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Gastrointestinal parasites (GIPs) and visual characteristics of fecal samples from local breed Dogs in Ubahumonu community in Okija, Nigeria: a baseline study

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Abstract: Gastrointestinal parasites (GIPs) are parasites found in the gastric (stomach) and intestinal sections of the alimentary canal (gastrointestinal tract) of humans and other animals. They cause various diseases in animals and humans with possibilities of zoonotic transmission and its related health burden. A baseline study was conducted to do a baseline test of three hypotheses that: fecal color and form (texture) consistency in dogs may not necessarily determine presence of gastrointestinal parasites. Secondly to determine the types of GIPs present in the analyzed stool samples and designed tentative measures that can support control of GIPs and zoonotic transmissions of related GIPs.

We randomly obtained fecal samples from 35 locally bred dogs in this community, comprising males and females of varying age groups, from a community in Okija, Anambra State, Nigeria. First, we conducted visual inspection of fecal on fecal; samples for color and form consistency, and presence/absence of mucous. in the dogs. Then engaged two GIPs recovery methods that are concentration based (formol ether sedimentation and zinc sulphate floatation techniques).

Microscopy revealed presence of two Protozoan and 3 helminthic GIPs were detected- Entamoeba histolytica, Giardia intetinalis (Protozoans), Ancylostoma caninum, Ascaris lumbricoides, Diphylidium caninum (helminthes). The highest prevalence was observed for Entamoeba histolytica (37.1%), while the least prevalence values were observed for Ascatis lumbrocoides and Diphylidium caninum (each at 5.7%).

The baseline test on our hypothesis indicated that fecal color, form (texture) and presence/absence of mucous in fecal sample are not indicative of presence of GIPs in the pet dogs, However, they serve as guides to pet dog owners to monitor their health to have clearer clues on when to quickly consult a veterinary clinician or visit nearest veterinary clinic.

Keywords: Gastro-intestinal, parasites, concentration, sedimentation, floatation, visual characteristics, transmission.

1. Introduction:

Parasitic diseases of companion animals comprise a group of globally distributed and rapidly spreading illnesses that are caused by a wide range of arthropods, helminthes and protozoa (Pereira et al, 2016). They are of veterinary and human medical importance because many of these parasites have zoonotic routes of transmission from animals to humans. This zoonotic potential is of public health importance (Razza et al, 2018). Gastro-intestinal parasites can inhabit both pet dogs and in shelter dogs. In an extensive survey and review by Pereira et al (2016) in which they probed into parasitic zoonoses associated with dogs and cats and Portuguese

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dog owners and there deworming practices, it was reported that majority of Portuguese pet dog owners that attended veterinary clinics, use endo-paraticides and ecto-parasitides in/on their pets as prophylactic measure, although in many cases not in the correct schedule of treatment.

Despite evidence of minor role of gastrointestinal parasites (GIPs), in causing diseases in owned pet populations prophylactically treated with anti-helmintes, gastrointestinal parasitism remains an important consideration (Razza et al, 2018). Gastrointestinal tract parasites affect the health of dogs and may be zoonotic (Urgel et al, 2019).

Some of the GIPs can be hard to detect and many of the infected dogs can be asymptomatic while symptomatic dogs can go undetected because their symptoms can be non-specific (Robertson and MacPete, 2014).

The most common signs and symptoms of GIPs are vomiting, diarrhea, distended abdomen, weight loss, occasional coughing and scooting (Robertson and MacPete, 2014). Intestinal parasitic infection is an important health issue in sub-saharan Africa (Ozurumba and Ukoh, 2016).

In a study by Dhanaalj et al (2014), evaluating prevalence of intestinal parasites in humans in low socio-economic areas comparatively, using floatation and wet mount methods, Entamoeba coli had highest prevalence at 23% followed by Cyclospora and E.histolytica, Giardia intestinalis and Ascaris lumbricoides (6.2%) in this order. The authors suggested that prevalence can be reduced by possible grouping of better ecological design and hygiene, coupled to routine medical examinations and treatment in low socio-economic areas.

In a study in Ibadan in Nigeria engaging two methods of formol-ether sedimentation and brine floatation techniques, formol ether sedimentation was more sensitive than brine floatation though with not much differences except in density and quantity of parasites detected (Alli et al, 2011).

