	7.50±0.20^{b}	7.90±0.10^{b}	6.90±0.20^{a}	6.8-8.5
Colour	Light brown	Light brown	Light brown	Dark brown	NS
Odour	Offensive	Offensive	Offensive	NS	NS
Turbidity (NTU)	7.49±0.34^{b}	7.40±0.28^{b}	7.20±0.30^{b}	5.80±0.20^{a}	5-25
TDS (mg/L)	46.27±3.21^{a}	47.20±2.38^{a}	49.22±2.76^{a}	400.00±4.58^{b}	500
TSS (mg/L)	700.00±4.39^{b}	1250.00±3.49^{c}	1358.00±10.21^{d}	680.00±6.47^{a}	500-1500
BOD (mg/L)	60.40±2.37^{a}	56.20±2.18^{a}	60.00±2.68^{a}	75.18±2.81^{b}	NS
COD (mg/L)	840.00±5.39^{c}	834.00±2.77^{bc}	830.00±1.68^{b}	120.00±3.29^{a}	100
EC (µS/cm)	111.26±2.18^{c}	111.16±1.26^{c}	100.70±2.20^{a}	106.50±2.18^{b}	100
DO mg/l	13.30±2.20^{b}	13.23±1.78^{b}	13.40±1.31^{b}	4.82±0.98^{a}	100
Chloride (mg/L)	8.13±0.89^{a}	8.62±0.84^{a}	9.00±1.34^{a}	8.50±0.67^{a}	250
Nitrate (mg/L)	3.24±0.23^{a}	3.36±0.21^{a}	3.81±0.34^{a}	5.00±0.26^{a}	50
Sulphate (mg/L)	26.33±1.74^{b}	26.00±1.06^{b}	30.00±1.77^{c}	20.00±2.10^{a}	100
Phosphate (mg/L)	2.31±0.17^{a}	3.00±0.21^{b}	2.70±0.23^{ab}	35.00±3.26^{c}	50-100

Values are presented as mean ± standard deviation of three replicates. Values with different superscripts in a row are significantly different at $p < 0.05$.

***Key:** NS = not specified; WHO = world health organization; FME = Federal ministry of environment; TDS = total dissolved solids; TSS = total suspended solids; BOD = biological oxygen demand; COD = chemical oxygen demand: EC =Electrical Conductivity; DO = Dissolve Oxygen*

Table 9: Physicochemical parameters of Abattoir wastewater samples in Maikunkele

Parameter	S1	S2	S3	Control	FME/WHO
Temp ºC	28.12±2.10^{a}	27.20±1.76^{a}	28.20±1.26^{a}	28.40±2.13^{a}	Ambient
pH	6.70±0.30^{a}	6.50±0.40^{a}	6.90±0.30^{a}	6.90±0.40^{a}	6.8-8.5
Colour	Light brown	Light brown	Light brown	Dark brown	NS
Odour	Offensive	Offensive	Offensive	NS	NS
Turbidity (NTU)	6.45±0.15^{b}	6.23±0.13^{b}	6.20±0.19^{b}	5.80±0.08^{a}	5-25
TDS (mg/L)	76.30±1.86^{a}	90.36±2.67^{b}	80.21±2.84^{a}	400.00±3.29^{c}	500
TSS (mg/L)	1100.00±4.59^{b}	1180.00±7.96^{c}	1150.00±9.29^{b}	680.00±6.49^{a}	500-1500
BOD (mg/L)	75.40±1.94^{b}	68.20±2.16^{a}	79.00±2.19^{b}	75.18±2.77^{b}	NS
COD (mg/L)	247.00±4.59^{c}	224.00±7.69^{b}	260.00±6.22^{d}	120.00±4.58^{a}	100
EC (µS/cm)	111.20±0.48^{b}	111.18±0.56^{b}	111.70±0.85^{b}	106.50±0.72^{a}	100
DO mg/l	13.22±0.46^{c}	13.40±0.27^{c}	11.55±0.21^{b}	4.82±0.31^{a}	100
Chloride (mg/L)	6.13±0.65^{a}	6.62±0.42^{a}	6.90±0.39^{a}	8.50±0.62^{b}	250
Nitrate (mg/L)	6.24±0.29^{b}	6.36±0.12^{b}	6.81±0.15^{b}	5.00±0.09^{a}	50
Sulphate (mg/L)	37.33±1.37^{c}	36.00±1.26^{c}	30.00±1.28^{b}	20.00±0.98^{a}	100
Phosphate (mg/L)	10.30±1.39^{a}	10.64±2.27^{a}	10.80±1.91^{a}	35.00±2.33^{b}	50-100

Values are presented as mean ± standard deviation of three replicates. Values with different superscripts in a row are significantly different at $p < 0.05$.

