AN INVESTIGATION ON AND ISOLATION OF HUMAN PARASITES ASSOCIATED WITH CONTAMINATED *CATHA EDULIS* LEAVES SOLD IN SELECTED PARTS OF NAIROBI CITY COUNTY, KENYA

Nthiga J. N.
College of Health Science, Jomo Kenyatta University of Agriculture and Technology, Kenya

Dr. Amos Mbugua
Department of Biomedical Science, Jomo Kenyatta University of Agriculture and Technology, Kenya

Dr. Christopher Anjili
Chief Research Officer (Parasitology/Entomology), CBRD, Kenya Medical Research Institute, Kenya

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ABSTRACT

Introduction: *Catha edulis (Khat)* is a stimulant containing the alkaloid, cathione. The most common form of C. edulis is as dried leaves which can be chewed, brewed into tea, sprinkled on food or smoked. Contamination of leaves can lead to widespread diorrhoeal diseases among the vendors and consumers. **Broad objective:** The main objective was to investigate and isolate human parasites associated with contaminated *c.edulis* leaves sold in selected streets of Nairobi City County. **Study design and site**. The study Design was descriptive Cross Sectional. The study sites was include selected street of Nairobi City County where the leaves are highly sold and consumed, and include East Leigh, Kawangware, Kibra, Mathare, Dandora. **Material and methods:** Authority to conduct the study was obtained from JKUAT/ KNH/UoN ERC. The study population was vendors of Khat in selected city streets. An administered structured questionnaire was used to collect data from a sample of 155 vendors across the study sites. *Khats* leaves were collected in aerated bags. The leaves were processed in Jomo Kenyatta University of Agriculture and technology Labs. Concentration and Direct method were carried out to isolate human parasites on the leaves. Data analysis was conducted using SPSS version 23.0 and STATA 12. A statistical analysis was done using the chi square; $P < 0.05$ was considered significant. **Results:** Parasites were isolated in 15.4% (n=24) of the study sites. G. lamblia 6.5% (N=10), E. hystolitica 5.8% (n=9) were the main parasites. Others were A. lumbricoides 1.9 (n=3), and strongyloides 1.3% (n=2). Majority 54.8% (n=85) stored the leaves on the ground uncovered. Stagnation wastes were in 70.3% (n=109) of the study sites. Toilets were mainly public open sharing and water vendors with open communal taps 84.2% (n=130 were the main) water suppliers. *E. hystolitica* and *G. lamblia* were mainly isolated in Eastleigh. *G. lamblia* was found in all areas except Kibra. Presence of parasites was statistically found to be associated with the area/ site, p=0.011 and the type of wates (p=0.043). **Conclusion:** The main contaminants of *C. edulis* leaves were *G. lamblia* and *E. Hystolitica* with a wide spread across Nairobi county. Parasites were associated with stagnation wastes poor hygiene, and poor storage of the leaves especially on the ground uncovered. **Recommendations:** Setting up of standard shops with required level of hygiene by the county government for vending C. edulis leaves, ensuring that vendors undergo regular medical checkup and proper disposal of wastes will reduce contaminations of the leaves, government to facilitate value addition mechanism to reduce contamination of leaves

Key Words: *isolation, human parasites, Catha edulis leaves, Nairobi City County*

INTRODUCTION

Khat scientifically known as Catha edulis is a flowering plant native to the horn of Africa and long history as social custom dating back thousands of years (Blackmore, 2007). Khat contains a

monoamine alkaloid called cathione an amphetamine like stimulant which is said to cause excitement, loss of appetite and euphoria. In 1980, the WHO classified it as a drug of abuse that can produce mild to moderate psychological dependence (less than tobacco or alcohol, although WHO does not consider Khat to be seriously addictive, the plant has been a target by anti-drug organizations such as the DEA (Drug Enforcement Administration) (Brenneinsen et al., 2009). Catha edulis is a shrubs which found in arid environment within temperature range of 5 to 35 °C (41 to 95 °F). And grows in equatorial region to attains a height of up to 10 meters (33 ft) but average of between 1 and 5 m (3.3 and 16.4 ft). It has evergreen leaves, which are 5–10 cm long and 1–4 cm broad. The shrub's flowers are produced on short axillary cymes that are 4–8 cm in length. Each flower is small, with five white petals. The samara fruit is an oblong, three-valved capsule, which contains one to three seeds (Robson et al., 1994).