To categorically state which stool form is normal or not is not as easy as that. In humans, a convention was developed called the Bristoll Stool Form Scale (BSFS) by some health professionals to classify the type of stool that is passed out. This is shown on Figure 1. This scale helps to assess how long the stool has spent in the bowel (Bladder and Bowel Community, 2022). BSFS is also called Meyers scale (DerSarkissian, 2002). It is often used as a measure of stool consistency (Vork et al, 2019). The BSFS is designed to help doctors measure the time it takes for food to pass through the body and leave as waste, with the shape and form of stool (poop) may also guide the doctor towards a diagnosis of some digestive patterns or anomalies (DerSarkissian, 2002). As such, Jelovic, (2022) remarked that pet and shelter dog owners should watch out for dog's stool for a variety f features like color, texture, urgency and frequency, difficulty in breathing and behavioral changes. Invariably, this implies that only one of these features is not an adequate determinant for illness nor diagnosis in dogs. Also, this is applicable in humans.

The normal color should be medium brown and normal texture should be neither too soft nor too hard to pass, and when it's liquid it can indicate diarrhea and when too hard can indicate constipation (Naviglia and Pendergrass, 2022).

Parasitic diseases are of companion animals comprise a group of globally distributed and rapidly spreading illnesses that are caused by a wide range of arthropods, helminthes and protozoa (Pereira et al (2016). As such, GIPs have Veterinary importance as well as Human public health importance due to the zoonotic nature of some of these GIPs. Dogs are very important animals to humans as they serve a variety of useful purposes such as companionship, personal and community home security support, psychological health support, and airport and boarder security screening animals, among other valuable uses. This implies that humans should strive to take care of them as they perceive themselves important and strive to take care of themselves. This connotes the health and wellbeing of these dogs.

This is a baseline study with 35 samples, not analyzed based on age and sex of sampled dogs.

1. Formol-ether sedimentation and Zinc sulphate floatation techniques for screening for GIPs can support each other in laboratory detection and diagnosis.

2. Fecal color, form texture consistency and presence/absence of mucous in dogs may not necessarily determine presence of gastrointestinal parasites but can help inform pet owners to keep closer tabs on monitoring of their dog's health.

3. From detected composition of GIPS, we can design tentative control measures that can support control of GIPs, zoonotic transmissions, veterinary and human public health, and community health.

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2. Materials And Method

2.1 Study area

This study was conducted on Dogs that were randomly rampled for their stool specimens within Ubahumonu community in Okija, in Ihiala local government of Anambra State, Nigeria.
The analysis on the stool samples was carried out in the General laboratory of Department of Microbiology, Legacy University Okija, Amabra State, Nigeria between 19th August 2022 to 5th September 2022.

2.2 Characteristics of dogs

The dogs are locally bred dogs owned by families as pet companions and helpers on security. They were of both sexes- males and females.
Fecal Stool Samples 1-20 are males.
Fecal stool samples 21-35 are females.
The age of these dogs was not obtainable for each. Their age ranged from 1 to 12 years. Hence, this is a baseline studies, such that subsequent studies can dig deeper to get specific age for each dog and run analysis with respect to age and sex, to see if there is any pattern for detections, quantity and species of GIPs.

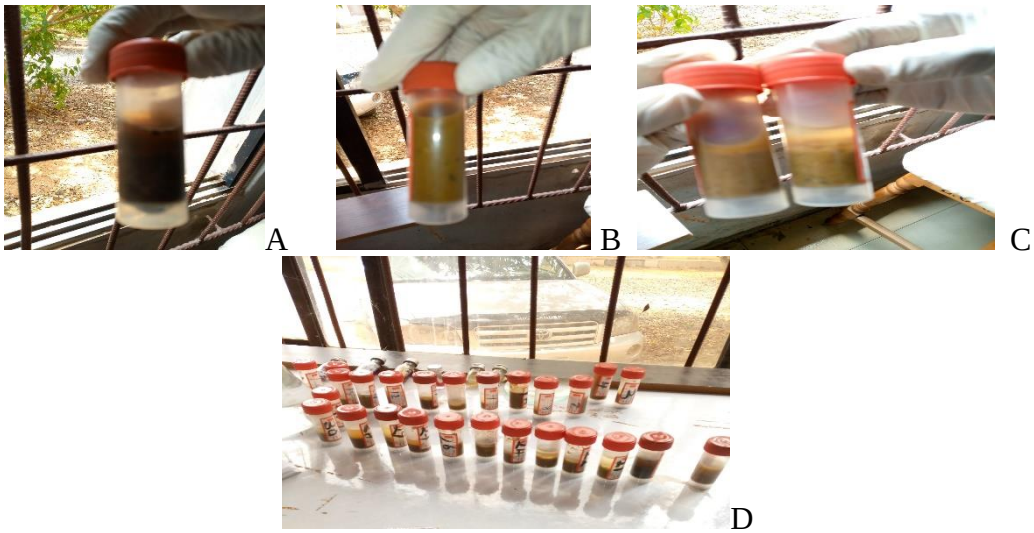

Figure 1: Collections of fecal samples of the sampled Dogs in this study showing the variants in color and from consistency, as observed in the laboratory.
A: Reddish brown stool; B: Yellow stool; C: Brownish and Yellow stool side-by-side
D: Collection of fecal samples of varying stool colors