Key: NS = not specified; WHO = world health organization; FME = Federal ministry of environment; TDS = total dissolved solids; TSS = total suspended solids; BOD = biological oxygen demand; COD = chemical oxygen demand: EC =Electrical Conductivity; DO = Dissolve Oxygen.

Physicochemical Parameters of Abattoir soil Samples Chanchaga: Table 10 shows the physicochemical parameters of abattoir soil samples in Chanchaga. There in, it was observed that no significant differences were recorded in temperature and silt of the samples (S1, S2, and S3) and the control whereas the pH of the samples was significantly higher ($p < 0.05$) than the control.

Also, the samples had the same colour and odour which were different from the control. The %clay, %sand, TOC, magnesium, salinity, nitrate, and sulphate of the samples were significantly higher than control's. Similarly, no significant was recorded for EC between samples and control except for S3. The chloride level was found to be highest S3 and lowest in S2.

Physicochemical Parameters of Abattoir Soil Samples in Tayi: Table 11 shows the physicochemical parameters of abattoir soil samples in Tayi. Here, it was also observed that there were no significant differences ($p < 0.05$) in temperature, silt, and sand contents of between the samples and the control. In addition, differences were observed in the colour and odour among the samples which were different from the control. The clay content, TOC, magnesium, salinity, nitrate, and sulphate contents of the samples were significantly higher ($p < 0.05$) than the control. However, EC of S2 and S3 was lower than the control while S1 recorded the highest and significantly higher ($p < 0.05$) than the control.

Table 10: Physicochemical parameters of the Abattoir soil samples in Chanchaga abattoir

Parameter	S1	S2	S3	Control	FME/ WHO
Temp ºC	30.42±1.98[a]	32.20±1.20[a]	31.21±1.09[a]	28.40±2.86[a]	Ambient
pH	7.70±0.30[b]	7.50±0.10[b]	7.90±0.20[b]	6.90±0.10[a]	6.8-8.5
Colour	Light brown	Light brown	Light brown	Dark brown	NS
Odour	Offensive	Offensive	Offensive	NS	NS
Clay (0%)	9.66±0.97[d]	7.23±0.21[b]	8.20±0.19[c]	5.80±0.64[a]	NS
Silt (0%)	22.33±2.13[a]	25.20±2.21[a]	23.10±1.97[a]	23.30±2.28[a]	NS
Sand (0%)	68.00±2.10[bc]	64.00±2.53	70.00±1.93[c]	57.00±2.13[a]	NS
TOC	13.76±1.21[b]	12.92±0.97[b]	12.59±1.11[b]	5.67±0.88[a]	50-100
Magnesium	947.00±5.48[d]	824.00±7.39[b]	860.00±3.28[c]	120.00±6.12[a]	100
EC (µS/cm)	112.24±3.21[b]	111.16±2.17[b]	92.70±2.19[a]	106.5±4.83[b]	100
Salinity	667.88±4.29[d]	649.83±3.28[c]	631.79±5.12[b]	580.45±4.12[a]	200
Chloride (mgKg-[1])	370.00±3.29[d]	340.00±2.18[a]	360.00±3.10[c]	350.00±3.81[b]	200
Nitrate (mgKg-[1])	58.94±3.21[b]	38.38±2.45[a]	38.10±2.51[a]	39.20±3.12[a]	40>
Sulphate (mgKg-[1])	27.33±2.20[bc]	26.00±1.21[b]	30.00±0.98[c]	20.00±1.34[a]	100
Phosphate (mgKg-[1])	1517.00±7.18[a]	1677.67±5.29[b]	1947.00±6.17[d]	1788.00±5.82[c]	50>

Values are presented as mean ± standard deviation of three replicates. Values with different superscripts in a row are significantly different at $p < 0.05$.

