# AN INVESTIGATION ON AND ISOLATION OF PARASITES THAT INFECT HUMANS ASSOCIATED WITH *CATHA EDULIS* LEAVES SOLD IN SELECTED PARTS OF NAIROBI COUNTY, KENYA

**JACOB NJERU NTHIGA**

**MASTER OF SCIENCE**

**(Medical Laboratory Science)**

**JOMO KENYATTA UNIVERSITY OF**

**AGRICULTURE AND TECHNOLOGY**

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# An investigation on and isolation of parasites that infect humans associated with *Catha edulis* leaves sold in selected parts of Nairobi County, Kenya

**Jacob Njeru Nthiga**

**A Thesis Submitted in Partial Fulfillment for the Degree of Master of Science in Medical Laboratory Science of the Jomo Kenyatta University of Agriculture and Technology**

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## DECLARATION

This thesis is my original work and has never been presented in any institution leading to the award of a degree or any other award.

Signature……..Date……

**Jacob Njeru Nthiga**

This thesis has been submitted for examination with our approval as University supervisors

Signature……..Date……

**Dr. Amos Mbugua, PhD**

**JKUAT, Kenya**

Signature……..Date……

**Dr Christoper Anjili, PhD**

**KEMRI, Kenya**

## DEDICATION

This work is dedicated to my wife Emily and son Caleb Mark who have been my shadow mentors and a great source of inspiration in my life.

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| **C.D.C** | Centers for Disease Control |
| **D.E.A** | Drug enforcement administration |
| **I.P.I** | Intestinal Parasitic Infections |
| **K.N.H** | Kenyatta national hospital |
| **N.T.Ds** | Neglected tropical diseases |
| **P.P.A** | Phenylpropanolamine |
| **R.P.M** | Revolution per Minute |
| **S.G** | Specific Gravity |
| **SSFS** | Sheather Sugar Floatation Solution |
| **S.T.H** | Soil Transmitted Helminthes |
| **W.H.O** | World Health Organization |

## ABSTRACT

*Catha edulis* (Khat) is a natural psycho-stimulant herb containing the alkaloid cathinone known for causing excitement, loss of appetite and euphoria among others, after chewing its young buds and tender leaves. Although khat is reported to cause various health problems, most of them have never been systematically investigated, especially on contamination with parasite stages and eventual transmission to humans. Food contamination may occur at any stage including preparation, production, processing and distribution. This risk therefore, depends largely on the health status of the handler, personal hygiene, knowledge and systematic application of food hygiene. This study explored the possibility of transmission of intestinal parasites through use of the herb. This survey was conducted between the months of December 2018 and May 2019 in Eastleigh, Kawangware, Kibra, Mathare and Dandora suburbs in Nairobi County. This involved 155 (105 males & 50 females) selected khat vendors using a structured questionnaire to collect demographic data. Khat leaves were collected in aerated bags, then processed and evaluated for presence of contaminant parasites that infect humans using concentration and direct methods, in the laboratory at Jomo Kenyatta University of Agriculture and technology. Data on environmental risk factors/conditions was gathered from the vendors through a structured questionnaire and physical observation of the surrounding. The minimum and maximum ages of respondents were 22 and 43 years respectively. Data obtained were analyzed using SPSS version 23.0 and significance pegged at <0.05. Parasites were isolated in 24 (15.4%) of the study sites: *Giardia lamblia* cysts were isolated in 10 sites (6.5%) and *E. histolytica* in 9 sites (5.8%) and were the main parasites across the suburbs. 54.8% (n=85) of the vendors stored the leaves on the ground uncovered. Garbage wastes were found in 70.3% (n=109) of the study sites. Presence of parasites was statistically associated with the area/ site, $p$=0.011 and the type of wastes ($p$=0.043). The present study revealed main contaminants of *C. edulis* leaves were cysts of *G. lamblia* (6.5%) and *E. histolytica* (5.8%); ova of *A. lumbricoides* (1.9%) and larvae of *Strongyloides stercilaris* (1.3%). Poor storage of leaves, personal hygiene and polluted environmental conditions significantly contributed to and represented potential routes for the transmission of parasitic infections. Public health education may be key to reducing parasites infections got through contaminations. Similarly, setting up of standard shops with required level of hygiene by the County Government for vending *C. edulis* leaves is essential.

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background Information

*Catha edulis* (Vahl) Forssk is a species of evergreen trees or shrubs (Curto *et al*., 2013) cultivated widely in Eastern African countries and some parts of Arabian Peninsula (Saif-Ali *et al*., 2003, Wabe, 2011). Khat, commonly referred to as miraa or veve in Kenya refers to the young leaves and shoots of *Catha edulis Forssk* plant belonging to the *Celastraceae* plant. The plant is branded as a natural stimulant, chewing its young buds, bark and tender leaves result in a state of stimulation and euphoria (Wabe, 2011). In Kenya, it is chiefly grown in Meru and Embu counties although other parts of the country also cultivate the plant but in smaller proportions.

The principal psychoactive constituents of *C. edulis* are cathinone and cathine which have sympathomimetic actions (Kalix and Braenden, 1985). These compounds are believed to be concentrated mainly in young leaves of *C. edulis* (WHO, 2006; Szendrei, 1980). The environment and climatic conditions where the plant is grown determine the chemical composition of the plant (WHO, 2006). Selling *Catha edulis* is a lucrative business and is traded openly in Kenya, Djibouti, Ethiopia, Somalia, Uganda, and Yemen but it is not legal in many countries including Eritrea, Kuwait, Saudi Arabia, Sudan, Tanzania, and Zambia (Roelandt *et al.,* 2011). Somalia has the highest percentage of khat consumers in the world with most of the khat consumed in the country being imported from neighboring Kenya.

Historically, Khat leaves have been chewed since ancient times to alleviate fatigue, enhance work capacity, stay alert, reduce hunger, induce euphoria and enhance self-esteem (Ongeri *t al*., 2019). Khat has been appreciated for medical purposes too and for recreational purposes. It is habitually used in informal meetings (Khat sessions) in which the participants are engaged in discussions and maintain social contact. During Khat

sessions, leaves and the tender younger stalk of the plant are chewed slowly over several hours and they are kept in the sides of cheeks until the mouth is filled with fresh leaves. The users then chew intermittently to release the active components and then spit out the residue (Al-Habori, 2005).

In Kenya, Khat is legal however two of its components, cathinone and cathine are classified as class C substances. It is a crop for export from Kenya with approximately 6 tons of khat being sent to the United Kingdom (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.

There are no reliable figures for the UK khat-using population, but estimates (presumed underestimates) seen range from 50,000–88,000 people (Singleton, 2011).

Current use of miraa in Kenya is 3.9%; it also varies by region of residence and gender. Although non-users both in rural and urban areas condemn the practice of chewing khat, the number of people who use this plant is increasing, particularly among the youth. In urban areas, chewing khat is becoming a common leisure activity. 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 closely followed by Coast at 12.8%. Miraa usage is marginal in Nyanza and Western Kenya. In Eastern region its where the bulk of the miraa comes. It is also interesting to note that North Eastern region (7.6%) has the highest proportion of female users of Miraa (NACADA, 2012).

Despite the daily consumption and use of khat by lots of people in Kenya and other countries, and its growing importance as a lucrative cash crop, there is very little knowledge about the associated parasitic infections. There is limited information on parasite transmission to humans via handling of khat by vendors (Nthiga *et al*., 2019). These are people who rarely undergo medical examinations despite Kenya's health requirements that all food-related handlers undergo regular medical examination to curb possible transmission of disease-causing agents (Kamau *et al.*, 2012). It is against this

background that this study was born. Hence, the objective of this study was to investigate the presence, species and distribution patterns of parasites, and environmental factors associated with contamination of C. *edulis* leaves in selected parts of Nairobi County, Kenya.

**Figure 1.1: Catha edulis (khat) plant (Source: Wikimedia.org)**

## 1.2 Statement of the problem

Parasitic infestations to humans 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 of drinking water, inadequate sanitary facilities and overcrowding aid in human parasite transmission, which include amoeba and helminths. Globally geohelminths influence the lives of millions of people.

About 819 million people are infected with roundworm (*Ascariasis*), while whipworm (*Trichuriasis*) are responsible for about 464.6 million infection and the two hookworm species (*Necator* and *Ancylostoma*) infecting 438.0 million individual. Considering over 480 million people were infected with *E. histolytica* and 36 million developed disabling colitis with 40,000 deaths attributed to amebiasis, and on a global scale, amebiasis likely ranks third among parasitic causes of death, only behind malaria and schistosomiasis.

*Giardia lamblia* prevalence rate in temperate climates is 2-10% in adults whereas in tropical countries 50-80% of people are carriers. *Giardia 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 parasites 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 most places where khat is grown, harvested and sold, there are usually no hygienic facilities such as well-maintained sanitary environmental and toilet facilities. Khat is usually chewed without washing the leaves; it is sold in open areas where it is exposed to dust and contaminants. All these factors can expose humans to a variety of pathogens ranging from bacteria, amoeba to intestinal geo-helminthes.

## 1.3 Justification of the study

An estimated 500,000 Kenyans depends on *C. edulis* cultivation (Nyongesa and Onyango, 2010) and sale for their livelihood. Loads of khat are exported from Kenya to Somalia daily, earning a substantial income to farmers. Experts have debated the impact of *C. edulis* on human health and recommended studies on khat consumption. Parasitic contamination of fresh vegetables in many countries around the world have been documented (Berger *et al.,* 2010; Sia *et al.,* 2012; Duedu *et al.,* 2014; Eraky *et al.,* 2014; Mohamed *et al.,* 2016; Robertson *et al.,* 2016 & Rostami *et al.,* 2016). Khat, in all aspects could be termed as fresh leaves for consumption. It is therefore prudent to assume that they can transmit parasites through unhygienic handling, moistening and post-harvest treatment. In consideration with the mode of parasite transmission and in order to be able to control parasitic infestation that are transmitted through oral route, it is important to study the source of transmission. It is possible that because of the unhygienic manner *C. edulis* is handled, consumption could be a source of parasitic infections. Studies on the effects of the plant have only been based on other medical conditions ignoring parasite transmission. Through available parasitological techniques, it was important to isolate and identify parasites that infect humans from *C. edulis* sold by vendors in selected parts of Nairobi County.

## 1.4 Null Hypothesis

There are no parasitic contaminants associated with use of *Catha edulis* leaves sold by different vendors in Nairobi County.

## 1.5 Objectives

### 1.5.1 General objective

To investigate the presence, species and distribution patterns of parasites, and environmental factors associated with contamination of C. *edulis* leaves in selected parts of Nairobi County.

### 1.5.2 Specific objectives

1. To determine parasite species that infect humans through use of *C. edulis* leaves sold by different vendors in selected parts of Nairobi County.
2. To evaluate the distribution pattern of parasite species that infect humans through use of *C. edulis* leaves in selected parts of Nairobi County.
3. To evaluate environmental factors enhancing parasites transmission through use of *C. edulis* in selected parts of Nairobi County.

# CHAPTER TW0

# LITERATURE REVIEW

## 2.1 Catha edulis (miraa)- Classification

*Catha edulis* (Khat) belongs to the kingdom Plantae, class Magnoliopsida, order Celastrales, family Celastraceae, genus *Catha* and species *edulis* (Simmons *et al.*, 2008). *Catha edulis* originated in Ethiopia and later spread to other parts of the world including Somalia, Yemen**,** Kenya, Uganda, Congo, Tanzania, Zambia, Zimbabwe, Afghanistan and Madagascar (Fitzgerald, 2009). *Catha edulis* chewing globally ranges from approximately 5 to 10 million people most of which are in the Horn of Africa and Arabian Peninsula (Mateen, 2010). *Catha edulis* (miraa) is cultivated and consumed in Ethiopia as well as in Kenya (Gebissa, 2004; 2010). The khat plant is known by a variety of descriptive names, such as Abyssinian Tea, Somali Tea, Miraa, Arabian Tea, Jimaa, and Kafta in its endemic regions of the Horn of Africa and the Arabian Peninsula (Nyongesa and Onyango, 2010)**.** Khat is a slow-growing shrub or tree that typically attains a height of 1–5 meters (3 feet 3 inches – 16 feet 5 inches). However, it can reach heights of up to 10 m (33 ft) in equatorial areas. The plant usually grows in arid environments, at a temperature range of 5–35 degrees Celsius (41–95 degrees Fahrenheit).[14] It has evergreen leaves which are 5–10 centimeters (2–4 inches) long and 1–4 cm (0.39–1.6 in) broad and take about 7-8 years to reach its full height..