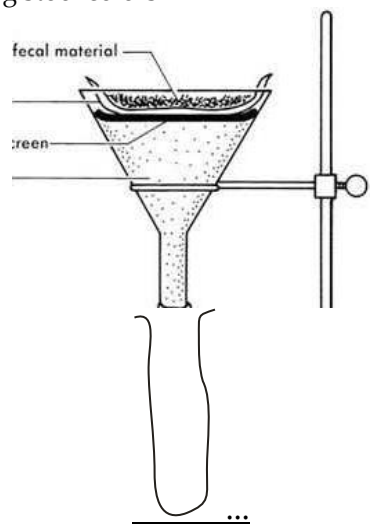

Figure 2: First stage of experimental set-up for recovery of GIPs through Wire gauze and Glass Funnel
2.3 (A). Zinc sulphate floatation concentration technique.

2.4 (B). Formol-Ether sedimentation concentration technique.
C). Method used to remove surface film and dropping film of glass slide in the Zinc sulphate floatation concentration technique.

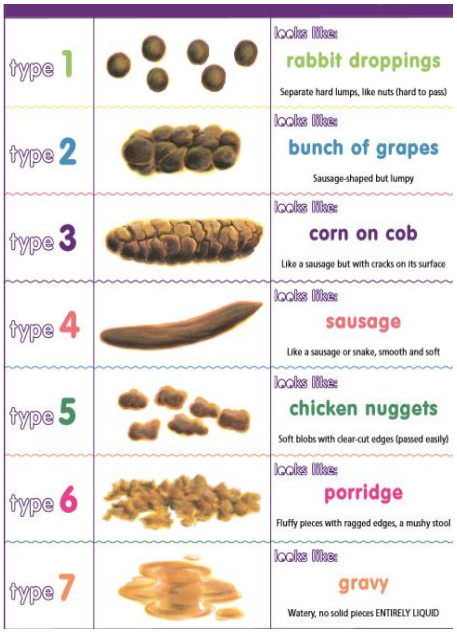

Figure 3: The Bristol Stool Form Scale (BSFC) Stanford University School of Medicine, 2022).

From the Bristol stool chart (WebMD 2002)
Stanford University School of Medicine, 2022), we have:
Type 1: Separate, hard lumps, like nuts and hard to pass.
Type 2: Sausage-shaped but lumpy; Type 3: Sausage shape but with cracks on surface.
Type 4; Sausage or snake-like smooth and soft; Type 5: Soft blobs with clear-cut edges and easy to pass.
Type 6; Fluffy pieces with ragged edges and mushy; Type 7: Watery with no solid pieces or entirely liquid.
Determination of pH and TTA According to AACC method (2000) 02-52, take 10 g of sweet wine fermented with different sweet wine kojis into Erlenmeyer flasks, add 90 mL of distilled water, stir magnetically for 30 minutes, let stand for 10 minutes, and measure pH. Titrate with 0.1 mol/L NaOH and stir to pH 8.6. The volume of NaOH consumed is the total titratable acidity. Repeat the operation at least three times for each sample.

The implications of stool color are as follows
Brown: This is generally the normal color.
Black or very dark: This can be due to undigested blood, sign of ulcer or upper tract gastrointestinal infection.
Red color or with streaks of blood: This can be due to meal of beats, tomatoes, gelatin desert, very red drinks; may be blood that streaked in from lower part of digestive tract, non-cancerous tumours, cancer, colitis (inflammation of colon), polyp growth in colon, diverticular disease (caused by small sacs in wall of colon) or haemorroids.
Pink: This can be related to haemorroids gastro-enteritis (HGE) which can cause vomiting and diarrhea (treatable).
Grey or grease: This can be due to exocrine pancreatic insufficiency (EPI), mal digestion in which most fat is not undigested (treatable).
Orange: This can be due to food, especially in diarrhoeic condition such as orange based foods, beta-carotene in food at high levels as found in carrot, white squash, pumpkin among others. It can also be due to certain medications of anti-biotic and antacid that have Aluminium hydroxide and in rare cases of liver problem..
Yelow: This is not much of a problem unless if accompanied by yellowish mucous (Navigha and Pendergrass 2022). In some rare cases, especially in humans, it could be from Celiac disease in which the body cannot handle a protein called Gluten. Gluten is formed at significant levels in foods like Wheat, Braley and Rye which are used in making Bread, Pestas and Cookies.
White specks: The pet dog owner can send dog for check-up on Tapeworm infection for health safety, especially