***Key:** NS = not specified; WHO = world health organization; FME = Federal ministry of environment; TDS = total dissolved solids; TSS = total suspended solids; BOD = biological oxygen demand; COD = chemical oxygen demand: EC =Electrical Conductivity; DO = Dissolve Oxygen. ; Mg/kg: milligram per kilogram;TOC = Total Organic Carbon.*

Table 11: Physicochemical parameters of Abattoir soil samples in Tayi abattoir

Parameter	S1	S2	S3	Control	FME/WHO
Temp ºC	30.22±1.986[a]	31.20±2.35[a]	31.21±1.87[a]	28.40±3.10[a]	Ambient
pH	7.60±0.20[b]	7.50±0.20[b]	7.90±0.10[b]	6.90±0.20[a]	6.8-8.5
Colour	Light brown	Light brown	Light brown	Dark brown	NS
Odour	Offensive	Offensive	Offensive	NS	NS
Clay (0%)	9.10±0.85[b]	9.23±0.96[b]	9.20±0.73[b]	5.80±0.46[a]	NS
Silt (0%)	22.33±1.29[a]	25.20±1.65[a]	24.10±1.30[a]	23.30±1.88[a]	NS
Sand (0%)	60.00±2.46[a]	55.00±2.78[a]	59.00±1.76[a]	57.00±2.75[a]	NS
TOC	10.76±1.20[b]	10.92±0.97[b]	11.59±1.03[b]	5.67±0.65[a]	50-100
Magnesium	647.00±6.48[b]	845.00±3.28[c]	860.00±7.93[d]	120.00±4.39[a]	100
EC (µS/cm)	112.24±3.47[d]	101.16±2.64[b]	72.70±3.12[a]	106.50±2.19[c]	100
Salinity	601.70±2.39	612.63±5.49	613.79±1.29	580.45±4.37	200
Chloride (mgKg-[1])	360.14±2.18[d]	320.23±1.64[b]	310.12±2.20[a]	350.00±3.26[c]	200
Nitrate (mgKg-[1])	47.64±3.29[d]	31.68±2.11[b]	35.10±2.54[bc]	39.20±3.20[c]	40>
Sulphate (mgKg-[1])	29.39±1.74[b]	21.40±2.10[a]	30.00±1.83[b]	20.00±2.22[a]	100
Phosphate (mgKg-[1])	1512.00±5.48[a]	1777.67±8.29[b]	1847.00±6.59[d]	1788.00±7.58[c]	50>

Key: NS = not specified; WHO = world health organization; FME = Federal ministry of environment; TDS = total dissolved solids; TSS = total suspended solids; BOD = biological oxygen demand; COD = chemical oxygen demand: EC =Electrical Conductivity; DO = Dissolve Oxygen; Mg/kg: milligram per kilogram; TOC = Total Organic Carbon

Physicochemical Parameters of Abattoir Soil Samples Maikunkele: Table 12 shows the physicochemical parameters of abattoir soil samples in Maikunkele. Here, it was observed that the temperature of samples S2 and S3 were lower than that S1 which showed no significant difference from the control. However, no significant differences were observed in the pH, silt, and sulphate levels between the samples and the control. The colour and odour of the samples were observed to be similar which were different from the control. Further, the clay, TOC, magnesium, and salinity levels of the samples were significantly higher than the control. On the other hand, the EC, chloride, sulphate, and phosphate levels of the control were significantly higher than the samples.