## 2.2 Frequency of miraa consumption

An estimated 10 million people globally use khat on daily basis. It's grown principally by communities in the horn of Africa and the Arabian Peninsula where khat chewing has a long history as social custom dating back thousands of years ago (Bekerleg, 2006). The traditional form of khat chewing in Yemen involves only male users; khat chewing by females is less formal and less frequent. Researchers estimate that about 70–80% of Yemenis between 16- and 50-years old chew khat, at least on occasion. It has been

estimated that Yemenis spend about 14.6 million persons per hour per day chewing khat. Researchers have also estimated that families spend about 17% of their income on khat.

In Finland, Khat is classified as an illegal drug and possession, use and sale of the substance is prohibited and punishable. As with all illegal drugs, operating a motor vehicle with detectable levels of Khat or its metabolites in one's system can also lead to a conviction for driving under the influence even if the driver does not appear intoxicated. In Africa, production, sale and usage of Khat is legalized in the following countries: Ethiopia, Somalia, Djibouti, and Kenya.

### 2.3 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 (Dhaifalaha & Šantavý, 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 (Hussein, 2009).

Khat consumption induces mild euphoria and excitement, similar to that conferred by strong coffee. According to a study conducted by Dhaifalaha & Šantavý, (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 (Dhaifalaha & Šantavý, 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 (Miriti *et al*., 2020).

The consequences of Miraa and other drugs use among youth are visible in the communities. Many youths have dropped out of school due to 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).

**2.4 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. However, the attribution was disputed by reports showing the plant extracts from fresh leaves contained another substance more behaviorally active than cathine (Carrier, 2008; 2017). 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. When khat leaves dry, the more potent chemical, cathinone, decomposes within 48 hours, leaving behind the milder chemical, cathine. Thus, harvesters transport khat by packaging the leaves and stems in plastic bags or wrapping them in banana leaves to preserve their moisture and keep the cathinone potent. It is also common for them to sprinkle the plant with water frequently or use refrigeration during transportation.

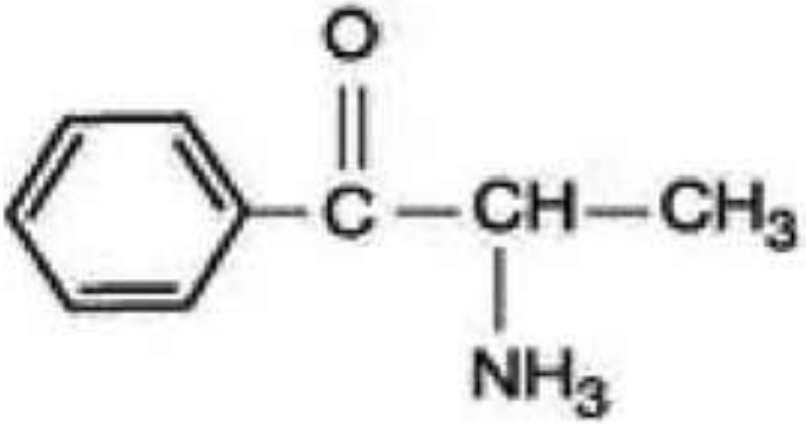


**Figure 2.1: Chemical structures of Cathinone (Wabel, 2011)**

When the *C. edulis* leaves are chewed, cathine and cathinone are released and absorbed through the mucous membranes of the mouth and stomach lining. The action of cathine and cathinone on the reuptake of epinephrine and norepinephrine has been demonstrated in lab animals, showing that one or both of these chemicals cause(s) the body to recycle these neurotransmitters more slowly, resulting in the wakefulness and insomnia associated with khat use. Receptors for serotonin show a high affinity for cathinone, suggesting this chemical is responsible for feelings of euphoria associated with chewing khat (Carrier, 2017). In mice, cathinone produces the same types of nervous pacing or repetitive scratching behaviors associated with amphetamines. The effects of cathinone peak after 15 to 30 minutes, with nearly 98% of the substance metabolized into

norephedrine by the liver. Cathine is somewhat less understood, being believed to act upon the adrenergic receptors causing the release of epinephrine and nor epinephrine. It has a half-life of about three hours in humans. The medication bromocriptine can reduce cravings and withdrawal symptoms within 24 hours.

### 2.5 Parasites that may be associated with Khat consumption

The human helminths are a group of parasites impacting negative health status throughout the world (Wright *et al.,* 2018). Soil-transmitted helminth infections are caused by different species of parasitic organisms. Their eggs or cysts present in human feces contaminate the soil or foodstuff in areas where sanitation is poor (Tiwali *et al.,* 2013). Approximately 1.5 billion people are infected with soil-transmitted helminths worldwide. Soil-transmitted helminth infections are among the most common infections worldwide and affect the poorest and most deprived communities (Mamo, 2014; Suntaravitun & Dokmaikaw, 2018; WHO, 2022). The main species that infect people are the roundworm (*Ascaris lumbricoides*), the whipworm (*Trichuris trichiura*) and hookworms (*Necator americanus* and *Ancylostoma duodenale*). These STH species are normally addressed as a group because they need similar diagnostic procedures and respond to the same medicines. *Strongyloides stercoralis* is an intestinal helminth with peculiar characteristics: the parasite requires different diagnostic methods than other soil-transmitted helminthiases, and for this reason is frequently not identified. In addition, the parasite is not sensitive to albendazole or mebendazole and therefore not impacted by large-scale preventive treatment campaigns targeting other soil-transmitted helminthiases (WHO, 2022). Parasitic amoeba, *Entamoeba histolytica* and *Giardia lamblia* frequently infects humans (Guamri *et al.,* 2011). Helminthes transmitted through contamination can be strongly associated with khat consumption particularly those that spend part of their development in the soil

### 2.5.1. Global distribution and prevalence of soil-transmitted infections

More than 1.5 billion people, or 24 percent of the world's population, are infected with soil-transmitted helminth infections. Out of these, over 267 million preschool-age children and over 568 million school-age children live in areas where these parasites are intensively transmitted, and are in need of treatment and preventive interventions (Suntaravitun & Dokmaikaw, 2018). Also, over 600 million people are estimated to be infected by *S. stercoralis*. Infections are widely distributed in tropical and subtropical areas, with the greatest numbers occurring in sub-Saharan Africa, the Americas, China and East Asia (Mathuria & Singh, 2017; WHO, 2022).

### 2.5.2 Morbidity and symptoms of soil-transmitted infections

Morbidity is related to the number of worms harbored. People with infections of light intensity (few worms) usually do not suffer from the infection. Heavier infections can cause a range of symptoms including intestinal manifestations (diarrhea and abdominal pain), malnutrition, general malaise and weakness, and impaired growth and physical development. Infections of very high intensity can cause intestinal obstruction that should be treated surgically. *S. stercoralis* may cause dermatological and gastro-intestinal morbidity and is also known to be associated with chronic malnutrition in children. In case of reduced host immunity, the parasite can cause the hyper-infection/dissemination syndrome that is invariably fatal if not promptly and properly cured and is often fatal despite the treatment (WHO, 2022).

### 2.5.3 *Ascaris lumbricoides* Linn. (Ascaridida: Ascarididae)

Human infections are acquired by ingesting fully embryonated eggs which have been accidentally picked up from polluted soil, food or drink contaminated by viable embryonated eggs, or children who eat dirt. In the tropics, all ages are heavily parasitized, whereas in subtropical countries young children are more commonly infected than adults and more commonly pollute the soil. In countries where human

feces are used as fertilizer for field crops or vegetable gardens, the adult population acquires infection from eating raw vegetables contaminated with fully embryonated eggs. Ascariasis is essentially a door yard and household infection, primarily propagated by the seeding of the soil immediately around the house with eggs present in promiscuous droppings of small children, who, in turn become reinfected from eggs which they pick up on their fingers and introduce into their mouth. Favorable 'seedbeds' of Ascaris eggs may remain infective for many months (Tripathi *et al.*, 2014).

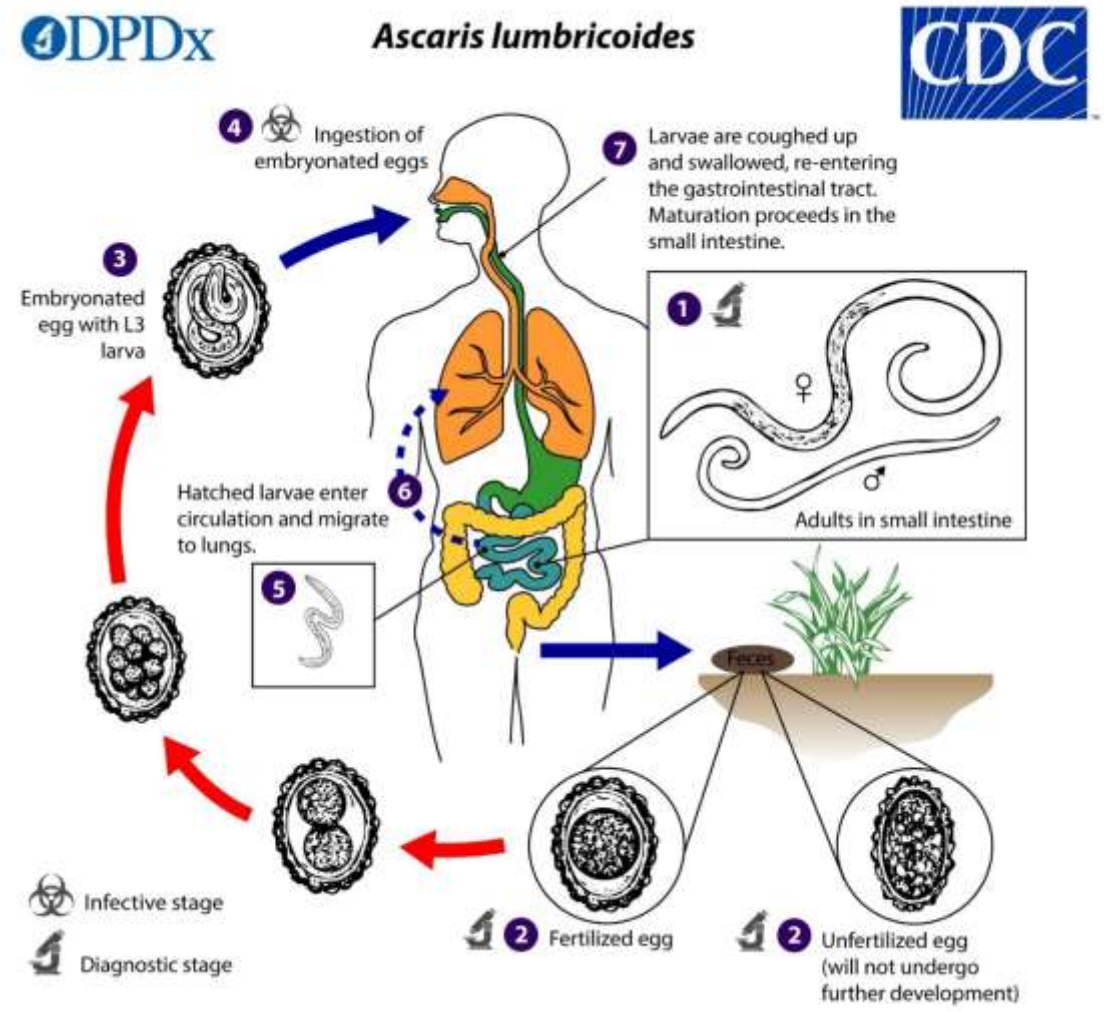


**Figure 2.2: Life-cycle of Ascaris lumbricoides (CDC, 2019)**

Adult worms live in the lumen of the small intestine. A female may produce approximately 200,000 eggs per day, which are passed with the feces. Unfertilized eggs may be ingested but are not infective. Larvae develop to infectivity within fertile eggs after 18 days to several weeks, depending on the environmental conditions (optimum: moist, warm, shaded soil). After infective eggs are swallowed, the larvae hatch, invade the intestinal mucosa, and are carried via the portal, then systemic circulation to the lungs. The larvae mature further in the lungs (10 to 14 days), penetrate the alveolar walls, ascend the bronchial tree to the throat, and are swallowed. Upon reaching the small intestine, they develop into adult worms. Between 2 and 3 months are required from ingestion of the infective eggs to oviposition by the adult female. Adult worms can live 1 to 2 years (CDC, 2019).

