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Cockroaches as carriers of human gastrointestinal parasites in Wolkite Town, southwestern Ethiopia

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Cockroaches are considered as vectors of different diseases caused by bacteria, fungi, viruses, protozoa and helminthes. The objective of this study was to examine the role of cockroaches as carriers of intestinal parasites in Wolkite town. Cockroaches were collected twice per month from five kebeles and 50 households, from March to April in 2016. A total of 209 cockroaches were collected in this study. In total, 157 (75.1%) specimens were infected with one or more intestinal parasites such as *Ascaris lumbricoides, Hymenolepis nana, Taenia* spp., *Enterobius vermicularis, Strongyloides stercoralis, Trichiuris trichuira, Giardia lamblia*, *Entameoba histolytica/dispar* and hookworm. The most frequent parasites found were *Taenia* spp. (29.7%) and *E. histolytica/dispar* (28.7%). Statistical difference was observed among the five kebelles (χ^2= 13.1, P = 0.011) and the body distribution of parasites (internal and external) (χ^2 = 28.415, P = 0.000). The high frequency of parasites in cockroaches in Wolkite town indicates that cockroaches are carriers of several zoonotic parasites that could infect Wolkite inhabitants. Therefore, controlling of cockroaches populations, creating awareness to the community about personal hygiene and environmental sanitation are essential to minimize the transmission of intestinal parasites by cockroaches.

Key words: Intestinal parasites, cockroach, Wolkite Town.

INTRODUCTION

Over 3,500 known species of cockroaches are found universally (Etim et al., 2013); thirty of these are considered as human pests (Lee and Lee, 2000). Of these, *Blattella germanica* (German cockroach), *Periplaneta americana* (American cockroach) and *B. orientalis* (the Oriental cockroach) are considered the most common pests to humans (Hamu et al., 2014; Shahraki et al., 2013).

Cockroaches are well known to cause considerable irritation and emotional distress in some people but they are not only nuisance in our houses (Kass et al., 2009). They also cause food poisoning with their feces or salivary gland excretions, and even the dead cockroaches (Etim et al., 2013). Some cockroaches are capable of biting human beings especially when they are sleeping (Okafor-Elenwo and Elenwo, 2014).

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Presence of body detritus and cockroaches feces causes allergy and asthma (Etim et al., 2013). Furthermore, they are considered vectors of bacteria, fungi, viruses, protozoa and helminthes (Tilahun et al., 2012). Although, some studies have been performed to assess the role of cockroaches as a mechanical carrier of pathogenic microorganisms in Ethiopia (Tachbele et al., 2006; Hamu et al., 2014), reliable information is not currently available in Wolkite. Therefore, this study was carried out to identify protozoa and parasite eggs present externally and internally in cockroaches collected from Wolkite town, south west Ethiopia.

MATERIALS AND METHODS

Study area and population

This study was conducted at Wolkite Town in Gurage Zone located at Global Positioning Systems coordinates 8°17′N and 37°47′ E in the southern region of Ethiopia. This town has an elevation of approximately 1935 m. The annual temperature ranges are between 13 and 30°C and the mean annual rain fall ranges between 600 and 1600 mm.

Collection and identification of cockroaches

Fifty households were randomly selected from the five kebeles (10 households from each kebele). Cockroaches were collected twice per month from March to April 2016. Cockroaches were captured directly using sterile hand-gloves and sterile screw-capped 250 ml jars (Paul et al., 1992).

During sampling, the number of trapped cockroaches were labeled and pooled as one sample from each of the sampling areas (kebeles). Then, numbers of trapped cockroaches were counted. Adult, whole and alive cockroaches were included in this study and those dead, or showing missing body parts were excluded. Finally, the number of trapped cockroaches' specimens were placed in labeled jars and immediately transported to the Microbiological Laboratory of Wolkite University, for identification and further processing. Morphological identification of the cockroach species was carried out using standard taxonomic keys (Lane and Crosskey, 1993).

Isolation and identification of parasites

Isolation and identification of parasites from the external surface of the cockroaches

Cockroaches were euthanized using chloroform. They were individually placed in a beaker and washed with 5 ml of sterile physiological saline by shaking for 2 min to detach the parasites of the cockroach surface. Solutions obtained from washing cockroaches were considered as external body homogenate samples. Subsequently, 2 ml of the washing fluid was transferred to a sterile test tube and centrifuged at 2000 rpm for 5 min. Supernatant was discarded and the deposits was stained with 1% Lugol's iodine on a clean glass slide, covered with a cover slip and viewed using light microscope 40x objective lens as described by Salehzadehah et al. (2007). Finally, parasites were identified and counted using standard keys (WHO, 2004). Parasites recovered were expressed as percentage abundance of the isolates (Iboh et al., 2014).