In Kenya Khat is legal however two of its components, cathione and cathione are classified as class C substances. It is a crop for export from Kenya with approximately 6 tons of khat being sent to the UK per week alone, mostly by air from Kenya. This is but one destination for the export of this product and the bulk of this is in transit for supply to United States of America. The UK is a base for khat distribution to many countries including the US where the drug is illegal (Septa, 2012). Current use of miraa in Kenya is 3.9%; it also varies by region of residence and gender. Like tobacco products, use of miraa is largely a male dominated affair. In North Eastern region, 35.8% of the male respondents reported using miraa. This was closely followed by Coast at 12.8%. Miraa usage is marginal in Nyanza and Western Kenya. In Eastern region where the bulk of the miraa comes from, only 9.4% reported being current users of the drug. It is also interesting to note that North Eastern region (7.6%) has the highest proportion of female users of Miraa (NACADA, 2012).

RESEARCH PROBLEM

Human parasite infection are common in tropical and sub-tropical regions of the developing world especially in sub-Saharan Africa where poor domestic and environmental hygiene prevails, Poor quality source for drinking water ,inadequate sanitation facilities and overcrowding aid in human parasite transmission, which include amoeba and helminthes. Globally geohelminths impact the lives of millions of people. 819 million people are infected with roundworm (Ascariasis), while whipworm (Trichuriasis) are responsible for about 464.6 million infection while two hook worm species(Necator and Ancylostoma) infect 438.0 million individual with Considering of 480 million people were infected with *E. histolytica* and 36 million developed disabling colitis with 40 thousand deaths attributed to amebiasis, and on a global scale, amebiasis likely ranks third among parasitic causes of death, behind only malaria and schistosomiasis. *G.lamblia* prevalence rate in temperate climates is 2-10% in adults whereas in tropical countries 50-80% of people are carriers *G. lamblia* is the most commonly identified intestinal parasite in the United states(US) as well as in Canada, Center for Disease Control(CDC) reports approximately 20,000 cases per year in US. According to one report from Ontario, Canada showed an incidence rate of 25.8 cases per 100,000 populations between

1990 and 1998. In developed countries, infection occurs most frequently among children care centers and congested population due to ingestion of mature cyst in drinking untreated water; unhygienic food being common source of infection and can result in community wide epidemics. These groups of intestinal parasite to are transmitted primarily through oral route. They have direct lifecycle and parasitic infection occurs through fecal contamination of foodstuffs and water supplies (Omitola *et al*., 2016). They are listed as part of neglected tropical diseases (NTDs) hence affecting more than one billion people worldwide mainly in Africa and mostly those living in remote rural, urban slum areas or conflict zones hence are obstacles to human settlement and social economic development of already impoverished communities, In 15 june 2016 Kenya launched the second NTD master plan2016-2020 to enhance elimination. In most places where it is grown, harvested and sold, there are usually no hygienic facilities such as well-maintained sanitation and toilet facilities. And as Khat is usually chewed without cleaning the leaves; it is sold in the open in areas where it is exposed to dust. All these factors can expose humans to a variety of pathogens ranging from bacteria, amoeba to intestinal geo helminthes.

JUSTIFICATION OF THE STUDY

An estimated 500,000 Kenyans depends on *C. edulis* cultivation(Nyongesa and Onyango (2010) and sale for their livelihood with Britain's importing some $25million worth of the leaves annually before the 2014 ban .More than 15 cargo planes full of cargo planes full of khat also leave Kenya for Somalia dairy with retail value Of $400,000.Expert have also debated the impact of *C. edulis* on health and central nervous system which has led to banning in UK despite an official recommendation from regulatory agencies that it remains legal. The loss of British market which consumed between 2500 and 2800 tons a year has left many farmer and traders in Maua with huge loss. In consideration with mode of parasite transmission and in order to be able to control human pathogens that can be transmitted through the oral route, it is important to study the source of transmission. It is possible that because of the unhygienic manner *C. edulis* is handled; chewing could be a source of transmission. Studies on the effects of the plant have only been based on other medical conditions ignoring parasite transmission. Through available parasitological techniques, attempts were made to isolate and identify human parasites from *C. edulis* bought from different vendors in selected parts of Nairobi County.