### 2.5.4 *Trichuris trichiura* Linn. (Trichocephalida: Trichiuridae)

Conditions favorable for development of the un-embryonated eggs of *Trichiuris trichiura* evacuated in human stool onto the ground consist of warm, shaded moist soil. Development to the infective stage requires about twenty-one days, after which an active first stage is coiled inside the shell. Infection results from the ingestion of these eggs obtained directly or indirectly from soil. The eggs are much resistant to temporary drought and heat than the *Ascaris* eggs, will not usually develop to the inactive stage on hard clay, ashes or cinders, and will not survive direct sun's rays or intense cold, even in moist atmosphere, a moderately dry film of feces will support survival for not more than two weeks. Areas of high incidence and heavy worm burden are usually those polluted by small children, who are often more commonly infected than are adults (Tiwali *et al.*, 2013). In areas of high endemicity small children develop heavy infections yet the greatest prevalence occurs typically in children of primary school age who contaminate door yards soil with their feces and later pick up the fully embryonated eggs on their fingers and transfer eggs to their mouth. The exact mechanism by which *T. trichiura* affects the human host is not known but there are at least two important processes at work, traumatic and allergy. Since the portal of entry into the human body is the mouth and the larva which escapes from the hatching e.g. requires no migration through the

lungs, the first serious damage produced at the site of permanent attachment of the worm to the intestinal mucosa in the cecal area. If only few worms have become adult the traumatic damage is trivial, but many worms transmitted together may block the appendiceal lumen or cause marked irritation and inflammation of the epithelium of the caecum, appendix and ascending colon (Suntaravitun & Dokmaikaw, 2018). Usually, a few worms provoke very little allergic reactions, but a large number produces colitis and proctitis and frequently a secondary anemia.

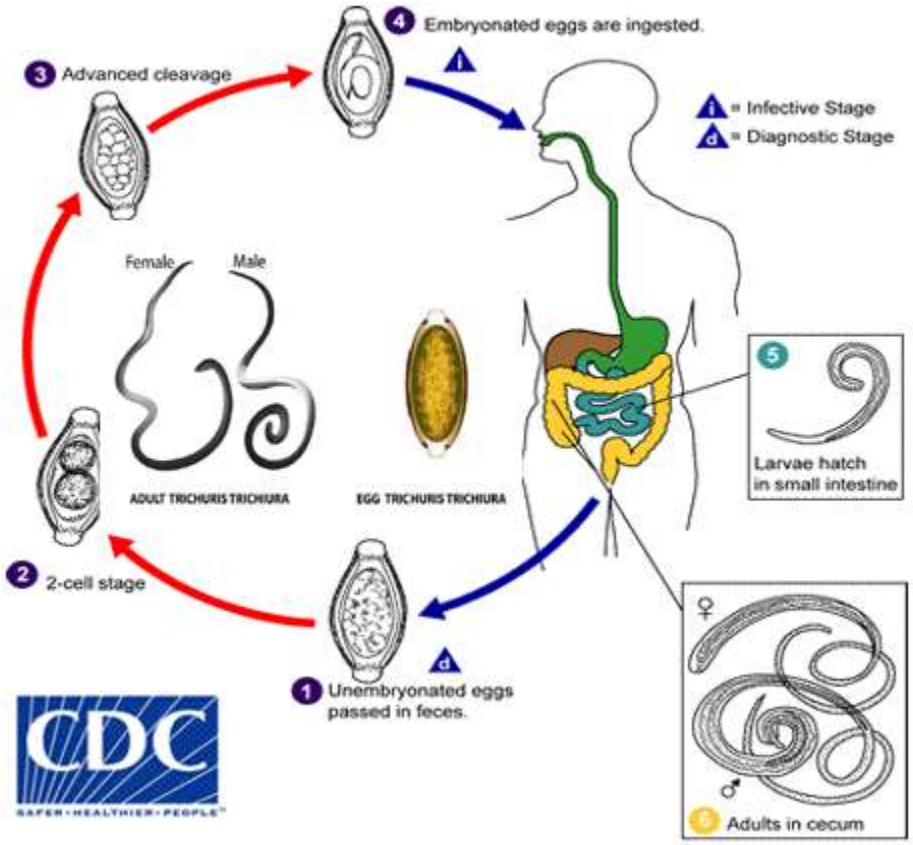


**Figure 2.3: Life-cycle of *Trichuris trichiura* (CDC, 2013)**

The un-embryonated eggs are passed with the stool. In the soil, the eggs develop into a 2-cell stage, an advanced cleavage stage, and then they embryonate; eggs become infective in 15 to 30 days. After ingestion (soil-contaminated hands or food), the eggs hatch in the small intestine, and release larvae that mature and establish themselves as adults in the colon. The adult worms (approximately 4 cm in length) live in the cecum and ascending colon. The adult worms are fixed in that location, with the anterior portions threaded into the mucosa. The females begin to oviposit 60 to 70 days after infection. Female worms in the cecum shed between 3,000 and 20,000 eggs per day. The life span of the adults is about 1 year (CDC, 2013).

### 2.5.5 *Strongyloides stercoralis* Bavay (Rhabditida: Strongyloididae)

Man is the most important host of *Strongyloides stercoralis.* The infective stage larvae are developed in the soil, from which man becomes infected typically through skin contact. Strongyloidiasis tends to be particularly common in institutional groups, as mental hospitals and prisons in warm moist climates. It is more prevalent in adults than in children in the general population. The pathogenic effects of *S. Stercoralis* begin with the active entry of the filariform larvae into the skin and continue long as it remains alive in the human body. The degree of systemic toxaemia and the host's reaction are indicated by high eosinophilia, which characteristically develops during the acute stage of the infection. As well as by giant urticaria and other sensitization reactions which frequently develop when a previously infected individual is subjected to re-exposure (Suntaravitun & Dokmaikaw 2018).

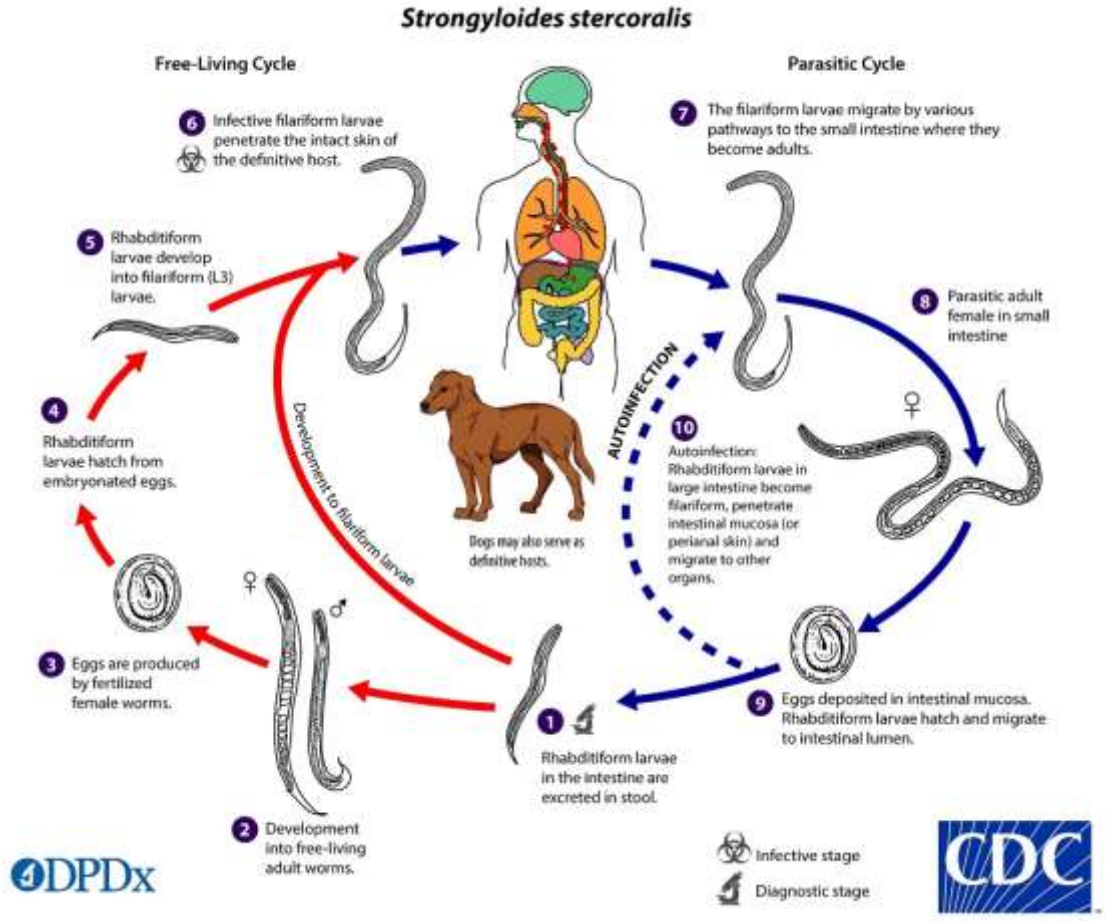


**Figure 2.4: Life-cycle of *Strongyloides stercoralis* (CDC, 2019)**

The *Strongyloides stercoralis* life cycle is complex, alternating between free-living and parasitic cycles and involving autoinfection. In the free-living cycle: Rhabditiform larvae are passed in the stool of an infected definitive host, develop into either infective filariform larvae (direct development) or free-living adult males and females that mate and produce eggs, from which rhabditiform larvae hatch and eventually become infective filariform (L3) larvae. The filariform larvae penetrate the human host skin to initiate the parasitic cycle (see below). This second generation of filariform larvae cannot mature into free-living adults and must find a new host to continue the life cycle.

**Parasitic cycle:** Filariform larvae in contaminated soil penetrate human skin when skin contacts soil, and migrate to the small intestine. It has been thought that the L3 larvae

migrate via the bloodstream and lymphatics to the lungs, where they are eventually coughed up and swallowed. However, L3 larvae appear capable of migrating to the intestine via alternate routes (e.g., through abdominal viscera or connective tissue). In the small intestine, the larvae molt twice and become adult female worms. The females live embedded in the submucosa of the small intestine and produce eggs via parthenogenesis (parasitic males do not exist) which yield rhabditiform larvae. The rhabditiform larvae can either be passed in the stool, or can cause auto-infection.

Rhabditiform larvae in the gut become infective filariform larvae that can penetrate either the intestinal mucosa or the skin of the perianal area, resulting in autoinfection. Once the filariform larvae reinfect the host, they are carried to the lungs, pharynx and small intestine as described above, or disseminate throughout the body. The significance of autoinfection in *Strongyloides* is that untreated cases can result in persistent infection, even after many decades of residence in a non-endemic area, and may contribute to the development of hyper-infection syndrome (Suntaravitun & Dokmaikaw, 2018; CDC, 2019).

### 2.5.6 *Ancylostoma duodenale* and *Necator americana* (Strongylia: Ancyclostomatidae)

The propagation of human hookworm infection depends on 1. Adequate source of infection in the human population 2. Defecation habits ensuring that eggs of these hookworms will be deposited in favorable locations for extrinsic development of the parasite, 3. Appropriate conditions of environment (moisture and warmth) and of the soil (shade and sandy humus containing an abundant supply of nutritive material for developing larva 4. Opportunity for the infective stage to be exposed to the skin of man so that the parasitic phase may be re-established. In many tropical and subtropical countries, conditions are satisfactory for maintenance of the cycle through the greater part of the year. The infective stage larvae of the hookworm actively enter the skin with which they make contact; usually they enter digital spaces between the toes of

barefooted of persons who step on infested soils harboring the infective stage of the parasite.

The most important manifestations of hookworm infections are caused by the adult worms in the intestine. The worms attach themselves to the gut mucosa by their buccal capsules. They suck in blood, which passes out undigested and not utilized through its intestines. A single Ancylostome adult can suck about 0.2ml blood a day, while the small *Necator* sucks in about 0.03ml per day. The worms frequently leave on site and attach themselves to another site. As the secretion of the worm contains anticoagulant activity, bleeding from the site continue for some time. This adds to the blood loss. This chronic blood loss over time leads to a microcytic hypochromic type of iron deficiency anemia (Suntaravitun & Dokmaikaw 2018).