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if accompanied by other signs like weight loss and eating problems.
Pale: This can be associated with medications for diarrhea, such as Dismuth subsalicylate (Kaopectale Pept-Bismol) in humans. It can also be due to lack of bile in stool because the liver normally synthesizes bile, stores in gall bladder and releases it into small intestine to help with food digestion.
Blockage in tubes conveying bile or liver diseases like Hepatitis can hinder bile action on food in small intestine. When bile duct is blocked, it can also be due to presence of gall stones, tumour or Bilary atresia health problem (Cristol and Pathak, 2020, Navigia and Pendergrass 2022, Watt, 2022).

Analysis of results
We engaged SPSS and Excel to analyze for basic descriptive analysis.

3. Results and Discussion

3.1 Prevalence and characteristics of Gastrointestinal parasites in fecal samples

The highest prevalence of GIPs detected was for Entamoeba histolytica (37.1% of samples) followed by hookworm Ancylostoma caninum (28.1%) and Giardia intetinalis (8.6% of samples), while the least prevalent were for Ascaris lumbricoides and Diphylidium caninum (each at 5.7% of samples) (Table 1).
Two Protozoal GIPs were detected (E. histolytica and Giardia intestinalis) and three helminth GIPs (Ancylostoma caninum, Ascaris lumbricoides and Diphylidium caninum). In a study by Epe et al (2010), Giardia was found to be a common enteric agent among dogs and cats with gastrointestinal signs acroos Europe colleated from 8685 dogs and cats using the IDEX SNAP Giardia test (IDEXX Laboratories), with a prevalence of 24.78% among tested dogs and 20.3% among tested cats. There were differences in rates in countries. The younger the dog and cat, the higher the risk of being positive, peaking in the category of puppies below 6 months. In a retrospective study on a human population in Nigeria by Ozurumba and Ukoh (2016), it was observed that prevalence was highest for E. histolytica at 10.76%, followed by Taenia at 2.32%.

Table 1: Data from microscopic examination of fecal samples

Sample #	Formol-Ether Sedimentation Method		Zinc sulphate Floatation Method	
	Iodine Stained (A)	Unstained (B)	Iodine stained (A)	Unstained (B)
1	-	Ancylostoma caninum	Ancylostoma caninum	Ancylostoma caninum
2	Ancylostoma caninum	-	Entamoeba histolytica	Ancylostoma caninum (egg), Ascaris lumbricoides (egg)
3	-	-	-	-
4	Entamoeba histolytica	Ancylostoma caninum	Ancylostoma caninum (egg)	Entamoeba histolytica
5	-	-	-	-
6	-	-	Entamoeba histolytica	Entamoeba histolytica, Ancylostoma caninum(larva)
7	Entamoeba histolytica	-	Entamoeba histolytica	Ancylostoma caninum (egg)
8	-	-	-	-
9	-	-	-	-
10	-	-	-	-
11	Diphylidium caninum, Ancylostoma caninum (egg)	Entamoeba histolytica, Ancylostoma caninum (egg)	Diphylidium caninum, Entamoeba histolytica	Entamoeba histolytica, Ancylostoma caninum (egg)
12	Ascaris lumbricoides	-	Entamoeba histolytica	Ancyclostoma duodenale (egg)
13	-	-	-	-