HEALTH EFFECTS OF CHEWING *C. EDULIS*

Chewing khat is both a social and a culture-based activity. It is said to enhance social interaction, playing a role in ceremonies such as weddings. In Yemen, Muslims are the most avid chewers. Some believe that chewing facilitates contact with Allah when praying. However, many Christians and Yemenite Jews in Israel also chew khat. Khat is a stimulant and it is used to improve performance, stay alert and to increase work capacity (Kalix, 2004). Workers on night shifts use it to stay awake and postpone fatigue. Students have chewed khat in an attempt to improve mental performance before exams. Yemeni khat chewers believe that khat is beneficial for minor ailments such as headaches, colds, body pains, fevers, arthritis and also depression

(Kennedy et al., 2003). Khat consumption induces mild euphoria and excitement, similar to that conferred by strong coffee. According to a study conducted by Kalix (2004), Individuals who chew khat become very talkative under the influence of the plant. The effects of oral administration of cathinone occur more rapidly than the effects of amphetamines pills, roughly 15 minutes as compared to 30 minutes in amphetamine. Khat can induce manic behaviors and hyperactivity similar in effects to those produced by amphetamine (Kalix, 2004).

The use of khat results in constipation. Dilated pupils (mydriasis) are prominent during khat consumption, reflecting the sympathomimetic effects of the drug, which are also reflected in increased heart rate and blood pressure. Withdrawal symptoms that may follow occasional use include mild depression and irritability. Withdrawal symptoms that may follow prolonged khat use include lethargy, mild depression, nightmares, and slight tremor. Khat is an effective anorectic (causes loss of appetite). Long-term use can precipitate the following effects: negative impact on liver function, permanent tooth darkening (of a greenish tinge), susceptibility to ulcers, and diminished sex drive (Mersubin, 2007). The consequences of Miraa and other drugs use among youth are visible in the communities. Many youth have dropped out of school due to their substance abuse, thereby freeing them to engage in petty business and earn money to purchase Miraa. There are frequently fights between youth and adults when they differ on some issue after chewing Miraa or drinking alcohol. Rape cases are often reported to involve perpetrators under the influence of drugs. Unwanted pregnancies have forced many girls to drop out of school. Prostitution and irresponsible sexual behaviors have also cropped up among youth as a result of drug use (NACADA, 2012).

CHEMISTRY AND PHARMACOLOGY OF *C. EDULIS*

The stimulant effect of the plant was originally attributed to "katin", cathine, a phenethylamine-type substance isolated from the plant (crombie 1980). However, the attribution was disputed by reports showing the plant extracts from fresh leaves contained another substance more behaviorally active than cathine (WHO, 2006; Balint, 2012). In 1975, the related alkaloid cathinone was isolated, and its absolute configuration was established in 1978. Cathinone is not very stable and breaks down to produce cathine and nor ephedrine. These chemicals belong to the PPA (phenylpropanolamine) family, a subset of the phenethylamines related to amphetamines and the catecholamines epinephrine and norepinephrine. In fact, cathinone and cathine have a very similar molecular structure to amphetamine. *Catha edulis* is sometimes confused with methcathinone (also known as cat), a Schedule I substance that possesses a similar chemical structure to the khat plant's cathinone active component. However, both the side effects and the addictive properties of methcathinone are much stronger than those associated with khat use.

HELMINTHES AND AMOEBA THAT MAY BE ASSOCIATED WITH *KHAT* CONSUMPTION

Helminthes transmitted through contamination can be strongly associated with khat consumption particularly those that spend part of their development in the soil. Some of the Helminthes include; *Ascarislumbricoides* Linn, *Trichuris trichiura, Strongyloides stercoralis, Ancylostoma duodenale* and *Necator Americana*. On the other side amoeba that may be associated with Khat consumption include; Genus Entamoeba and Giardia lamblia.

RESEARCH METHODOLOGY

The study used cross sectional design and targeted population consisted of the collected samples of *C. edulis* leaves from vendors in Eastleigh, Kawangware, Kibra, Mathare, Dandora. Using the formula by Fisher *et al.* (1998) sample size was calculated where 160 miraa Vendors were recruited. A stratified sampling method was used to recruit the venders in various locations. Each street represented a stratum. Vendors were distributed as follows; 74 vendors were selected from Eastleigh, 29 from Kawangware, 20 from Kibra, 16 from Mathare and 21 from Dandora. Collection Of *C. edulis* from Study Site was done from all the selected five study sites, an average of 300g of khat leaves from 160 vendors located in 5 study sites was obtained and stored in a cool dry aerated bags during transportation. Samples not processed immediately were refrigerated. A questionnaire having a number for confidentiality was used to each enrolled vendor by the principle investigator (PI). The PI as potential consumer posed questions in questionnaire directly without antagonizing the vendor in language understood where necessary. Data collected was analyzed using statistical package of social sciences (SPSS) version 23.0. Comparison of parasites within and between vendors and sites was done using Chi Square. Data findings were presented in tables, pie charts and graphs besides narrative descriptions.