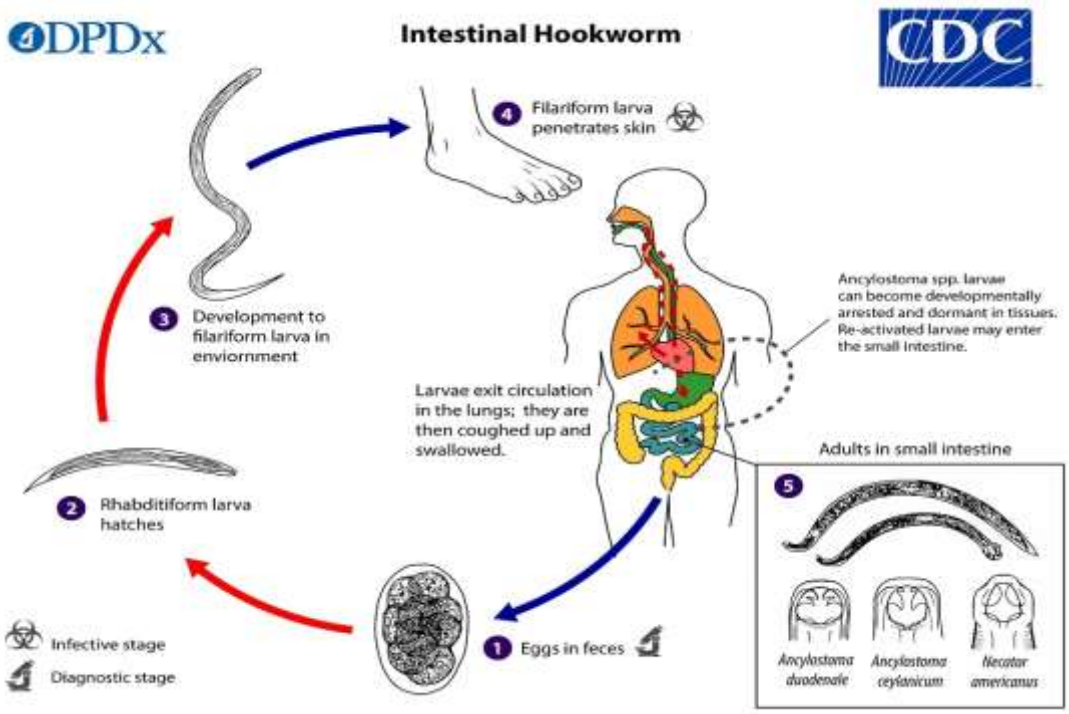


**Figure 2.5: Life-cycle of human hookworm (CDC, 2019)**

Eggs are passed in the stool, and under favorable conditions (moisture, warmth, shade), larvae hatch in 1 to 2 days and become free-living in contaminated soil. These released

rhabditiform larvae grow in the feces and/or the soil, and after 5 to 10 days (and two molts) they become filariform (third-stage) larvae that are infective. These infective larvae can survive 3 to 4 weeks in favorable environmental conditions. On contact with the human host, typically bare feet, the larvae penetrate the skin and are carried through the blood vessels to the heart and then to the lungs. They penetrate into the pulmonary alveoli, ascend the bronchial tree to the pharynx, and are swallowed. The larvae reach the jejunum of the small intestine, where they reside and mature into adults. Adult worms live in the lumen of the small intestine, typically the distal jejunum, where they attach to the intestinal wall with resultant blood loss by the host. Most adult worms are eliminated in 1 to 2 years, but the longevity may reach several years.

Some *A. duodenale* larvae, following penetration of the host skin, can become dormant (hypobiosis in the intestine or muscle). These larvae are capable of re-activating and establishing patent, intestinal infections. In addition, infection by *A. duodenale* may probably also occur by the oral and the trans-mammary route. *A. ceylanicum* and *A. caninum* infections may also be acquired by oral ingestion. *A. caninum*-associated eosinophilic enteritis is believed to result following oral ingestion of larvae, not percutaneous infection (Suntaravitun & Dokmaikaw 2018). *N. americanus* does not appear to be infective via the oral or trans-mammary route (CDC, 2019). WHO recommends albendazole (400 mg) and mebendazole (500 mg) – effective, inexpensive and easy to administer by non-medical personnel. They have been through extensive safety testing and have been used in millions of people with few and minor side-effects, and generic ivermectin for the control of *S. stercoralis* (WHO, 2022).

### 2.6 Amoeba that may be associated with Khat consumption

#### 2.6.1 Genus Entamoeba

Pathogenic *Entamoeba histolytica* infecting humans and other primates causes amoebiasis, E. histolytica is estimated to infect about 50 million people worldwide (Martínez-Palomo & Espinosa-Cantellano, 2003). Previously, it was thought that 10% of

the world population was infected, but these figures predate the recognition that at least 90% of these infections were due to a second species, *E. dispar*. Mammals such as dogs and cats can become infected transiently, but are not thought to contribute significantly to transmission. When they cyst of *E. histolytica* reaches caecum or lower part of ileum encystations occurs and an amoeba with four nuclei emerges and that divides by binary fission to form eight trophozoites (Nagata *et al.*, 2012; Mamo, 2014).

Trophozoites migrate to the large intestine and lodge in to the sub mucosal tissue where it grow and multiply by binary fission in large intestine (Trophozoite phase of life cycle is responsible for producing characteristics lesion of amoebiasis), hence number of trophozoites are discharged in to the lumen of the bowel and are transformed into cystic forms. However, cysts thus formed are unable to develop in the same host and therefore necessitate transference to another susceptible host. The cysts are passed in the feces**.** *E. histolytica* can be distinguished from other amoebas by two major criteria.1) Nature of the nucleus of the trophozoite; 2) Cyst size and number of its nuclei. Infections by *Entamoeba histolytica* occurs by ingestion of mature quadrinucleate cysts in fecally contaminated food, water, or hands. The quadrinucleate cyst is resistant to the gastric environment and passes unaltered through the stomach (Martínez-Palomo & Espinosa-Cantellano, 2003).

The active stage exists only in the host and in fresh loose feces; cysts survive outside the host in water, in soils, and on foods, especially under moist conditions on the latter. The infection can occur when a person puts anything into their mouth that has touched the feces of a person who is infected with quadrinucleate cyst of *E. histolytica*, swallows something, such as water or food that is contaminated, or swallows E. histolytica cysts picked up from contaminated surfaces or fingers. The cysts survive for only a few months outside of the host. When cysts are swallowed they cause infections by encysting in the digestive tract; infection can be asymptomatic or can lead to amoebic dysentery or amoebic liver abscess. Symptoms can include fulminating dysentery, bloody diarrhea, weight loss, fatigue, abdominal pain, and amoeboma (Mathuria & Singh, 2017). The amoeba can actually 'bore' into the intestinal wall, causing lesions and

intestinal symptoms, and it may reach the blood stream. From there, it can reach different vital organs of the human body, usually the liver, but sometimes the lungs, brain, spleen, etc. A common outcome of this invasion of tissues is a liver abscess, which can be fatal if untreated (Singh *et al.*, 2013; Mamo, 2014).

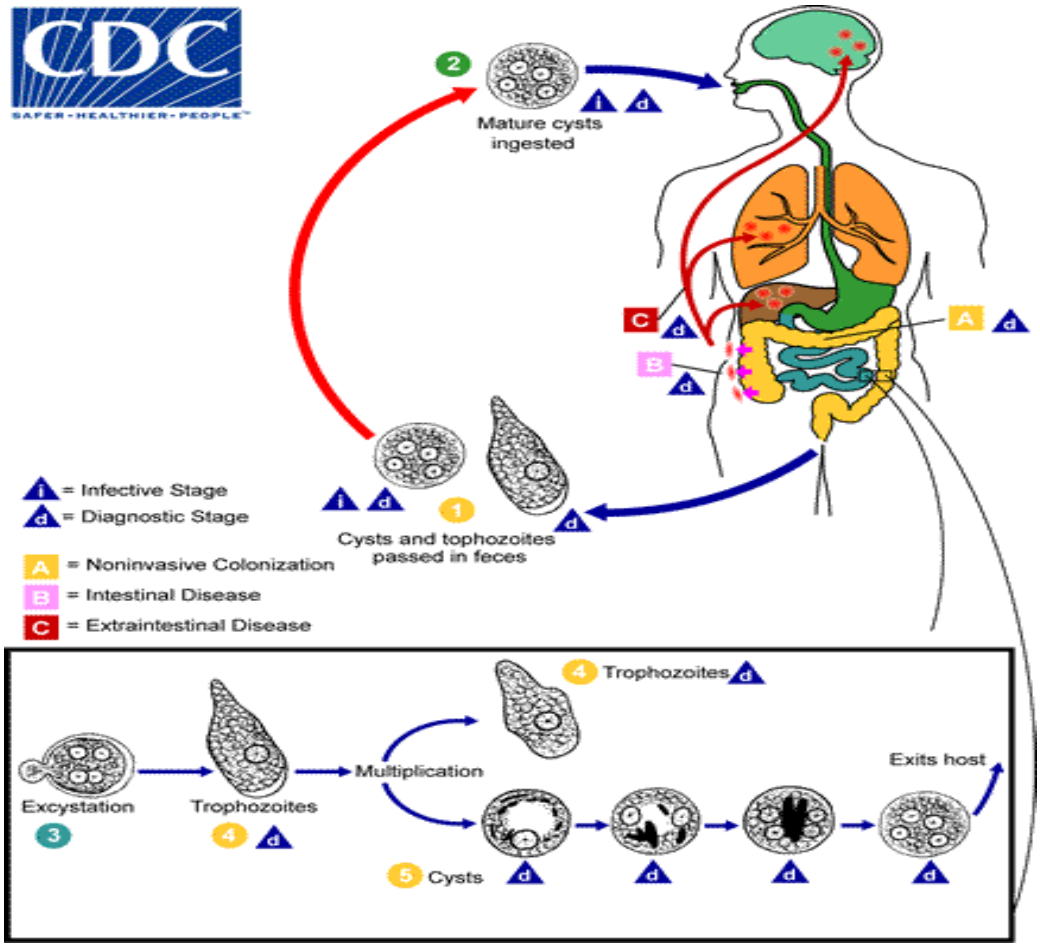


**Figure 2.6: Life-cycle of *Entamoeba histolytica* (CDC, 2015)**

### 2.6.2 *Giardia lamblia*

*Giardia lamblia* is a microscopic parasite that causes the diarrheal illness known as giardiasis. Infection occurs through ingestion of dormant microbial cysts in

contaminated water or food, or by the fecal–oral route (through poor hygiene practices). The cyst can survive for weeks to months in cold water, so can be present in contaminated wells and water systems, especially stagnant water sources, such as naturally occurring ponds, storm water storage systems, and even clean-looking mountain streams. Can also be found on surfaces, soil, food, or water that has been contaminated with feces from infected humans or animals .The may also occur in city reservoirs and persist after water treatment, as the cysts are resistant to conventional water treatment methods, such as chlorination and ozonolysis. In addition to waterborne sources, fecal–oral transmission can also occur, where community may have poor hygiene practices (Mamo, 2014). However not all *Giardia* infections are symptomatic, and many people can unknowingly serve as carriers of the parasite.