14	-	-	-	-
15	-	-	-	-
16	Entamoeba histolytica, Ascaris lumbrocoides	-	Entamoeba histolytica, Ascaris lumbricoides	Entamoeba histolytica., Ascaris lumbricoides
17	-	-	-	-
18	-	-	-	-
19	Entamoeba histolytica, Ancylostoma caninum (egg)	Ancylostoma caninum (egg)	Entamoeba histolytica, Giardia intestinalis	Entamoeba histolytica
20	-	-	-	-
21	Giardia intestinalis, Ascaris lumbricoides	Ancylostoma caninum (egg)	Entamoeba histolytica, Ancylostoma caninum (egg)	Entamoeba histolytica, Ascaris lumbricoides
22	-	-	-	-
23	Entamoeba histolytica	Entamoeba histolytica	Diphylidium caninum	Entamoeba histolytica
24	-	-	-	-
25	Ancyclostoma duodenale (egg)	Entamoeba histolytica	Giardia intestinalis, Ancylostoma caninum (egg)	Entamoeba histolytica
26	-	-	-	-
27	-	-	-	-
28	-	-	-	-
29	-	-	-	-
30	Ancylostoma caninum (egg), Ascaris lumbricoides	Entamoeba histolytica	Ancylostoma caninum (egg)	Entamoeba histolytica
31	Entamoeba histolytica, Giardia intestinalis, Ascaris lumbricoides	-	Entamoeba histolytica, Ascaris lumbricoides	-
32	-	-	-	-
33	-	-	-	-
34	Entamoeba histolytica, Ascaris lumbricoides	Entamoeba histolytica, Ascaris lumbricoides	Ascaris lumbricoides	Entamoeba histolytica
35	-	-	-	-

GIPs detected: Entamoeba histolytica: 13 samples (37.1% of samples); Giardia intestinalis: 3 samples (8.5% of samples)
Ancylostoma caninum: 10 samples (28.6% of samples); Ascaris lumbricoides: 2 samples (5.7% of samples); Diphylidium caninum: 2 samples (5.7% of samples)
The highest prevalence for Protozoan GIP was recorded for E. histolytica while the highest prevalence for helminth GIPs was for Ancylostoma caninum (28.6% of samples).
Single GIP species infection in a sample was not found nor was it common on this occasion of this study, but mixed infections of two or three GIP species were observed. This indicates that possibilities for mixed infections should be pre-empted and plans for control programe put in place.

3.2 Comparing results from stained and unstained fecal samples for GIP detection

Data from sedimentation method indicated that in some samples, there was positive result for using technique of Iodine stain while they were negative results using unstained technique, such as in samples 2, 7 and 16 (Table 1). Then recorded negative result for Iodine stained and positive for same samples that were unstained, such as

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in sample 1 (Table 1). This same feature was observed in sample 31 under floatation technique. This connotes that Iodine stained and unstained samples can be complimentary in laboratory analysis of patients' stool samples when doing laboratory diagnosis for GIPs by fecal analysis with microscopy.

3.3 Looking through results in respect of the three created hypothesis

Evaluation for hypothesis 1: Formol-ether sedimentation and Zinc sulphate floatation techniques for screening for GIPs can support each other in laboratory detection and diagnosis.

3.3.1 Prevalence

Positive for GIP: 15; Negative for GIP: 20; Prevalence of GIP: 42.9%

3.3.2 Specific GIP

Entamoeba histolytica: 13 samples (8.6% of samples); Giardia intetinalis: 3 samples (37.1% of samples).
Ancylostoma duodenale: 10 samples (28.6% of samples); Ascaris lumbricoides: 2 samples (5.7% of samples); Diphylidium caninum: 2 samples (5.7% of samples).

3.3.3 Single and multiple infections

Single infection: 0 sample (0%); Multiple infections: 13 samples
2 GIP multiple infection: 6 samples (5.7% of all samples).
3 GIP multiple infection: 7 samples (20% of all samples)

Protozoal and helminth infection categories per sample

Protozoal only mixed infection: 3; Helminth only mixed infection: 4
Protozoal-helminth mixed infection: 15

Analysis on fecal samples for color and form (texture) consistency

#BRW (Brown): 25 samples (71.4%); *DB Dark (Brown): 3 samples (8.6%).
*RBW (Reddish brown): 5 samples (2%); #*BRY (Brownish yellow): 2 samples (5.7%).
Total: 35 samples

3.4 Comparing sedimentation and floatation techniques for GIPs detection

From the observation in sample 6, in which there was detection of GIP by flotation technique but negative in fl sedimentation, it implies that both methods can be used complimentarily to support laboratory analysis, where resources in the diagnostic laboratory can accommodate the two methods used per sample and pet dog pet owner can foot the bill. This does not imply that flotation technique was more effective from this study because the sample size was 35, and the variant in opposite direction could be possibly observed with bigger pool of samples (Table 1).