RESULTS AND DISCUSSIONS

Place of Storage of the Leaves

More than half 54.8 %(n=85) were storing the leaves of *C. edulis* in the ground uncovered which was likely to expose them to various contaminants. This was followed by 29.7% (n=46) who kept the leaves on the ground but covered. Majority 80.0% (n=124) felt that the environment was Okay meaning that the vending sites were clean and didn't not have any decontaminants. Similarly, 5.2% (n=8) indicated that the environment was good. This meant that of the entire participants 85.2% (n=132) either felt their environment was okay or good to conduct their activity, unlike 14.8% (n=23) who felt otherwise.

Wastes Found in the Environment

Results indicated that majority 70.3% (n=109) of the respondents indicated that the most common waste within their environment where they sell the leaves were stagnation wastes. Stagnation wastes are known breeding places for pathogens and hence could have been an easy source of contamination of the leaves.

Toilets Available

According to research findings, open/ sharing toilets were most common 27.7% (n=43) followed closely by personal toilets 24.5% (n=38)

Source and Storage of Drinking Water

The main sources of water available for the respondents were water vendors 46.5% (n=72). For those who dependent on both municipal shared taps and water vendors were 38.7% (n=60) of the total respondents. Further, 12.3% of the respondents indicated that they use municipal taps while 2.6% of the respondents said they use a well. Majority of the respondents 41.9% (n=65) were using water jerry cans for water storage. Others were using water from open environment sources 27.7% (n=43) while 21.3% (n=33) were storing them in a Protected environment.

Parasites Isolated from the Study Sites

Parasites were isolated using both Concentration Method and direct methods this was mainly to ensure that all the parasites which could not be isolated by one method was isolated using the other. In both cases resultant sediment was transferred to slides and examined at x400 magnification for parasite cyst and ova. All ova and cysts were identified using manuals available at Kenya Medical Research Institute and National Museums of Kenya. Various parasites were found in 24 study sites representing 15.4% of the total study sites. The common parasites isolated was *G.lamblia* 6.5% which was isolated in 10 sites, followed by *E. hystolitica* that was found in 9 sites 5.8% (n=9). However most of the sites 84.5% (n=131) had no parasites isolated.

Distribution of Parasites per Location

Table 1: Study site and Parasites found Cross tabulation

Area of Residence	**Parasites found**					**Total**
	E.hystolitica	*G.lamblia*	*A. lumbricoides*	*Strongloides*	None	
Eastleigh	5	4	0	0	64	73
Kawangware	0	1	0	0	27	28
Kibra	2	0	1	2	14	19
Mathare	2	2	1	0	10	15
Dandora	0	3	1	0	16	20
	9	10	3	2	131	155

Characteristics of the Study Site with Parasites Isolated

The general condition of the study sites which had parasites were examined in relations with the method used to store *C. edulis* leaves, types of wastes in the environment, water sources and methods of water storage. The findings were as follows.

The Method of Storage of *C. edulis* Leaves

E. hystolitica was mainly found in study sites where *C. edulis* leaves were stored on the ground uncovered. However, the parasites were also found in sites where the leaves were stored in the ground covered as well as in bags. Similarly, *G.lamblia* was also isolated in similar environment with leaves stored in similar conditions. *A. lumbricoides* was mainly found in areas with leaves stored in the ground uncovered. From the study, majority of the parasites were common in areas where the *C. edulis* leaves were stored on the ground uncovered.

Table 2: The distribution of the parasites in relation to type of wastes

	Kind of wastes found within the environment					Total
	Human feaces	Stagnation wastes	Animal feaces	All the above	None of the above	
E.hystolitica	0	5	0	2	2	9
G.lamblia	1	6	0	2	1	10
A. lumbricoides	0	1	0	2	0	3
Strongloides	0	2	0	0	0	2
None	0	95	8	15	13	131
Total	1	109	8	21	16	155

Table 3: Distribution of the parasites in relation to the type of toilets

	Kind of toilets found at the site						Total
	Public Toilet	Personal Toilet	Open/Sharing Toilet	All the above	Both public & open sharing	No toilets available	
E.hystolitica	1	1	3	0	4	0	9
G.lamblia	2	1	3	2	2	0	10
A. lumbricoides	0	0	0	1	2	0	3
Strongloides	0	0	1	1	0	0	2
None	17	36	36	22	19	1	131
Total	20	38	43	26	27	1	155

Parasites Isolated in relation to Sources of Water

All the parasites were found in sites where there was both municipal taps and water venders as the source of water, with *G. lamblia* and *E. Hystolitica* being the most common pathogens found. Similarly, *E. hystolitica* and *G. lamblia* were also very common in areas where water vendors were the main suppliers.