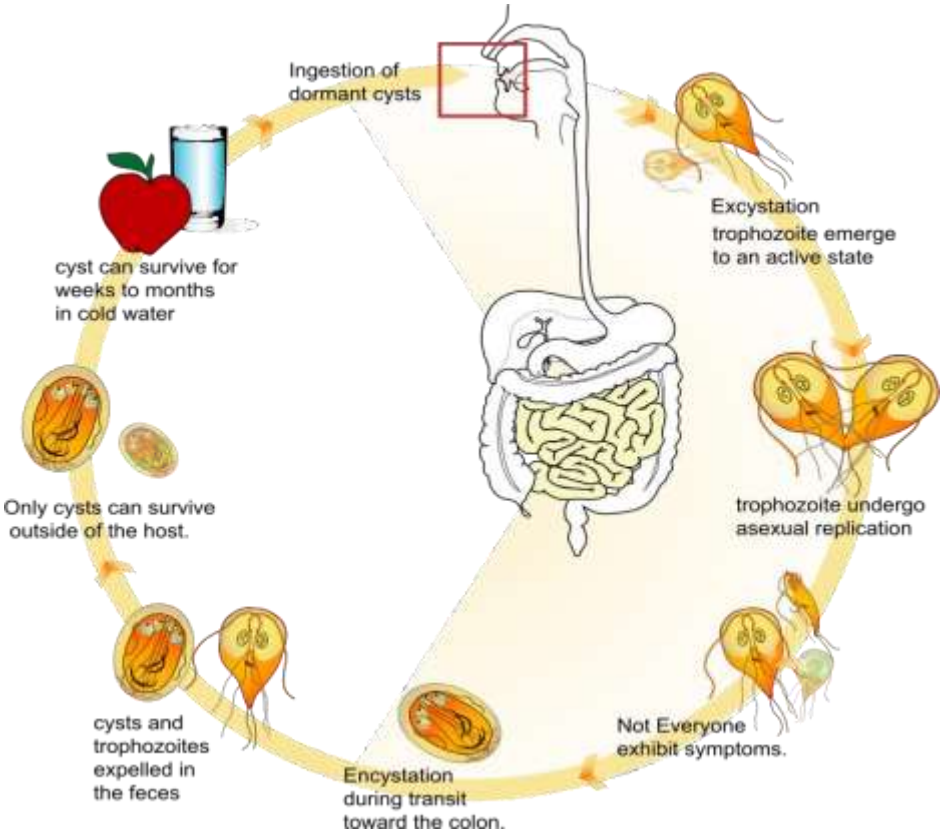


**Figure 2.7: Life cycle of *Giardia lamblia* (Huang and White, 2006)**

## 2.7 Risk factors for transmission of soil-transmitted infections (STI)

Many factors including environmental, socio-economic, demographic, low education level and hygiene related behavior influence the transmission and distribution of intestinal parasitic infections (Norhayati *et al.*, 2003; Kimonge, 2019). One study done in Brazil associated place of residence, age, intake of raw / poorly cooked vegetables and quality of drinking water as major risk factors. Prevalence of STI is more related to poor environmental sanitation and personal hygiene than to climate. Socio-economic factors as well as unpredictable factors such as food insecurity, droughts, and floods greatly contribute to the problem (WHO, 2006). Others include un-availability of safe domestic water and lack of knowledge on sanitation also contribute to transmission. Most intestinal parasites gain entry into the intestines orally through ingestion of undercooked food, vegetables, or contaminated water or hands, while hookworm larvae penetrate skin. Poor personal hygiene, garbage disposal and insanitary disposal of human excreta is important for this oral-fecal infection. Infective eggs may contaminate vegetables when untreated human waste of infected individuals is used as fertilizer for food crops and vegetables. Infection may also take place when food is handled with dirty hands, or if clothes, hair, raw vegetables / fruit are infested with viable organisms (Kumari *et al*., 2017).

Other transmission methods include mechanical vectors such as cockroaches and flies which may carry the infective cysts or eggs from contaminated sites or dirty latrines to food and / or water. Poor sanitation witnessed in many developing countries and lack of adequate supply of clean domestic water could lead to contamination with parasitic forms. Other risk factors include lack and improper usage of toilets which may lead to defecating in the open, making way for cysts and ova to be washed down into water bodies or may be carried by mechanical vectors such as flies and cockroaches into food or water sources (Kumari *et al*., 2017).

## 2.8 Control of intestinal parasitic infections

It is documented that improving on sanitation, clean / safe water supply, food hygiene and health education together with treating infected individuals eventually reduce intestinal parasites' transmission (Kumari *et al*., 2017). A systematic review of health progress and systems performance of 1994 – 2010 by the Ministry of Public Health in Kenya noted that improved sanitation- provision of safe domestic water, availability of improved VIP latrines and flush toilets together with regular hand washing contributed greatly in reduction of diarrheal diseases. In another study establishing the prevalence of water-borne protozoan parasites in western Cameroon, it was observed that due to improved sanitation in one village, infections with intestinal parasites were lower at 7.1% compared to another village (15.7%) which had unimproved sanitation (Kuete *et al*., 2015).

One important factor- health education is key in creating awareness on personal hygiene and healthy behavior to reduce infection and re-infection of intestinal parasites. Most importantly, communities need to be educated on proper usage of latrines / toilets, regular washing hands, protection of water supplies from fecal contamination, proper cooking and handling of food (Kumari *et al*., 2017). Enhanced education programs on sanitation and hygiene through conferences and seminars saw 84% reduction in water borne diarrheal diseases in Bawa village in western Cameroon (Kuete *et al*., 2015).

Contracting intestinal parasitic infections are easily got from eating food or drinking water contaminated with intestinal parasites' ova, cysts or trophozoites. Food-related practices that may contaminate food with intestinal parasites are many and include, among others, poorly prepared food, failure to wash hands thoroughly with soap and warm running water after visiting the toilet or changing a baby's diaper and before handling food, eating raw unwashed vegetables and eating street foods especially in unhygienic public places. Water source / supply is a important risk factor for intestinal parasites and several major outbreaks of intestinal infections have been reported from contamination of municipal water supplies with human excreta (Kotian *et al.*, 2014).

# CHAPTER THREE

# MATERIALS AND METHODS

## 3.1 Study Site.

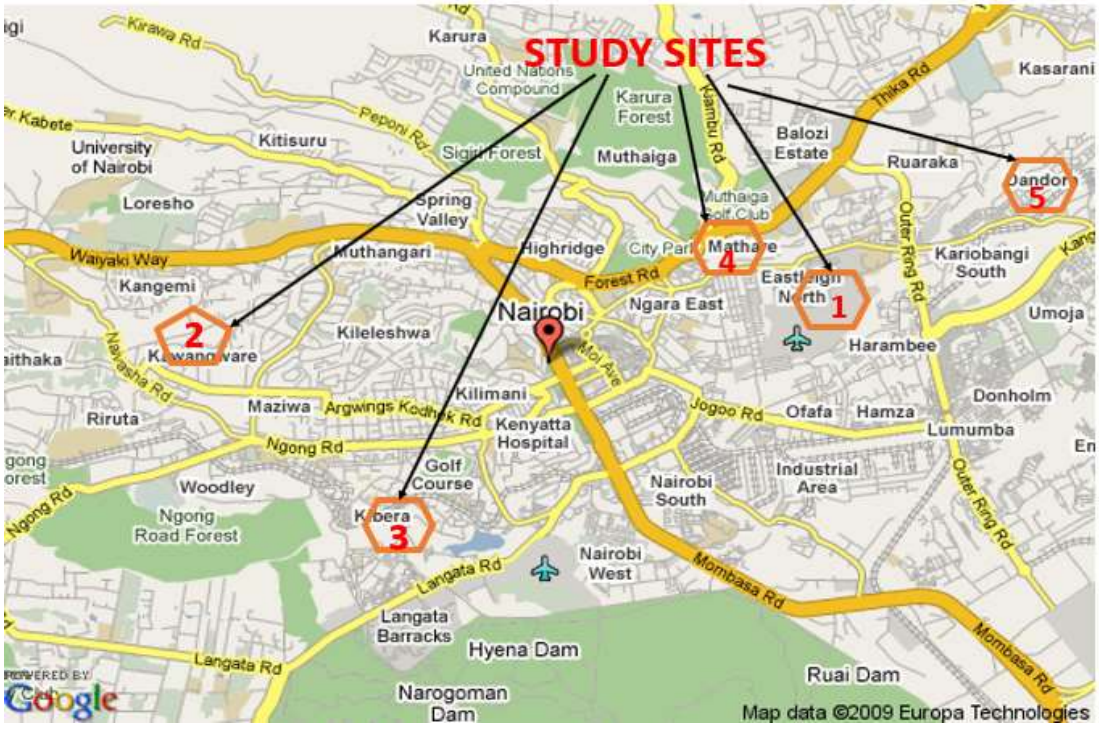


**Figure 3.1: Study sites where khat vendors were recruited in Nairobi**

**Key: 1. Eastleigh, 2. Kawangware, 3. Kibra, 4. Mathare, 5. Dandora**

Source: http://www.destination360.com/africa/kenya/nairobi/map], with modifications by Author

*Catha edulis* (Khat) was purchased from vendors within the Nairobi County. The areas were selected based on the purchase history, Eastleigh leading, Kawangware, Kibra, Mathare, finally Dandora. These are places often lacking basic amenities among them foodstuff, water, shelter and healthcare while khat is sold in the streets. Toilets are hard to get, including Mathare where raw sewer openly drains from the nearby suburbs like

Utalii area, Muthaiga, and Survey of Kenya. The stench of raw sewer fills the air as the overflowing sewer pass across the shanties, eventually draining into the nearby Nairobi River. Dandora is an eastern suburb in Nairobi, Kenya. It is part of the Embakasi division. Surrounding neighbor hoods estates include Kariobangi, Baba Dogo, Gitare Maringo and Korogocho. Dandora dumpsite has heaps of uncontrolled waste leading to health, social, economic and political problems. This study was significant because its' findings provided insights on parasite transmission through khat use and consumption.

### 3.2 Study Design

This was a cross-sectional descriptive study design involving one-time sampling of khat (*C. edulis*) sold by vendors in several locations in Eastleigh, Kawangware, Kibra, Mathare and Dandora areas in Nairobi County. Khat leaves were bought from eligible vendors, packed in aerated bags, then processed and evaluated for presence of contaminant parasites that normally infect humans.

### 3.3 Study Population

The study population were khat vendors from the streets in five randomly selected study estates in the City of Nairobi. Each estate represented a stratum and stratified sampling was used to select the streets while convenient sampling was used to select eligible vendors. In total, 160 (106 males and 54 females) vendors were recruited for the study. However, 5 (4 females and 1 male) later declined citing intimidation by the spouse.

### 3.4 Selection criteria

The study participants were selected from eligible males and females, based on the laid down criterion of inclusion and exclusion to avoid bias.

### 3.4.1 Inclusion criteria

Miraa vendors residing in the specified study areas and those who gave informed consent were included in the study.

### 3.4.2 Exclusion Criteria

Those miraa vendors who did not consent to participate in the study or those not residing in the specified study sites were excluded from the study.

### 3.5 Sample size determination

The average total numbers of Khat vendors according to NACADA in Eastleigh, Dandora Kawangware, Kibra, and Mathare, were approximately 262 and because N is less than 10,000 the Cochrane's formula was used in determining the sample size thus:

$$nf = \frac{n}{1+n}$$

Where:-

nf = desired sample size for a population less than 10,000

n = desired sample size for population more than 10,000 which was found to be 384

N = Population which is 262

In substitution,

$$nf = \frac{384}{1+\frac{384}{262}}$$

$$= \frac{384}{1 + 2.4}$$

= 160 Miraa Vendors

Sample size of 160 miraa vendors were recruited

### 3.6 Sampling Method

A stratified sampling method was used to select the streets in the five estates. Each street represented a stratum. Convenient sampling method was used to get the number of respondents per stratum.

**Expected sample representation per stratum**

| Street/Location | Total | Expected representation | n |
|---|---|---|---|
| Eastleigh | 121 | 121/262 X160 | 74 |
| Kawangware | 48 | 48/262 X160 | 29 |
| Kibra | 32 | 32/262 X160 | 20 |
| Mathare | 26 | 26/262 X160 | 16 |
| Dandora | 35 | 35/262X160 | 21 |
| Total | **262** | | **160** |

**Data source: NACADA, 2018**

### 3.7 Data Collection procedure

#### 3.7.1 Sample collection procedure

Collection of *C. edulis* from study site was done from all the selected five study sites, an average of 300g of khat leaves per site from 155 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 for each enrolled vendor by the principal investigator (PI). The

PI as potential consumer posed questions in questionnaire directly without antagonizing the vendor in an understandable language where necessary. The purpose of the questionnaire was to obtain bio-data (source of *C. edulis* leaves, site of vendor, and public health awareness on infection transmission, source of social amenities such as sewerage, toilet, food and water.

### 3.7.2 Parasite Isolation Using Concentration Method

In order to isolate ova and cyst, sheather's sugar floatation technique was used. The sheather's sugar floatation solution (SSFS) was prepared by mixing the following ingredients:

**Table 3.1*:* Sheather's sugar floatation solution ingredients**

| Component | Quantity |
|---|---|
| Water | 355 ml |
| Granulated sugar | 454 gm |
| 40% formaldehyde solution, U.S.P | 6 ml |

The mixture was transferred into the upper half of a double boiler. The sugar was dissolved by stirring up to $90^{o}$C and then cooled to room temperature. From the total 300 grams collected, 150 grams of *C. edulis* leaves and the branches that are usually chewed were cut into small pieces and placed in 150 ml glass beaker containing the concentrated sugar solution (SG 1.300) and shaken for one hour. The leaves and stems were removed using forceps, after which the sediment were filtered through fabric screen into a different container to remove large particles. The filtrate was then centrifuged at 3500, 2500, 1500 and 1000 revolutions per minute (rpm) for ten minutes. The 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.