Comparative Table for Occurrence of Protozoans and Helminthes in Chanchaga,Tayi,Maikunkele Abattoirs for wastewater and soil: Here, the table shows the total number of parasites (Protozoans and Helminthes) that were observed in the three study locations and it was observed that chanchaga had more occurrence of parasites in soil (138) than in wastewater (106), Tayi had more occurrence of parasites in wastewater (151) than in soil (143) and Maikunkele had more parasitic occurrence in soil (101) than in wastewater (83). In general,from the wastewater and soil samples collected from the three study locations, Tayi had the highest number of occurrence of parasites. The role played by animal and human wastewaters as sources of parasitic pathogens infecting human is very significant (Dufour and Dufour, 2012). Many of these intestinal parasites of domestic animals are zoonotic and can be transmitted to humans through ingestion of eggs or (oo)cysts in contaminated water and food (vegetables) and those that do not cause human disease cause severe disease in livestock and have the potential to cause substantial economic losses. The

infected hosts, whether human or animal, shed large numbers of (oo)cysts and eggs via the feces into the environment, and these parasites are very resistant and may survive in the environment for over a year (Saxena *et al*., 2016).

Table 12: Physicochemical parameters of Abattoir soil samples in Maikunkele

Parameter	S1	S2	S3	Control	FME/WHO
Temp ºC	27.42±0.38^{b}	22.20±0.93^{a}	21.21±0.78^{a}	28.40±0.67^{b}	Ambient
pH	6.70±0.50^{a}	6.50±0.40^{a}	6.90±0.30^{a}	6.90±0.30^{a}	6.8-8.5
Colour	Light brown	Light brown	Light brown	Dark brown	NS
Odour	Offensive	Offensive	Offensive	NS	NS
Clay (0%)	7.66±0.86^{b}	7.23±0.57^{b}	7.20±0.50^{b}	5.80±0.47^{a}	NS
Silt (0%)	20.33±1.40^{a}	20.20±0.96^{a}	21.10±1.24^{a}	23.30±0.86^{a}	NS
Sand (0%)	48.00±2.19^{b}	44.00±2.78^{ab}	40.00±1.85^{a}	57.00±2.39^{c}	NS
TOC	7.76±0.86^{c}	8.92±0.93^{d}	6.59±0.68^{b}	5.67±0.30^{a}	50-100
Magnesium	447.00±1.84^{c}	424.00±2.85^{b}	460.00±3.20^{d}	120.00±2.85^{a}	100
EC (µS/cm)	79.24±1.94^{a}	81.16±2.10^{a}	82.70±1.48^{a}	106.50±1.94^{b}	100
Salinity	407.88±2.84^{a}	549.83±6.21^{c}	531.79±5.43^{b}	580.45±6.48^{d}	200
Chloride (mgKg-^{1})	320.00±3.94^{b}	310.00±2.17^{a}	320.00±2.85^{b}	350.00±2.19^{c}	200
Nitrate (mgKg-^{1})	27.94±2.19^{a}	28.38±2.10^{a}	28.10±1.85^{a}	39.20±2.94^{b}	40>
Sulphate (mgKg-^{1})	21.33±1.85^{a}	22.00±0.95^{a}	27.00±1.04^{b}	20.00±1.63^{a}	100
Phosphate (mgKg-^{1})	1517.00±3.49^{c}	1377.67±4.76^{b}	1247.00±3.29^{a}	1788.00±4.59^{d}	50>

Values are presented as mean ± standard deviation of three replicates. Values with different superscripts in a row are significantly different at $p < 0.05$.

Key: NS = not specified; WHO = world health organization; FME = Federal ministry of environment; TDS = total dissolved solids; TSS = total suspended solids; BOD = biological oxygen demand; COD = chemical oxygen demand: EC =Electrical Conductivity; DO = Dissolve Oxygen; Mg/kg: milligram per kilogram; TOC = Total Organic Carbon.

Table 13: Comparative Table for Occurrence of Protozoans and Helminthes in Chanchaga,Tayi,Maikunkele Abattoirs for wastewater and soil