INFERENTIAL STATISTICS

Table 4 shows cross tabulation of selected study site characteristics and the presence of parasites. There was statistically significant association between the study site and the presence of parasites (p=0.011). Similarly, there was also a significant association between the types of wastes and the presence of parasites (p value=0.04). However, there was no significant statistical association between the presence of parasites and place of storage of leaves (p=0.293); water sources (p=0.532); ways of storing water (p=0.227) and types of toilets (p=0.579).

Table 4: Cross tabulation of selected study site characteristics and the presence of parasites

Variables	**Presence of parasites**			
	Chi square	**Phi Val.**	**Cramer's Val.**	**P value**
Study sites				
Eastleigh	31.672	0.452	**0.226**	**0.011**
Kawangware				
Kibra				
Mathare				
Dandora				
Place of storage of *C. edulis* leaves				
Ground covered	14.117	0.302	0.174	0.293
Ground uncovered				
In a bag				
Types of wastes				
Human feaces	26.844	0.416	**0.208**	**0.043**
Stagnation wastes				
Animal feaces				
All of the above				
None of the above				
Water sources				
Municipal taps	10.970	0.266	0.154	**0.532**
Wells				
Water vendors				
Municipal taps/ vendors				
Ways of storing water				
Open environment	15.278	0.314	0.181	0.227
Protected environment				
Water jerry cans				
Types of toilets				
Public toilet	18.123	0.342	0.171	0.579
Personal toilets				
Open sharing toilet				

DISCUSSION

The study population were vendors of *C.edulis* in selected parts of Nairobi town where usage of *C.edulis* leaves have been reported to be high. This was according to a report by NACADA on areas within Nairobi with high consumption of khat and *C.edulis* leaves (NACADA, 2012). The study sites included for the study were in Eastleigh, Kawangware, Kibra, Mathare and Dandora. Eastleigh estate formed the main study area with 47.1% of the study sites were located.

Across all the sites, more than two thirds (67.7%) of the vendors were males which was a clear indication that vending of *C. edul*is were male dominated however, significant proportion (one thirds) of the females were also involved in the trade. The mean age of the participants was 30.2 years with a standard deviation of 4.13. This showed that the vendors were young people who were in their most productive age group, which are in agreement with a study by Kinoti, Jason and Harper (2011) which established that majority of youth involved in drugs and consumption of Khat and C. Edulis leaves are young people aged below 35 years of age.

The study established that in more than half of the study sites (54.8%), the *C edulis* leaves were being stored on the ground uncovered. This could have contributed to more contamination of the leaves as the parasites could easily get access to the leaves. The findings are similar to a study by Kerrat et al., (2015) who estabsihed that Poor storage and handling of Khat and other substances in the family can be major form of transmission of parasites that are transmissible via fecal oral especially when contaminated. Generally, in this study, 85.2% of the participants perceived their environment to be good and conducive to conduct their business and hence saw no need of making it better. However, over 70.3% of the sites had stagnation wastes which were could have been a major source of contamination of the leaves which were otherwise kept on the ground uncovered.

Further, in 13.5%, of the other sites, there was a combination of all sorts of wastes scattered within and included human faeces, animal faeces and stagnation wastes although the vendors appeared not to be moved by any of them. Such perception that the environment was good meant that the venders were unlikely to take any action to improve on the hygienic status of the vending sites despite the fact that the environment did not appear hygienic. The findings were in agreement with a study by Anderson et al., (2007) which established that poor perception of being at risk by the vendors of khat is a major contributing factor to transmission of various parasites through feaco-oral route. Similarly, the study established that More than half of the sites (52.2%) had either public toilets or open toilets that were being shared by the general public, with 85.2% of them dependent on water vendors and communal municipal taps that were being shared by the general public as sources of water. Most of the water vendors do not collect water from properly treated sources and as such can easily supply contaminated water that can be a major source of transmission of infections.