Isolation and identification of parasites from the internal body of the cockroaches

After external body examination, the cockroaches were individually placed in 90% ethanol for five min (to remove parasites from the external surfaces). Afterwards, cockroaches were washed in sterile saline solution to remove the traces of alcohol from the body of the cockroaches. They were allowed to dry at room temperature. Then, cockroaches were put on Petri-dish and dissected; the heads were severed first, followed by the legs, then the abdomen was opened using fine pointed forceps and discarded. Alimentary tract was dissected using auto-clave sterilized entomological needles under a dissecting microscope to locate gut homogenates. The gut and other abdominal organs were removed using fine needles and after every dissection, instruments were sterilized. The instruments were dipped in ethanol and flamed between dissections. The excised gut was then homogenized in 5 ml of sterile saline solution, and the sample was considered an internal body homogenate sample. Then, 2 ml of the macerate was centrifuged at 2000 rpm for 5 min from the homogenate sample (Etim et al., 2013). The sediments were examined using the direct wet mount. Briefly, a drop of the suspended sediment was placed on clean, grease-free microscope slides, and stained with 1% Lugol's iodine and each slide was examined for parasites under 10 and 40x magnification of a binocular microscope. Eggs and larvae of intestinal parasites present were identified using taxonomical keys. Adult worms were observed using magnifying glass or hand lens (Okafor-Elenwo and Elenwo, 2014).

Statistical analysis

The data collected in the study was entered into MS Excel before analysis. Descriptive analysis was carried out on the various intestinal parasites carried by cockroach samples, including determination of their frequencies of occurrence and percentages/prevalence rates. Subsequently, a Chi-square test was used to compare external and internal carriage rates of the different intestinal parasites with significant differences at the $p<0.05$ level using SPSS software version 16.

RESULTS AND DISCUSSION

In total, 209 cockroaches were collected and examined for intestinal parasites from five kebeles in Wolkite Town, Southwestern Ethiopia. *Blattela germanica* was the only species of cockroach collected in this study. Samples from 157 (75.1%) cockroaches tested positive to at least one intestinal parasite. Nine species of medically importance parasites were identified (Figure 1). *Taenia* spp., 62 (29.7%) were the dominant parasite followed by *E. histolytica/dispar*, 60 (28.7%), *Giardia lamblia*, 50 (23.9%) and hookworm, 38 (18.2%).

There was a significant difference (χ^2= 13.1, P = 0.011, 95%CI = 0.000, 0.030) in the occurrence of intestinal parasites among cockroaches collected from the five selected kebeles. The highest infected cockroaches were collected from Ediget chora kebele, 28 (100%) followed by Selamber Kebelle, 48 (76.2%) (Table 1).

There was also a significant difference among each intestinal parasite species among the selected Kebelles (Table 2). The most significant difference observed