Names of Parasites	Chanchaga abattoir wastewater samples	Chanchaga abattoir soil samples	Tayi abattoir wastewater samples	Tayi abattoir soil samples	Maikunkele abattoir wastewater samples	Maikunkele abattoir soil samples
	No. & %	No. & %	No. & %	No. & %	No. & %	No. & %
Giardia lamblia	Ova 18 [16.9]	Cyst 15 [10.8]	Cyst 32 [21.2]	Cyst 37 [25.9]	Cyst 12 [14.5]	Cyst 11 [10.9]
Ascaris lumbricoides	Ova 5 [4.7]	Ova 9 [6.5]	Ova 12 [7.9]	Ova 7 [4.9]	Ova 15 [18.0]	0va 7 [6.9]
Trichuris trichura	Ova 8 [7.5]	Ova 12 [8.7]	Ova 4 [2.6]	Ova 4 [2.8]	Ova 2 [2.4]	Ova 6 [5.9]
Hymenolepis nana	Ova 8 [7.5]	Ova 5 [3.6]	Ova 4 2.6]	Ova 4 [2.8]	Ova3 [3.6]	Ova 5 [4.9]
Fasciola hepatica	Larvae 6 [5.7]	Nill	Nill	Nill	Larvae 5 [6.0]	Larvae 11 [10.9]
Schistosoma mansoni	Larvae 12 [11.3]	Larvae 35 [25.4]	Larvae 25 [16.5]	Larvae17 [11.9]	Larvae 7 [8.3]	Larvae 6 [5.9]
Hookworm	Ova 22 [20.7]	Ova 26 [18.8]	Ova 32 [21.2]	Ova 30 [20.9]	Ova 16 [19.3]	Ova 20 [19.8]
Strogyloides stercoralis	Larvae 6 [5.6]	Larvae 12 [8.7]	Larvae 24 [15.9]	Larvae42 [29.4]	Larvae 13 [15.7]	Larvae 12 [11.9]
Toxocara vitulorum	Larvae 5 [4.7]	Larvae 4 [2.9]	Larvae 11 [7.3]	Larvae 2 [1.4]	Larvae 6 [7.2]	Larvae 8 [7.9]
Entamoeba histolytica	Ova 16 [15.0]	Cyst 20 [14.5]	Cyst 7 [4.6]	Nill	Cyst 4 [4.8]	Cyst 15 [14.9]
Total Number of parasites	106	138	151	143	83	101

Protozoans and helminthes were encountered in all the water and soil samples. In this study, protozoans and helminthes in their different stages of growth (ova, cyst, and larvae) were observed in all the water and soil samples obtained from abattoir in the three local study locations of Minna. Among the parasitic organisms identified in the water and soil samples collected in the three study location of Minna, the protozoans are only *Entoamoeba histolytica* and *Giardia lamblia*, while the helminthes include *Ascaris lumbricoides, Trichuris trichiura, Hookworm, Hymenolepis nana, Schistosoma mansoni, Strongyloides stercoralis, Toxocara vitulorum,* and *Fasciola hepatica* indicating higher prevalence of helminthes than protozoans. The findings of this study is in conformity with that of (Hatam-Nahavandi *et al*.,

2023) who reported the presence of the parasitic protozoans and helminthes in water samples. The presence of these parasitic organisms in the abattoir wastewater and soil is because the parasites harbor in the intestines or other parts of the cattle including the ones slaughtered in abattoir.

Physicochemical parameters such as temperature, pH, total dissolved solids, total suspended solids; biological oxygen demand, chemical oxygen demand, electrical conductivity, dissolved oxygen and total organic carbon have been shown to affect the growth of organisms (Simon-oke *et al*., 2020). As a result, the favorable condition provided by the water and soil where the parasites inhabit could be responsible for their occurrence.