As stated previously parasites were isolated using both concentration and direct method and identified using manuals from KEMRI and National museums of Kenya. Of all the 155 sites

under study, 15.4% of them had various parasites isolated, with 84.6% having no parasites isolated at all. The parasites isolated were *G. Lamblia, E. Hystolitica, A. Lumbricoides, and strongyloides*. The findings were in agreement with a study by Masese, Joseph, and Ngesu (2012) which indicated that the most common pathogens which are transmitted via feaco-oral rout and can easily cause diarrheal among khat consumers were *G. Lamblia, E. Hystolitica, A. Lumbricoides, and strongyloides*.

In among the sites where parasites were isolated, *G. lamblia* was the most prevalent at 6.5%, followed by *E. hystolitica* at 5.8%, *A. lumbricodes* and *strongyloides* had the least prevalence at 1.9% and 1.3% respectively. *E. histolytic* and *G. Lamblia* was mainly found in Eastleigh, however, *E. Hystolitica* was isolated 5 sites in Eastleigh, two sites in Kibra, and 2 sites in Mathare with none in all the sites in Kawangware and Dandora. As regards *G. Lamblia*, isolation was done at least in all the study areas except in Kibra. However, it was mainly isolated in Eastleigh (4 sites) and Dandora (3 sites). *A. lumbricoides* was isolated in one site each in Kibra, Mathare, and Dandora while *Strongiloides* was isolated in two sites both in Kibra.

Majority of the parasites were mainly found in sites the *C. edulis* leaves were stored on the ground uncovered. However, the occurrence of the parasites was found not to have any statistical association with the method of storage of the leaves (p value=0.293) in all the sites. Similarly, all the parasites were isolated in sites with stagnation wastes. This indicated that such wastes were major source of contamination of *C. edulis* leaves and therefore no vending should take place in such areas. However this continued unabated which could have put consumers at risk. Further the study established a statistical significant association between the isolation of parasites and presences of wastes in the study sites (P value=0.043). Infection of the pathogens occurs through ingestion of dormant microbial cysts in contaminated water or food, or by the fecal-oral route (through poor hygiene practices) and as such proper hygiene conditions are critical in preventing infections (CDC, 2015).

As regards types of toilets, *G. Lamblia* was isolated in sites with all types of toilets , however, more isolation was done in sites with both public toilets and sites where there was open toilets being shared. Public toilets and open public toilets being shared were associated with high levels of *G. Lamblia.* However, the study established that there was no statistically significant association between the presence of the parasites and the type of toilets (p=0.579). Similarly, as regards methods of water sources and isolation of parasites, all the types of parasites were isolated in sites which dependent on communal municipal shared taps and water vendors as their main sources of water. However, the study established no statistical significant association between the presence of parasites and sources of water (p=0.532). Further, water stored in open environment and in jerry cans was found to provide a major source of contamination of the leaves as all the types of parasites were isolated in sites using jerry cans a water storage facility. However, there was no statistical association between the presence of parasites and water sources (P Value =0.227).

CONCLUSIONS

1. The main parasites isolated from the leaves of *C. edulis* were *G. lamblia*, and *E. hystolitica* and hence were the main contaminants. Other trace parasites isolated were *A. lumbricoides* and *strongyloides.*
2. Generally, there was a wide spread of various parasites across the study areas. *E. hystolitica* was found in Eastleigh, Kibra, and Mathare only, but not in Kawangware or Dandora. *G. lamblia* was in all the study areas except Kibra. A. *lumbricoides* was found in Kibra, Mathare, Dandora but none in eastleigh or Kawangware. *Strongiloides* was only found in Kibera. Kawangware had only one site where *G. lamblia* was isolated and hence was the least contaminated study area.
3. Parasites were common where the *C.edulis* leaves were stored on the ground uncovered and where vending was taking place near stagnated wastes, near open/ public shared toilets, communal taps and water vendors as source of water.
4. There was statistical association between the presence of parasites and the study area (P=0.011), and the types of wastes within the environment (P=0.043).

RECOMMENDATION

1. Vending of *C.edulis* within Nairobi city should be regulated and should strictly be done where hygienic standard are properly maintained. There should be good sanitation services, treated water distributed through taps and not from vendors.
2. The county government should construct standard shops with good hygienic conditions for *C. edulis* vendors and restrict sales to these shops.
3. The county government should set a minimal requirement or standards that must be met by people intending to vend *C. edulis* leaves, and this should include, regular medical checkup (Medical certificate every 3 monthly), a standard shop within a clean environment with proper sanitation and adequate treated water supply.
4. The county government should ensure proper waste disposal throughout the city as they are major sources of contaminants and hence may contribute to diarrheal diseases outbreak.

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