### 3.7.3 Parasite Isolation Using Direct Wet and Iodine Preparations

The remaining 150 grams of *C. edulis* leaves was used for direct wet prep and iodine preparation for ova and cyst identification. Normal saline and logo's iodine 5% solution was prepared by mixing the following ingredients:

**Table 3.2: Ingredients of 5% potassium iodine**

| Component | Quantity |
|---|---|
| Potassium iodine (KI) | 10g |
| Iodine | 5g |
| Distilled water | 100ml |

Potassium Iodine (KI) was dissolved in about 20-30ml of distilled water. Iodine was then added and was then heat gently with constantly mixing until iodine was dissolved. It was then diluted up to 100ml with distilled water and was stored in a dark closed container.

**Table 3.3: Preparation of normal saline**

| Component | Quantity |
|---|---|
| Sodium chloride (NaCl) | 8.5g |
| Distilled water | 100ml |

A total of 150 grams of *C. edulis* leaves and the branches that are usually chewed was cut into small pieces and placed in 150 ml glass beaker containing normal saline and centrifuged for 10 minutes then sediment filtered through fabric screen into a different container to remove large particles. The filtrate was then be centrifuged at 3500, 2500, 1500 and 1000 revolutions per minute (rpm) for ten minutes. The 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.

### 3.7. 4 Determination of parasite distribution by vendor location

Distribution of parasite in each site was determined qualitatively whereby absence or presence of either or both of protozoa or helminthes was recorded according to site where samples were collected. Samples were designated a unique number according to site of collection which facilitated easier recording of parasite presence.

### 3.7.5 Determination of environmental factors among *C. edulis* vendors

Data on environmental conditions of the site was captured by use of questionnaire. This aided in investigating possible sources of parasitic infections which predisposed the khat samples to contamination with parasite stages.

### 3.8. Ethical consideration

Approval to carry out the study was obtained from KNH-UoN ethical review committee, National Commission for Science, Technology and Innovation, Ministry of Interior and Coordination of National Government, and the Ministry of Health – Nairobi County. Research authorization and guidance was obtained from JKUAT. Signed informed consent was obtained from the khat vendors. Confidentiality was maintained throughout the study and the names of the vendors were replaced with numbers.

### 3.9 Data analysis

Data collected on the khat vendors- residence and sex, source of water and hygiene practices was entered into raw data forms before entering it into excel spreadsheet and checked for correctness. It was then 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 ($X^2$). Data findings were presented in tables, charts and graphs besides narrative descriptions. Percentages were used to describe the characteristics of the studied population, including the prevalence of IPI in each stratum, age sets and sex. A Pearson's Chi-square ($X^2$) on proportion was used to test the associations between the

dependent variable against the independent variable. The dependent variable which was the prevalence of IPIs, while the independent variables were socio-demographic factors (age and sex), source of water, estate and environmental sanitation. The level of statistical significance was considered as $P < 0.05$.

# CHAPTER FOUR

# RESULTS

This chapter presents the results of the study analyzed and presented as per the objectives. A total of 155 respondents participated in the study out of expected sample size of 160. This corresponded with the study sites in various locations. Response rate was therefore 96.8%.

## 4.1 Demographic characteristics of the vendors

### 4.1.1 Distribution of eligible khat vendors in the study sites

Figure 4.1 indicates the distribution pattern of participants in the study sites from where samples were acquired for the study. Eastleigh was the main area where majority of the vendors (73) were recruited based on the number of vendors per site. This was followed by Kawangware 18.1% (n=28), Dandora with Mathare being the least 9.7% (n=15).

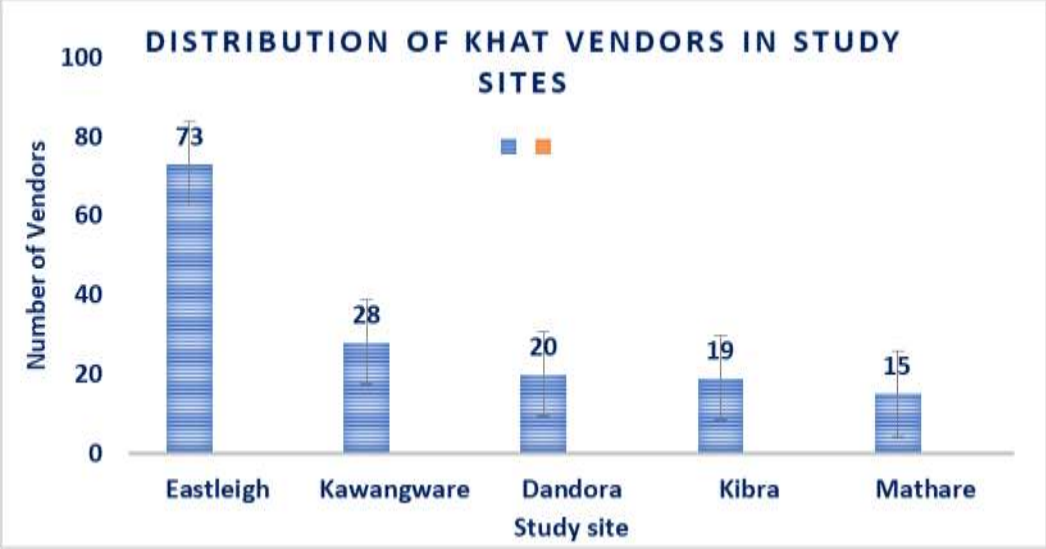


**Figure 4.1: Distribution of khat vendors in the study sites**

### 4.1.2 Gender of the respondents

Of the total respondents (n=155) who participated in the study, majority 67.7% (n=105) were males, while females were 32.3% (n=50). This indicated that vending of *C. edulis* was mainly practiced by men although significant numbers of females were also involved. Figure 4.2 illustrates these findings.

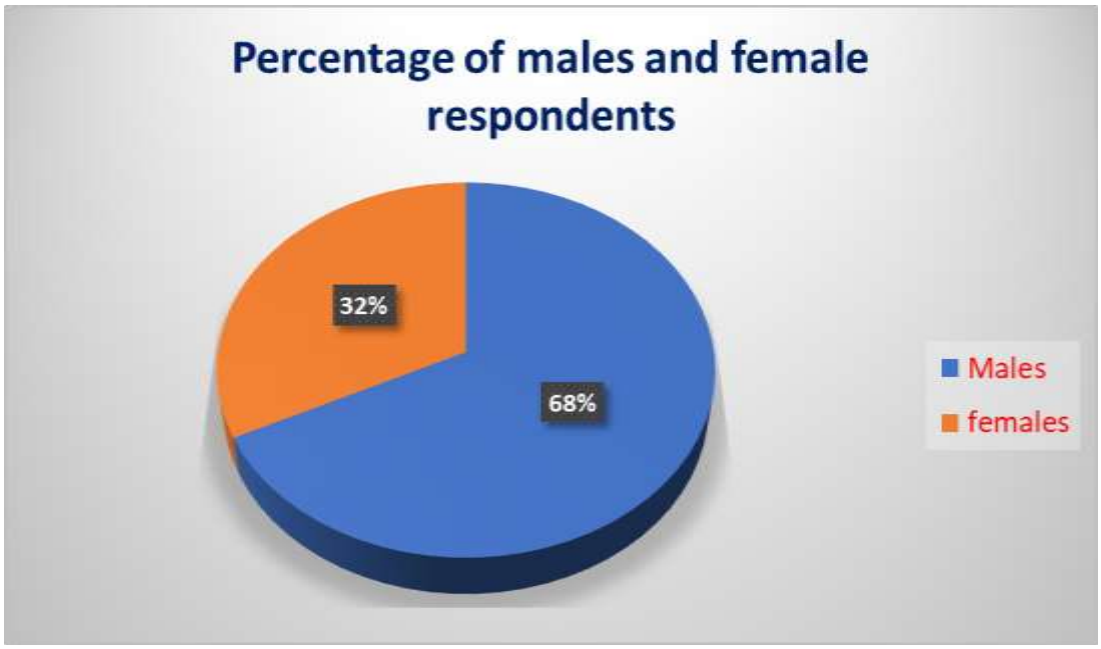


**Figure 4.2: Proportion of gender distribution of the respondents**

**Table 4.1: Gender representation and total respondents per site**

| | Male | Female | |
|---|---|---|---|
| **Eastleigh** | 48 | 25 | 73 |
| **Kawangware** | 23 | 5 | 28 |
| **Dandora** | 11 | 9 | 20 |
| **Kibra** | 13 | 6 | 19 |
| **Mathare** | 10 | 5 | 15 |
| **Total** | 105 | 50 | 155 |

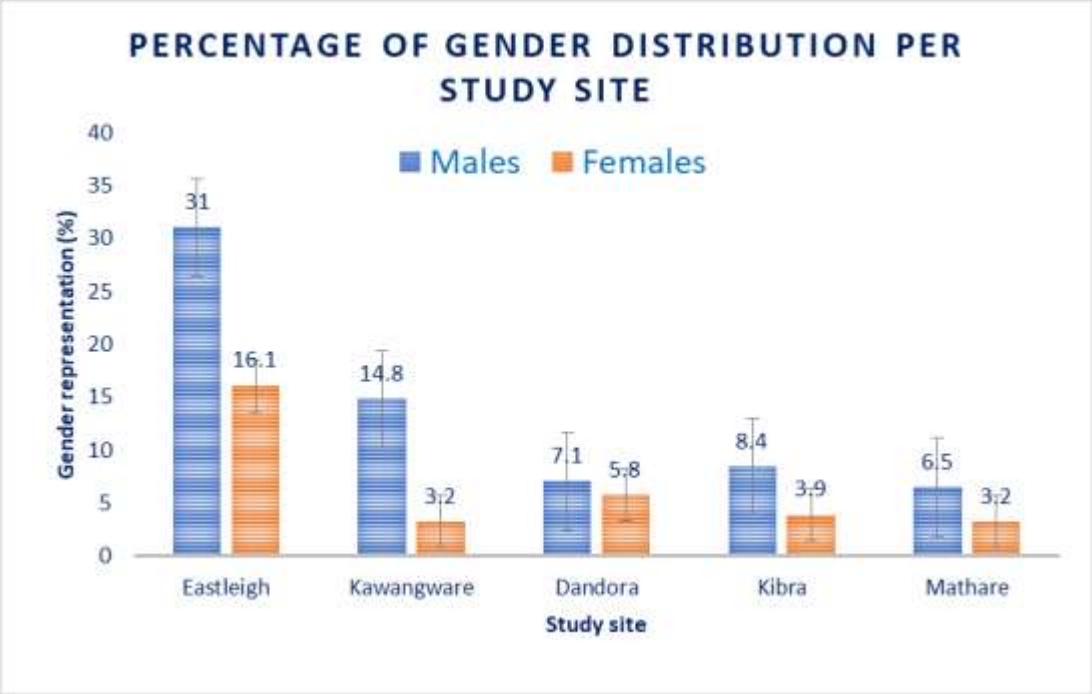


**Figure 4.3: Percentage of gender distribution of respondents in each study site**

### 4.1.3 Age of the respondents

The mean age of the respondents was 30.24 years, with a standard deviation of 4.134. The maximum age was 43.0 years with a minimum age being 22.0 years, giving an age range of 21. The median age was 29.0 years while the mode was 26.0 Table 4.2

**Table 4.2: Age variance of the respondents**

| Variables | N | range | Min | Max | Mean | Mode | Median | Std. Dev | Var |
|---|---|---|---|---|---|---|---|---|---|
| **Age** | 155 | 21.0 | 22.0 | 43.0 | 30.24 | 26.0 | 29.0 | 4.134 | 17.092 |

### 4.1.4 Storage and packaging of the khat leaves

More than half (54.8 %; n=85) were storing the leaves of *C. edulis* spread on the floor while exposed which was likely to expose them to contamination including dust, bacteria and parasitic forms. The other group (29.7%; n=46) kept the leaves on the floor but covered with transparent paper. Others kept the leaves in paper bags to preserve moisture while the last group kept their products on tabletops but kept sprinkling water on them to keep moisture to avoid drying.