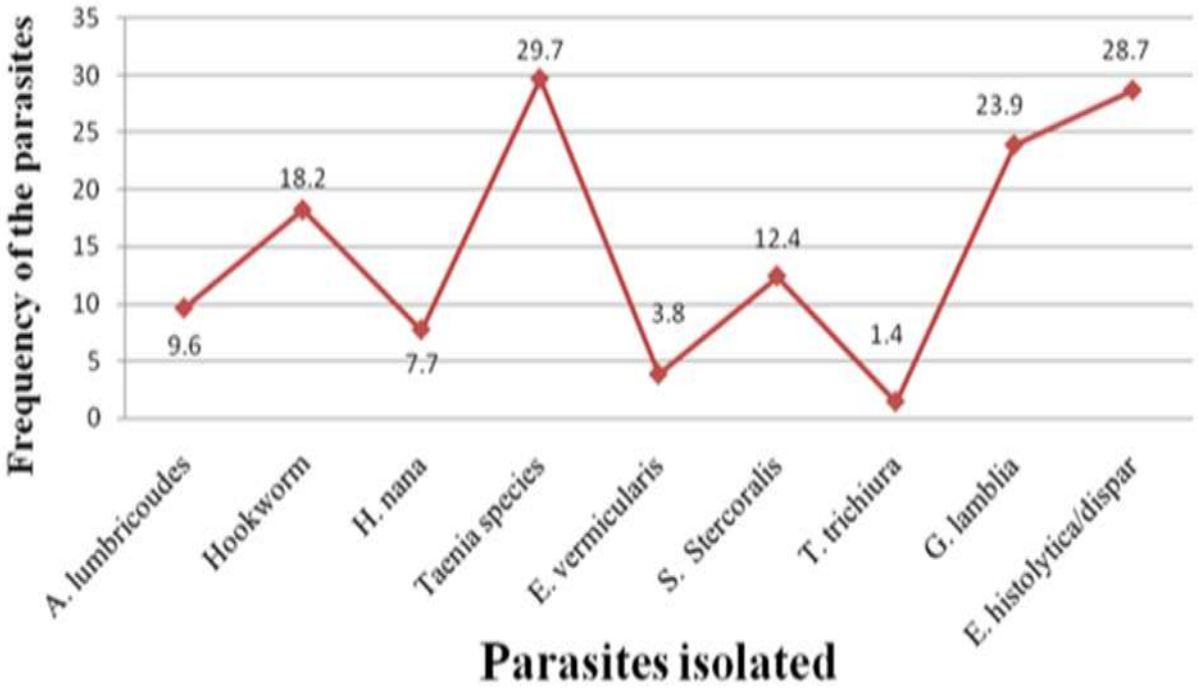

Figure 1. Percentage of parasite species isolated from populations of *B. germanica* in Wolkite Town, southwestern Ethiopia, 2016. *A. lumbricoides = Ascaris lumbricoides*, *H. nana = Hymenolepis nana*, *E. vermicularis = Enterobius vermicularis*, *S. stercoralis = Strongyloides stercoralis*, *T. trichiura = Trichiuris trichuira, G. lamblia = Giardia lamblia*, *E. histolytica/dispar = Entameoba histolytica/dispar*.

Table 1. Percentage of intestinal parasites isolated from populations of *B. germanica* by kebeles in Wolkite Town, southwestern Ethiopia, 2016.

Kebelles	No. of cockroaches examined	Infected cockroaches n (%)
Addis hiwot	40	27 (67.5)
Ediget chora	28	28 (100)
Ediget ber	39	25 (64.1)
Meneharia	39	29 (74.4)
Selamber	63	48 (76.2)

among Cockroaches infected with *Giardia lamblia* (χ^2= 26.1, P = 0.000, 95% CI = 0.000, 0.014).

Of the 157 infected cockroaches, 87 (55.4%) and 53 (33.8%) were found to harbor parasites on their internal and external parts, respectively (Figure 2). There was a significant difference between the infected parts of the cockroaches (χ^2 = 28.415, P = 0.000). The isolated intestinal parasite species showed significant differences in infecting the parts of the collected cockroaches (Table 3).

DISCUSSION

Results from this study showed that cockroaches play an important role in the transmission of intestinal parasite species that are medically important. The overall parasite carriage rate (75.1%) recorded in this study was comparable with reports from Jima, Southwestern Ethiopia (75.6%) (Hamu et al., 2014) and Nigeria (77.52%) (Bala and Sule, 2012). The study result is also higher than that of study conducted in Thailand (54.1%) (Chamavit et al., 2011), Calabar, Nigeria (58.6%) (Etim et al., 2013) but lower than 94.0% reported by Nagham et al. (2011) and 98% observed in Egypt by El-Sherbini and El-Sherbini (2011).The observed difference might be due to environmental condition differences of the area, socio-economic conditions, degree of presence of unsanitary conditions and individual habit difference of selected households. A number of studies has also noted that

Table 2. Prevalence of each isolated intestinal parasite species from populations of *B. germanica* among kebeles in Wolkite Town, southwestern Ethiopia, 2016.

Parasites	Ah n (%)	Ec n (%)	Eb n (%)	Me n (%)	Se n (%)	95% CI	χ^2	*P*- value
Al	3 (7.5)	2 (7.1)	2 (5.1)	0 (0)	13 (20.6)	0.000-0.014	14.3	0.006
Hw	8 (20)	5 (17.9)	3 (7.7)	11 (28.2)	11 (17.5)	0.164-0.276	5.6	0.228
Hn	4 (10)	1 (3.6)	8 (20.5)	2 (5.1)	1 (1.6)	0.000-0.014	13.7	0.008
Ts	17 (42.5)	14 (50)	5 (12.8)	11 (28.2)	15 (23.8)	0.000-0.014	15.1	0.005
Ev	2 (5)	0 (0)	5 (12.8)	0 (0)	1 (1.6)	0.000-0.014	12.2	0.016
Ss	9 (22.5)	2 (7.1)	0 (0)	5 (12.8)	10 (15.9)	0.003-0.045	10.7	0.031
Tt	0 (0)	0 (0)	0 (0)	0 (0)	3 (4.6)	0.003-0.101	7.1	0.133
Gl	6 (15)	17 (60.7)	10 (25.6)	8 (20.5)	9 (14.3)	0.000-0.014	26.1	0.000
Eh/d	9 (22.5)	15 (53.6)	10 (25.6)	8 (20.5)	18 (28.6)	0.006-0.051	10.7	0.031