In one sample (sample number 6), presence of GIP was not detected by sedimentation-based microscopy, GIP was detected by floatation. This indicates that both methods have their strengths. They can complement each other. I n our literature search, we noticed that at Centers for Disease Control and Prevention (CDC) in Atlanta United States, For instance, in their last review of the information in 2016, they stated that they utilize a type of sedimentation technique that engages formalin-ethyl acetate technique (which we used in this study) which can be used with specimens preserved in formalin, Merthiolate-iodine formalin or Sodium acetate acetic acid formalin (Centers for Disease Control and Prevention, 2016). The same laboratory stated that varying types of flotation techniques can be used using zinc sulfate, sodium nitrate and saturated sodium chloride AS flotation solution, adding that the type selected should be informed by the relative sensitivity of the solution in detecting the parasitic pathogens sought (CDC, 2018). The use of sugar solution was included by the University of Minnesota as floating solution for flotation technique (University of Minnesota Clinical Veterinary Diagnostic Laboratory, 2023). In a study in Cebu Philippines using three methods of direct smear, sedimentation and floatation techniques, gastro-intestinal tract (GIT) parasites were detected in owned and shelter dogs. The authors suggested that the result can be of use in baseline information about canine parasites fauna in Cebu Philippines (Urgel et al, 2019).

Evaluation for hypothesis 2: Fecal color, form texture consistency and presence/absence of mucous in dogs may not necessarily determine presence of gastrointestinal parasites but can help inform pet dog owners to keep closer watch in monitoring of their dog's health.

3.5 Visual inspection-based characteristics of fecal samples: Stool color, GIPs and dog's health

High percentage of fecal samples (at 71%) had brown stool color (BRW) indicative of usually normal stool color (Figure 3). This does not imply absence of GIPs in such dogs because some of these samples tested positive for

presence of GIPs. In some of these samples, GIPs were detected and undetected in others. As such, routine laboratory examination of samples (such as fecal matter from the dogs) is a surer way to know if there is GIP infection than by visual inspection.

A lower percentage of fecal samples had fecal color (at 22.9% - combined for deep brown (DB) and reddish brown (RBW) stool color that suggest that pet owner should monitor the dog's health condition but does not imply the presence of GIP. Some of the either deep blown or reddish-brown colored stool had GIPs detected in them while in some others, no GIP was detected.

Table 2: Stool color and form consistency

Sample #	Color	Form consistency	Mucous	GIP	Helminth	Protozoa	Remark
1	BRW#	SW	-	+	+	+	*A.caninum, E.histolytica*
2	BRW#	SW	-	+	+	+	*A.caninum E.histolytica*
3	BRW#	SHF	-	-	-	-	-
4	BRW#	SHF	-	+	+	+	*A.caninum, .lumbricoides, E.histolytica*
5	BRW#	SW	-	-	-	-	--
6	BRW#	SW	-	+	+	+	*E.histolytica, A.caninum*
7	BRW#	WT	-	+	+	+	E. histolytica, A. caninum (egg)
8	BRW#	SHF	-	-	-	-	-
9	BRW#	SHF	-	-	-	-	-
10	BRW#	SHF	-	-	-	-	-
11	DB*	SHF	-	+	+	+	*E.histolytica, D.canunum,*
12	DB*	SHF	+	+	+	+	*A. lumbricoides, E. histolytica, A. duodenale (egg)*
13	BRW#	SHF	+	-	-	-	-
14	BRW#	VH	-	-	-	-	-
15	BRW#	SHF	+	-	-	-	-
16	BRW#	SHF	+	+	+	+	*E.histolytica, A.caninum*
17	BRW#	VH	-	-	-	-	-
18	RBW*	SW	-	-	-	-	-
19	BRW#	SW	+	+	+	+	*E.histolytica, G.intestinalis, A.caninum*
20	DB*	SHF	-	-	-	-	-
21	BRY ^^	SW	-	+	+	+	*G.intestinalis, A.lumbricoides, A.caninum*
22	RBW*	VH	-	-	-	-	-
23	RBW*	SHF	-	-	+	+	*A.caninum, D.caninum, E.histolytica*
24	BRW#	VH	-	-	-	-	-
25	BRW#	VH	-	+	+	+	*G.intestinalis, E.histolytica, A.caninum*
26	BRW#	VH	-	-	-	-	-
27	RBW*	SHF	-	-	-	-	-
28	RBW*	SHF	-	-	-	-	-
29	BRW#	SW	-	-	-	-	-
30	BRW#	SS	+	+	+	+	*E.histolytica, A.lumbricoides*
31	BRW#	VH	-	+	+	+	*G.intestinalis, A.lumbricoides, E.histolytica*
32	BRW#	SW	-	-	-	-	-
33	BRW#	SHF	-	-	-	-	-