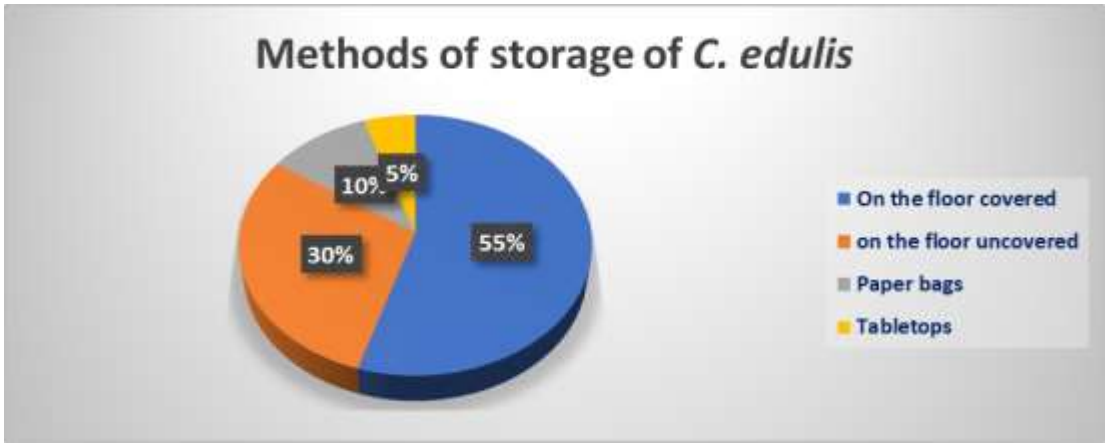


**Figure 4.4: Storage methods of *C. edulis* in the study areas**

## 4.2 General hygienic conditions of the study sites

### 4.2.1 Participants' general feeling on the cleanliness of the environment

Participants were asked about their feelings regarding the general cleanliness of the environment in which they vended the *C. edulis* leaves. Majority 80.0% (n=124) felt

that the environment was satisfactory meaning that the vending sites were thought to be clean and assumed that they did not have any decontaminants. Similarly, 5.2% (n=8) indicated that the environment needed regular maintenance. This meant that 85.2% of the participants (n=132) felt their environment was okay/ good but needed regular attention to make them conduct their activity safely. About 14.8% (n=23) indicated that conditions at their places of work are in bad shape and needed immediate clean up.

Figure 4.4 illustrates these findings.

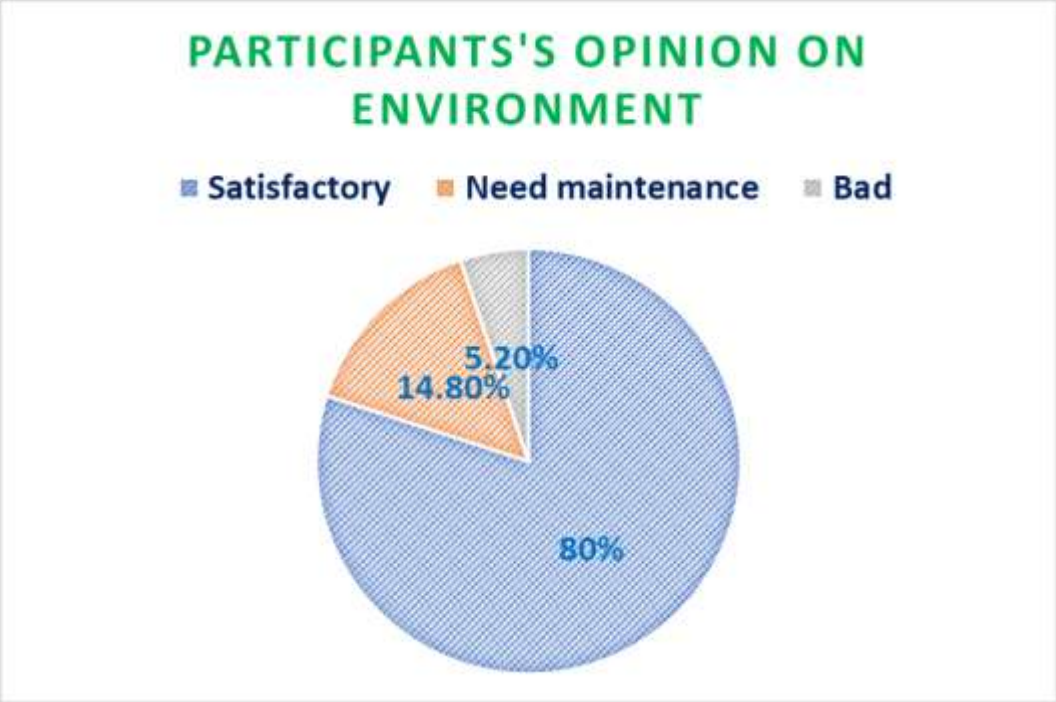


**Figure 4.5: Participants' responses on environmental conditions at their working area**

### 4.2.2 Kind of wastes found in the environment

Figure 4.5 shows that majority 70.3% (n=109) of the participants said that the most common waste within their environment where they sell the leaves were uncollected garbage. Garbage heaps are known breeding places for pathogens and hence could have

been an easy source of contamination of the leaves. Also reported were human and animal wastes. Other places were clear of any wastes.


**Figure 4.6: Type of wastes found in the environment in the study sites**

### 4.2.3 Type of toilets facilities available in the study areas

Figure 4.6 illustrates that open/ sharing toilets were the most common types of toilets 27.7% (n=43), personal toilets 24.5% (n=38) and public sharing were also predominant in the study sites. However, there were places without any toilet at all, which led to the conclusion that vendors and customers travelled for some distance to find at least public, open toilets. These toilets normally lacked water for hand-washing purposes and are a recipe for parasites transmission.

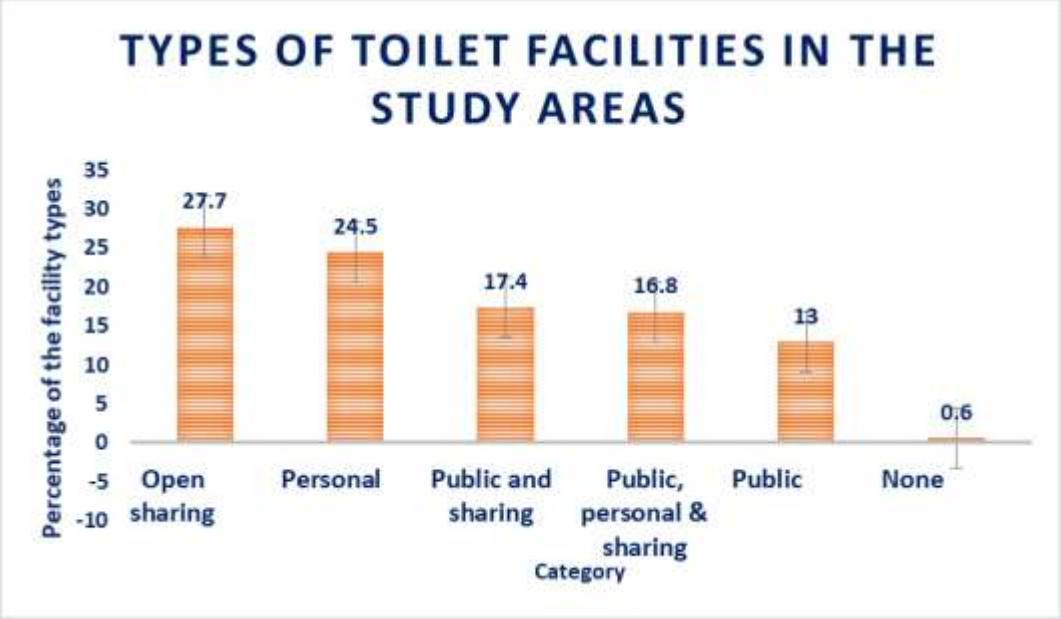


**Figure 4.7: Types of toilets facilities available in the study sites**

### 4.2.4 Source of drinking water in the study sites

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. Figure 4.7 illustrates these findings.

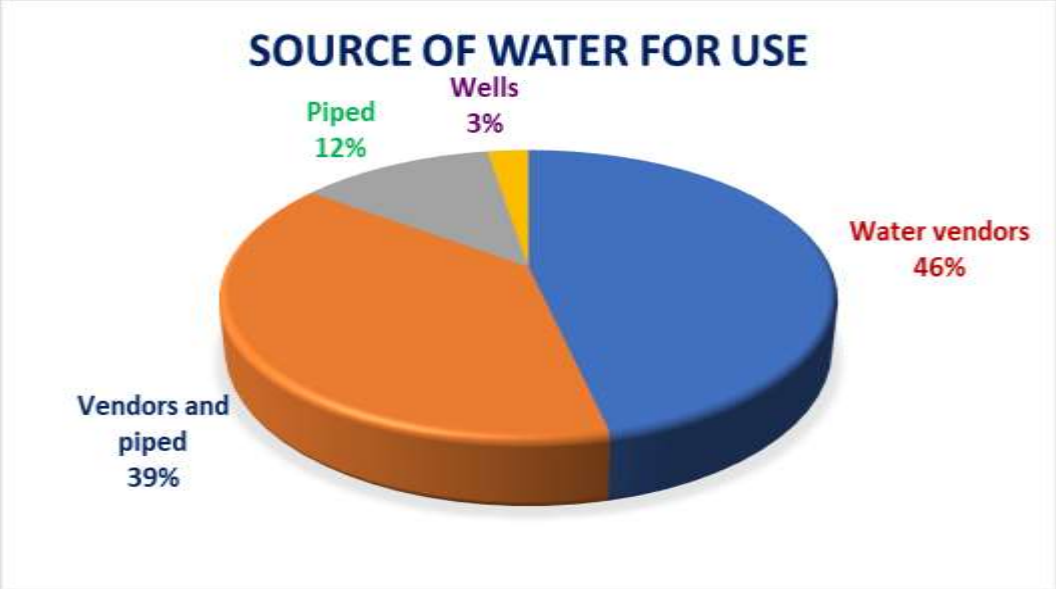


**Figure 4.8: Source of water for daily use**

### 4.2.5 Method of Water storage

The respondents were asked about the methods they use to store water, majority 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

### 4.2.6 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 were isolated using the other. In both cases resultant sediment was transferred to microscope slides and examined at x400 (X 10 eyepiece and power 40 objective) 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.

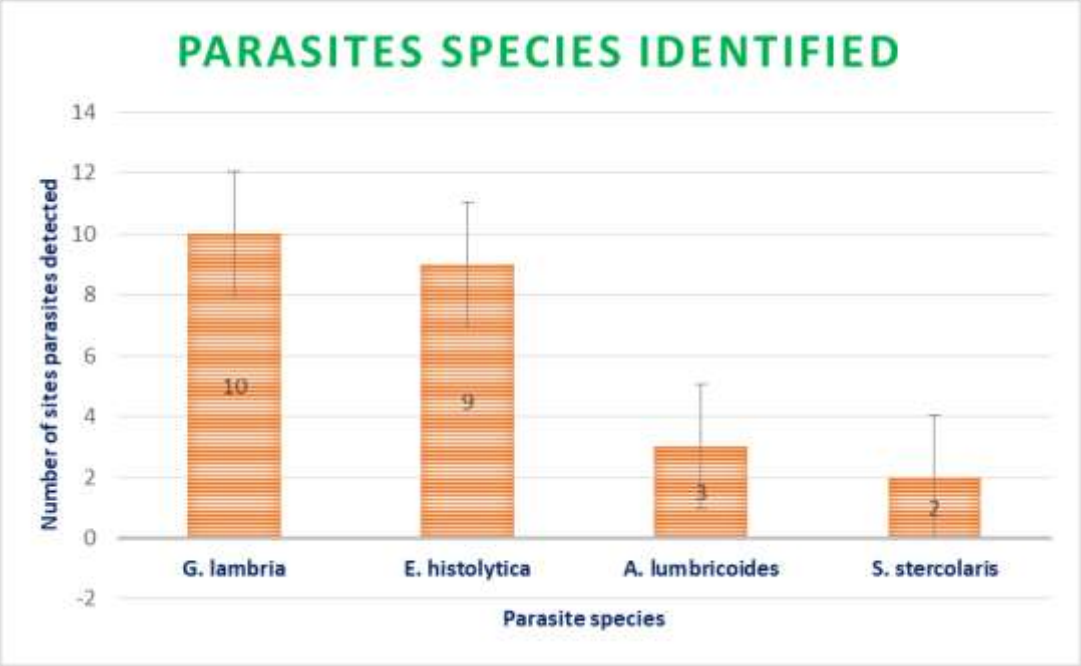


**Figure 4.9: Parasite species identified in the study sites**

### 4.2.7 Distribution of parasites in each site

Table 4.3 illustrates the parasites distributions per study area. In Eastleigh, the most common pathogens isolated were *E. histolytica* and *G. lamblia* only. Kawangware had the least number of pathogens found i.e. *G. lamblia* was only found in one site at Kawangare. Kibra had 3 different parasites isolated in 5 different sites which included *E. Histolytica, A. lumbricoides, and S. stercolaris* as indicated in figure 4.10