Ah = Addis hiwot, Ec = Ediget chora, Eb = Ediget ber, Me = Meneharia, Se = Selamber, *Al = Ascaris lumbricoides, Hn = Hymenolepis nana, Ts = Taenia species, Ev = Enterobius vermicularis, Ss = Strongyloides stercoralis, Tt = Trichiuris trichuira, Gl = Giardia lamblia, Eh/d = Entameoba histolytica/dispar.*

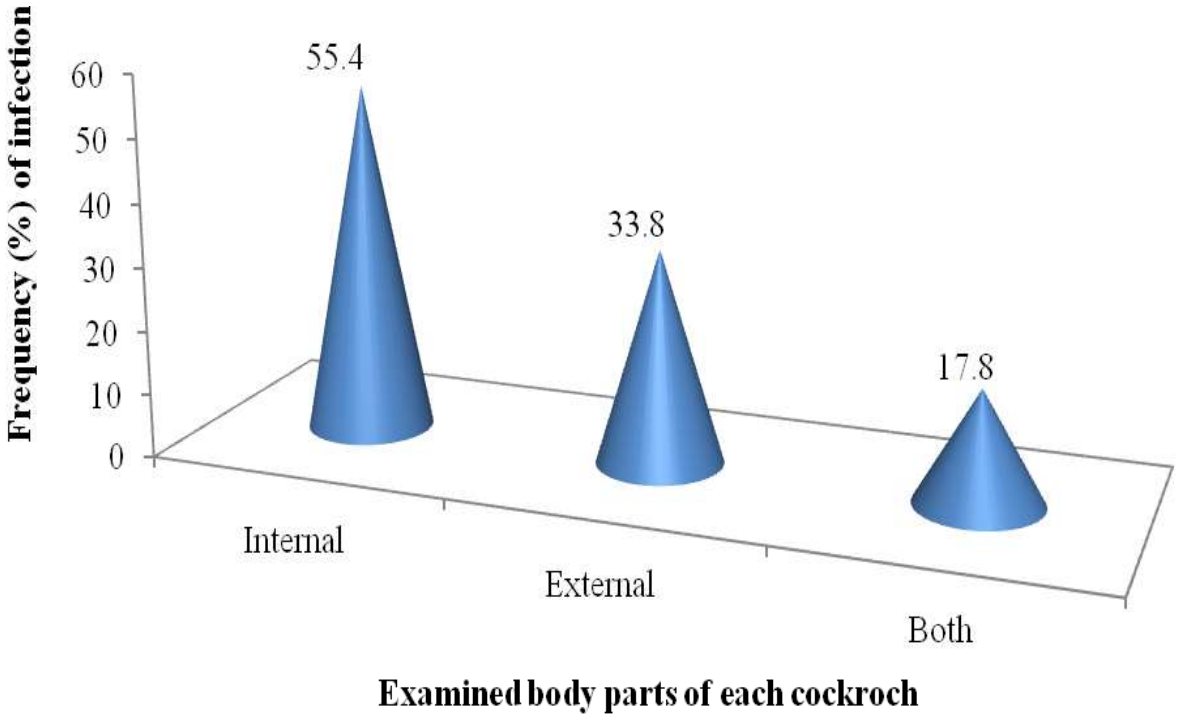

Figure 2. Percentage of intestinal parasites isolated from the internal and external body surfaces of the populations of *B. germanica* in Wolkite Town, southwestern Ethiopia, 2016.

environmental dirtiness, low levels of living standards, low income and ignorance contribute to the continued increase in prevalence and morbidity of parasitic infections in Africa (Myung and Kyu-Earn, 2012). Furthermore, the high infective rate recorded in cockroaches trapped might be an indication of their filthy feeding habit which makes them efficient carriers of parasitic worms, cysts or eggs (Nagham et al., 2011).