The results from the study indicated a prevalence of (55%) of helminthes in the soil samples in the study area with Loamy soil having the highest prevalence of 36.3%. The prevalence in the samples were statistically significant as ($p<.05$). Equally, a temperature of 27.2°C, pH of 6.3 and 12.7% organic matter was recorded. The temperature of the soils in the area were slightly above room temperature which is suitable for development thriving of infective stages of helminthes ,The temperature ranges agree with (Gad *et al*., 2019) who in their various findings agreed that the optimum temperature for the embryonation of soil transmitted helminthes 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. This might be due to the effect of heat to chemical reactions occurring inside the eggs for their development. Enzymes might be activated easily with higher temperature and molecules come in contact more often when excited due to the energy from heat. This is also evident in *Ascaris* eggs which were observed to halt development in freezing temperatures, which may be mainly due to the inhibition of the chemical reactions needed for the egg development (Moser *et al.*, 2018). The pH was slightly acidic tending towards the neutral point which is equally suitable for the development of the organisms. The pH ranges as observed is in line with studies which mentioned that helminthes eggs are said to tolerate a large range of pH. However, *Ascaris* spp eggs were said to have an arrested development whenplaced 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. The organic carbon was equally high ensuring that there are enough nutrients for the survival of the different helminthes and protozoans soil dwelling stages. Though the organic matter in the soil types were almost at the same level, loamy soils had 14.9% organic content which is the highest and more of the helminthes and protozoans recovered with the increase of the content of the organic matter (Table 2). Loamy soils equally have the ability to retain, nutrients, humus and moisture while still allowing excess water to drain away thereby giving the helminthes and other microorganisms access to oxygen for their survival. Also the continuous seeding of the soil with the infective stages of these parasites through defecation could also be responsible for this high prevalence of helminthes. The soils in months of January- March had a prevalence of 52.9% while 47.1% prevalence was recorded between the months of April-June. This could be as a result of the moderate temperature and high organic contents of the soils in the months of January- March when compared to that of April-June. While between the months of April-June, there was a slight decrease temperature and organic content which may have affected the number of organisms recovered. This finding is equally in agreement with who recorded a prevalence of (18.7%) and (12.0%) respectively these months. During the study period Loamy soils had the highest prevalence of 64.5% of the organisms while clayey soils had the lowest prevalence of 8.5%, this could be attributed to physicochemical parameters of Loamy soils which though were almost same with those of sandy and clayey soils had a higher organic content. It was equally observed that there was an increase in prevalence geo-helminthes in the soil types with an increase in the physicochemical parameters. Sandy and loamy soils are equally preferred by animals and indeed humans for defecation as they have loose texture for them to burrow their feces deeper into the soil. Also, soil transmitted helminthes eggs have been found to survive more in sandy soils, with high silt content, since they provide aeration and moisture for their development. Clay soil had a very low prevalence which according to may be as (Ovutor *et al.*, 2017) a result of clayey soils not providing enough oxygen needed for soil transmitted helminthes egg development and are believed to prevent egg dispersal by water. This agrees with the findings of who reported that there is no direct relationship between soil texture and the prevalence of helminthes eggs in soil even though physical properties of soil do influence survival of eggs in the soil. The high prevalence of *Schistosoma mansoni, Strongyloides stercoralis,* Hookworm*Entamoeba histolytica* and *Giardia lamblia*, in this study may be as a result of them thriving under different levels of physico-chemical parameters and soil types. Other studies in southern Nigeria stated that the high prevalence of the organisms may be as a result of their eggs being very resistant to harsh environmental conditions and can remain in the environment for longer period. This

result is also in line with results obtained by in Anambra State eastern Nigeria and in Rivers State. *Trichuris* spp prevalence between the range of 2.4% to 8.6% was a bit lower when compared with reports from studies in other parts of the country which reported *Trichuris* spp prevalence to be 14.0% (lorenzi *et al*., 2010). Hookworm had a prevalence of 20.7%,21.2%,19.3% and 19.8%, this result is in line but significantly different compared with the values from other studies in various parts of the country which reported 22.5%, 58.3%, 29% and 31.1% (Chaisiri *et al.,* 2019).. However, from the results the different parameters had some effect in the distribution of protozoans and helminthes.

Conclusion: In determination of the physicochemical parameters of abattoir samples, an increase in the organic content led to an increase in the abundance of pathogenic helminthes in the various sites. Since various number of pathogenic helminthes were observed, therefore combination of sanitation and community health education is a necessary and effective control measure of helminthes. Sanitation by building of functional and accessible fecal disposal facilities that is suitable to the local conditions, as the only sure way of eradicating helminthes especially those of public health importance remains the non-deposition of human and other animal waste directly into the soils. From the results obtained in this study, it can be concluded that the samples (wastewater and soil) collected from Chanchaga, Tayi, and Maikunkele Area of Minna are contaminated with protozoans and helminthes which could be attributed to the favorable physicochemical conditions of the water and soil samples. Proper measures like, regular monitoring and surveillance Implementation of proper waste management practices, reintroduce sanitary inspection of our environment.

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