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34	BRW#	SW	-	+	+	+	*E.histolytica, A.lumbricoides*
35	BRY ^^	SHF	-	-	-	-	-

Number of males: 20 (57.1%); Number of females: 15 (42.8%).
#Normal fecal color BRW (25) = 71.4%
*May require monitor of Dog's health by pet owner for possible consultation with a Veterinarian RBW (5) + DB (3) = Total of (8) = 23.9%.
^^Not much of a concern, except in some rare cases where it could be associated with some rare clinical conditions BRY (2) = 5.7%
From the foregoing analysis, color of stool sample was not indicative of presence of GIPs but served as means of guiding pet dog owners on health care management of their dogs. As such, fecal color was not indicative of presence of GIP, nor was it a marker for GIP in pet dogs.

3.5.1 Further evaluation for hypothesis 2

Fecal color, form texture consistency and presence/absence of mucous in dogs may not necessarily determine presence of gastrointestinal parasites but can help inform pet dog owners to keep closer watch in monitoring of their dog's health.

3.6 Visual inspection-based characteristics of fecal samples: Mucous presence, GIPs and dog's health

Six samples (samples 12, 13, 15, 16, 19, 30) (17.1%) were streaked with mucous while 29 samples (82.9%) were not streaked with mucous (mucous absence) which did not imply absence of GIPs in all as observed during laboratory diagnosis by the two concentration methods of sedimentation and floatation (Table 2). From the 6 mucous streaked samples, 3 samples were infected (50% of mucous streaked) while the non-infected samples among mucous streaked samples were 3 samples (50% of them). This indicates that presence of mucous is not an indicator for presence of GIPs in pet dogs. Presence of GIPs is known and ascertained when appropriate laboratory diagnosis is done.
From the stool samples that were streaked with mucous 3 (50% of them) had presence of GIPs.
Out of the 25 brownish (BRW) samples, GIP was not detected in 15 samples (accounting to 60% of the brownish samples) except in 10 samples (40% of the samples). This indicates that stool color cannot be used as a marker for GIPs infection (Table 2).

3.6.1 Further evaluation for hypothesis 2:

Fecal color, form texture consistency and presence/absence of mucous in dogs may not necessarily determine presence of gastrointestinal parasites but can help inform pet dog owners to keep closer watch in monitoring of their dog's health.

3.7 Visual inspection-based characteristics of fecal samples: Fecal form (texture) consistency, GIPs and dog's health

Out of the 3 deep brown (DB) fecal samples, GIPs were detected in 2 but not detected in one. Among the 5 brownish (RBW) fecal samples, GIP was not detected in 4 but detected in 1 sample (Table 2).
Two of the very hard (VH) form of fecal samples were cracked and in separated lobules while one fecal sample had presence of several undigested unbroken food items. The only watery fecal sample had presence of E. histolytica (cyst stage found) and A. caninum hookworm eggs. This is closest to Type 1 category stool and is probably a constipated condition (Table 2).
Based on stool form classifications as shown on Figures 4, 16 (SHF) and 1 (SS) totaling 17 (17/35) have good stool forms while 7 (VH-tending towards constipation), 10 (SW- tending towards diarrhoea) and 1 (WT-tending towards diarrhoea). In all, 18 (18/35) are not in the category of good stool forms.
By implication, nature of stool form consistency is not indicative of presence of GIPs as some well formed stools (SS, SHF samples 4, 11, 12, 15, 16, 23, 30) in which GIPs were recorded, and some poorly formed stool samples (VH, SW, WT stool samples 5, 14, 17, 18, 26, 29, 32) in which GIPs were not recorded (Table 2). This implies that the texture form of consistency of fecal samples is not an absolute determinant of presence of GIPs in pet dogs. Kim H, et al (2023) remarked in their study that the gastrointestinal tract of dogs, especially the colon, is inhabited by complex microbiota that contributes to energy source absorption, metabolic functions, and immunogenic responses. Adding that differences in body condition score (BCS) did not affect the overall