In this study, nine species of intestinal parasites were identified from the collected cockroaches. This might indicate that cockroaches serve as important vectors in the transmission of different parasite that cause numerous types of intestinal diseases. Findings from various studies have confirmed that cockroaches are not only nuisance in our houses but reservoirs and disseminators of pathogenic microorganisms to humans

Table 3. Percentage of each intestinal parasites species isolated from the gut contents and external body surfaces of the Populations of *B. germanica* in Wolkite Town, Southern Ethiopia, 2016.

Parasites	Examined body part		X^2	P value
	Internal contents n (%)	External surface n (%)		
A. lumbricoides	12 (5.7)	13 (6.2)	27.422	0.000
Hookworm	28 (13.4)	12 (5.7)	0.117	0.732
H. nana	9 (4.3)	8 (3.8)	1.355	0.244
Taenia spp.	38 (18.2)	36 (17.2)	6.712	0.010
E. vermicularis	8 (3.8)	0 (0)	-	-
S. stercoralis	26 (12.4)	0 (0)	-	-
T. trichiura	3 (1.4)	0 (0)	-	-
G. lamblia	40 (19.1)	26 (12.4)	34.494	0.000
E. histolytica/dispar	49 (23.4)	37 (17.7)	54.923	0.000

A. lumbricoides = Ascaris lumbricoides, *H. nana = Hymenolepis nana*, *E. vermicularis = Enterobius vermicularis*, *S. stercoralis = Strongyloides stercoralis*, T. trichuira = *Trichiuris trichuira, G. lamblia = Giardia lamblia*, *E. histolytica/dispar = Entameoba histolytica/dispar.*

in our homes (Alam et al., 2013). The research by Etim et al. (2013) showed that the discovery of *Trichiuris trichuira* and *Ascaris lumbricoides* ova in the external surface and gut of cockroaches agrees with the pre-position that cockroaches are seriously involved in the epidemiology of soil transmitted helminthes (STH). According to Dehghani et al. (2014), cockroaches are the carriers of many pathogenic organisms, they pick up from contaminated places such as sewers, drains, garbage, landfills, bathrooms and toilets. In addition, Chan et al. (2004) and Iboh et al. (2014) reported that the presence of *Enterobius vermicularis* signifies the obvious contact of cockroaches with infected persons in houses or clothings which confirm their ability to transmit pathogens. Furthermore, Kassiri and Kazemi (2012) stated that cockroaches can bear pathogenic agents both on their teguments and in their intestines, and cause many intestinal diseases and illnesses.

Several researches revealed that cockroaches are considered to be vector for zoonotic parasites (Caccio and Ryan, 2008; Alam et al., 2013). Similarly, *Etamoeba* spp. and *Giardia lamblia* were zoonotic protozoan parasites isolated in the present study. This indicates that cockroaches can serve as a means of mechanical or biological vector of several zoonotic parasites which cause zoonotic disease. For instance, *Cryptosporidium* spp. and *Giardia* spp. are zoonotic protozoan isolated from cockroach specimens (Adam, 2001; Alam et al., 2013). Hamu et al. (2014) also reported that *Giardia doudenalis*, *Entamoeba* spp. and *Balantidium coli* were isolated from cockroaches collected in Jima Town, southwestern Ethiopia. The study conducted in Nigeria reported that *Balantidium coli* and *E. histolytica* were isolated from cockroach sample (Etim et al., 2013; Iboh et al., 2014). Furthermore, the report of El-Sherbini and El-Sherbini (2011) indicated that oocysts of Coccidian parasites such as *Cryptosporidium* and *Cyclospora* spp. had been isolated from cockroach specimen.

In the current study, more parasites were isolated from the internal body (55.4%) than external parts (33.8%) of the cockroaches with a significant difference between the infected parts ($X^2 = 28.415$, P = 0.000). This might be due to the fact that most of the cockroaches were infected through feeding on contaminated fecal materials which had an egg or cyst of intestinal parasites rather than body contact. In contrast, a report by Etim et al. (2013) showed that 65.3% of total parasites obtained were isolated from the external surface than the gastro-intestinal tract that had 34.6%.

Moreover, in this study, there was a significant difference (P = 0.011, $X^2 = 13.1$, 95% CI = 0.000, 0.030) in the occurrence of intestinal parasites among the five selected kebeles. The differences in the hygienic condition of the environments, including human excreta disposal, may account for the observed variation in the parasite carriage rate among different settings (Hamu et al., 2014). Previous studies carried out by Iboh et al. (2014) and Tachbele et al. (2006) showed that most times, cockroaches inhabit area with poor sanitation or dirty environments, feed on dirty materials including human faeces which may be colonized by parasites and other pathogenic organisms.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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