distribution of the microbiota and predicted functional features. Brambillasca et al. (2010) opined from their study that differences in food digestibility are also associated with differences in fecal characteristics.
In a study by Grellet et al (2016), fecal consistency assessed by gross examination for fecal moisture content, calprotectin, fecal quality and IgA markers are of no diagnostic value to detect presence of enteropathogens in clinically healthy puppies or puppies with abnormal feces, but could help to better understand the malnutrition of digestive tract. In this study the researchers created a hypothesis that fecal calprotectin and IgA concentrations in puppies are not influenced by fecal moisture in puppies but by enteropathogen shedding.
From the foregoing analysis involving visual inspection of stool samples, despite the fact that changes in stool color and form in dogs can be normal, changes can occur anytime they have changes in meal diet given to them. As such, fecal from (texture) consistency is not a marker for GIP infection.
Pet dog owners should pay attention to their dog's fecal color, texture based form and frequency of stool outlets, so that they can recognize negative health issues early and consult their veterinary clinician. A simple episode where there are few instances of softer stool can be perfectly normal based on diet and related to the unique flora of bacteria within the dog's gut which can be individualized in manner (Shmalberg, 2022).
Our observation on visual characteristics falls in line with the remark by (Pereira et al, 2016) that observing for signs and symptoms of infection in animal health like dogs should be supported with laboratory diagnosis, as the signs and symptoms may be non-specific.

3.7.1 Design of tentative control measures based on hypothesis 3:

From detected composition of GIPS, we can design tentative control measures that can support control of GIPs, zoonotic transmission, veterinary and human public health, and community health.

3.8 This design is based on GIP composition observed, their mode of transmission and effects on host

These serve as recommendations to support Veterinary Public Health of the community:

1. Bathing of pet digs regularly with antiseptics or disinfectants in water to prevent habouring ecto-parasites like lice that can support transmission of Diphylidium caninum and help control other body ecto-parasites like flea known to play roles in transmission. This can help check and control percutaneous transmission through the skin for related GIPs.
2. Avoid exposing unclean water around or within compounds where pet dogs spend most of their time. This can help check transmission by contaminated water containing protozoan cysts of Giardia and Entamoeba protozoans or Ascaris helminth eggs.
3. Create platform for routine community education on need to prevent fecal extracts on soil or ground within and around compound where pet dogs spend most of their time. This can help check this transmission route in relation to Giardia, Entamoeba, Ascaris and Ancylostoma GIPs.
4. Create platform to educate pet owners on need to feed pet dogs more with their own regular dog food with less emphasis on feeding them with remnants or leftover deposited from human meals. This can help check transmission through contaminated left-over food meals. This is a difficult measure because it will cost pet dog owners more to maintain feeding of their dogs, more-so for economies are fragile.
5. Encourage research by Animal nutritionists, Animal biochemists, Animal physiologists and Agricultural scientists to develop cheaper and affordable food for pet dogs sourced from local crop sources. This can support control of transmission through possibly contaminated food remnants.
6. Create forum to periodically educate community dwellers and pet owners on practices that help check zoonotic transmission of GIPs such as the ones tentatively detected here in a baseline study, such as Entamoeba, Giardia, Ancylostoma and Ascaris.
7. Educate community dwellers and pet owners on principles that help reduce risks of contacting GIPs and transmissions.
8. Check for weight consistencies in dogs, especially when suspicious stool s characteristics are observed by pet owners. Also, they should check for signs of weakness.
9. We suggest that Pet dog owners should watch out for abnormal behaviour in their dogs, of which includes pet's withdrawal to self, to further guide their decisions for consultations.

The presentation in this design for control measures is not absolute as some other GIPs with other avenues for transmission and effects on hosts can be detected in future studies in the study area, which will warrant inclusions of some other measures.

4. Conclusion

Sedimentation and floatation techniques for detection of GIPs have their separate strengths. They can complement each other where resources in the diagnostic laboratory can accommodate the two methods used per sample and dog pet owner can foot the bill.

Stool color, nature of form consistency and mucous presence/absence are not determinants of presence of GIPs in the pet dogs but are good to serve as guide that helps pet dog owners to monitor the health of their dogs. This will help them know when to do closer inspection and consequent consultation with the nearest veterinary clinic or with a veterinary clinician.

The outcome of this study falls in line with the three hypothesis we created and studied from the laboratory but can be validated in by other researchers with tests using more samples, done across categorized separate sexes and stratified age groups. This is the limitation of this project which is basically a baseline study using 35 fecal samples, set to have clues as to what could be the trends.

Recall that the three hypotheses were that: visual characteristics of feacal samples, formol-ether sedimentatiom and zinc sulphate floatation techniques for screening for GIPs support for each other, and lastly that we can design tentative control measures that can support control of GIPs from composition of GIPs observed, visual characteristics of fecal samples and routes of transmission of these GIPs.

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