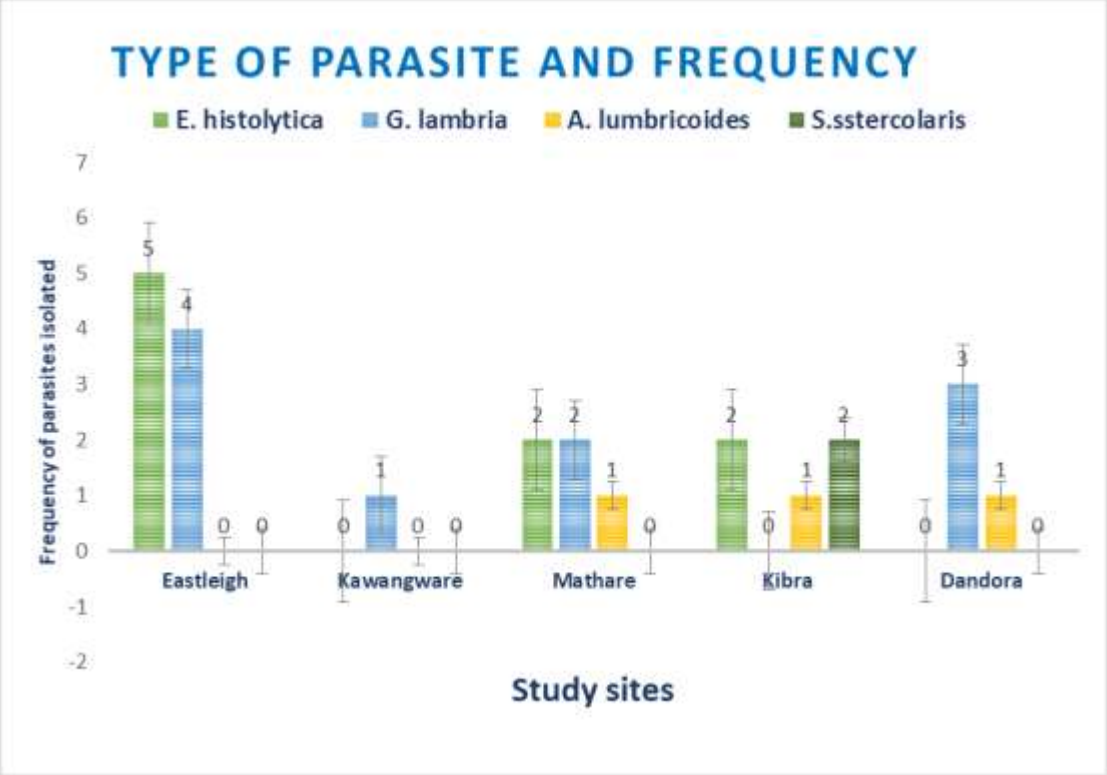


**Figure 4.10: Parasites identified and frequency of isolation in the study sites**

### 4.3 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.

#### 4.3.1 The method of storage of *C. edulis* leaves

*E. histolytica* found in study sites where *C. edulis* leaves were stored on the ground uncovered. However, the parasites 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 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 4.3: Parasites found in relation to place of storing *C. edulis* leaves**

| Parasite species relative to lave storage methods | | | | | |
|---|---|---|---|---|---|
| **Parasites found** | **Place of storing *C. edulis* leaves** | | | | **Total** |
| | **Ground Covered** | **Ground uncovered** | **Table-top/bench** | **Paper bag** | |
| E.hystolitica | 2 | 6 | 0 | 1 | 9 |
| G.lamblia | 2 | 6 | 0 | 2 | 10 |
| A. lumbricoides | 0 | 3 | 0 | 0 | 3 |
| Strongloides | 0 | 1 | 1 | 0 | 2 |
| None | 42 | 69 | 7 | 13 | 131 |
| **Total** | **46** | **85** | **8** | **16** | **155** |

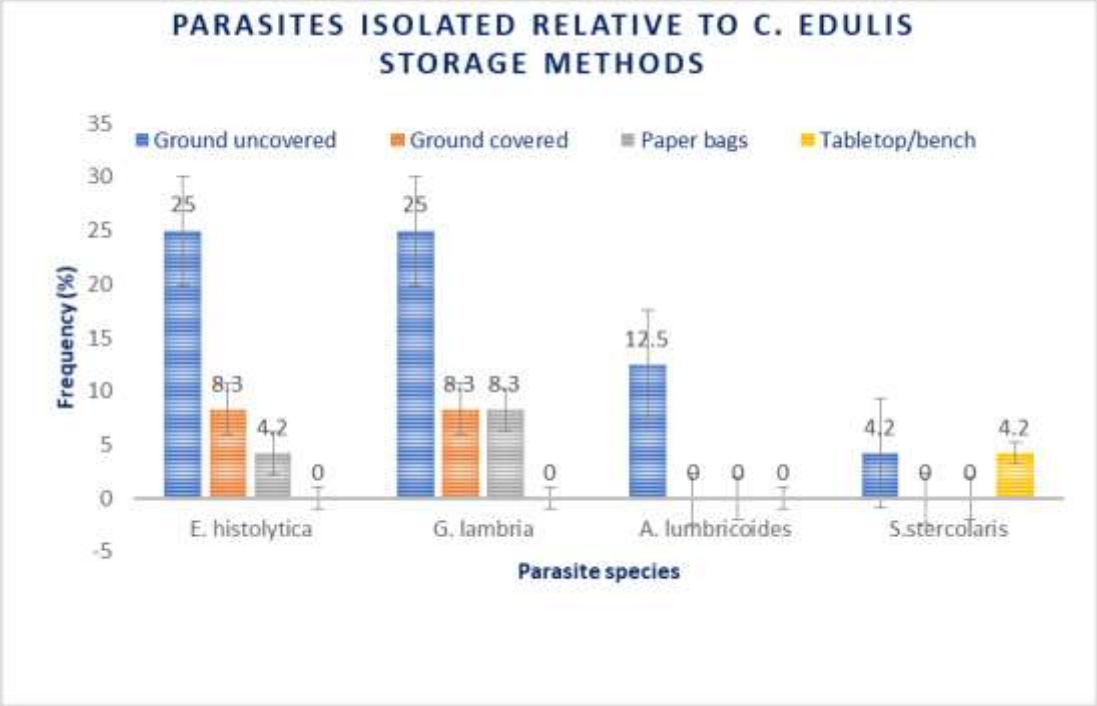


**Figure 4.11: Parasites isolated in relation to methods of *C. edulis* leaves storage**

### 4.3.2 The distribution of the parasites in relation to type of wastes

Figure 4.13 shows the distribution of parasites in relation to the type of wastes found in various study sites. Most of the parasites were isolated in areas with general wastes however, presence of other wastes were also significant.

**Table 4.4: Parasites isolated in relation to the type of wastes found within the environment**

| | Kind of wastes found within the environment | | | | | Total |
|---|---|---|---|---|---|---|
| | Human feces | General wastes | Animal feces | 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 |

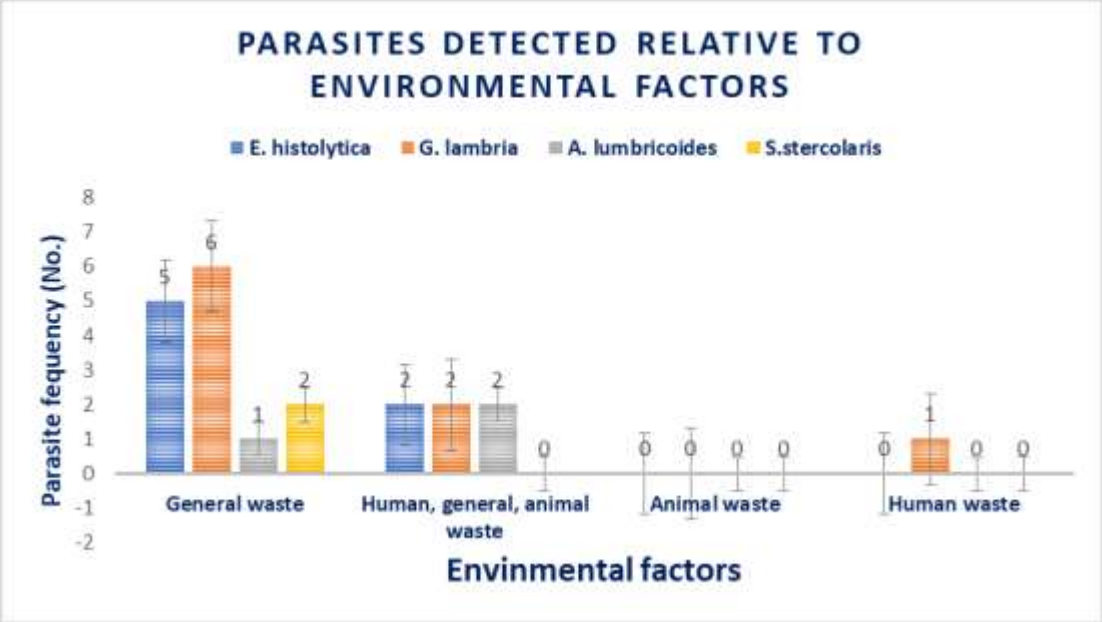


**Figure 4.12: Parasites isolated in relation to environmental conditions**

### 4.3.3 Distribution of the parasites in relation to the type of toilets

The types of toilets were found to significantly determine the presence of parasites from a particular study site. All the pathogens isolated were found in sites where there were either open sharing toilets or public or both. However, *E. hystolitica* and *G. lamblia* was also common in sites where there were private personal toilets.

**Table 4.5: Parasites found and Kind of toilets found in the area Cross tabulation**

| | 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 |

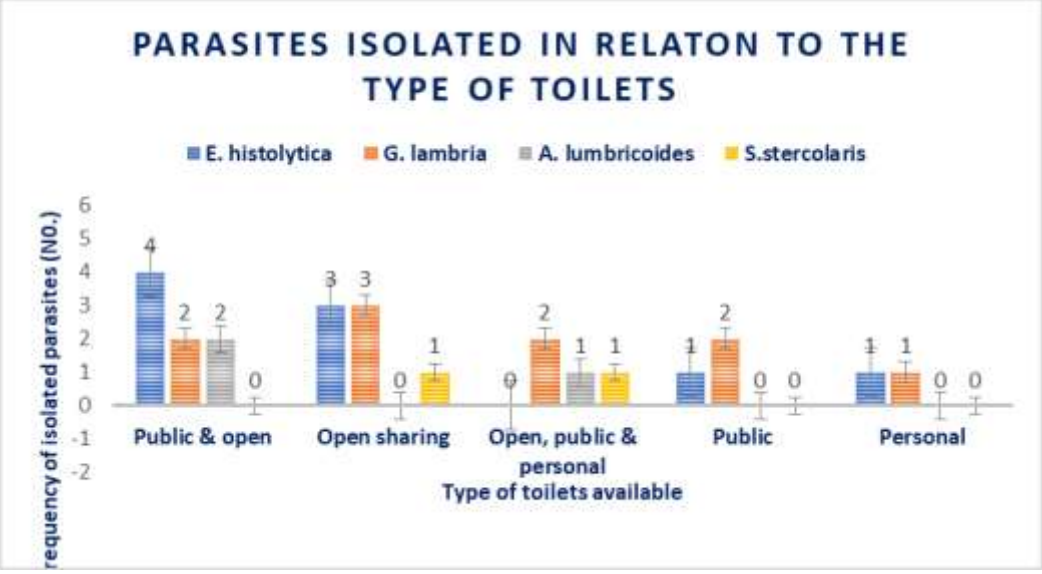


**Figure 4.13: Parasites isolated in relation to the kind of toilets available in the locality**

### 4.3.4 Parasites isolated in relation to sources of water

Table 4.7 indicates the various parasites isolated as per the source of water from the study site of which parasites were found in sites where there was both tapped water and water vendors as the source of water, with *G. lamblia* and *E.* histolytica being the most common pathogens found. Similarly, *G. lamblia* was also common in areas where water vendors were

**Table 4.6: Parasites found in relation to source of water the main suppliers.**

| Parasites found | Source of water | | | | Total |
|---|---|---|---|---|---|
| | Piped water | Wells | Water vendors | Piped and water vendors | |
| *E histolytica* | 1 | 0 | 3 | 5 | 9 |
| *G.lamblia* | 2 | 0 | 2 | 6 | 10 |
| *A. lumbricoides* | 0 | 0 | 0 | 3 | 3 |
| *Strongyloides s.* | 0 | 0 | 1 | 1 | 2 |
| None | 16 | 4 | 66 | 45 | 131 |
| **Total** | **19** | **4** | **72** | **60** | **155** |

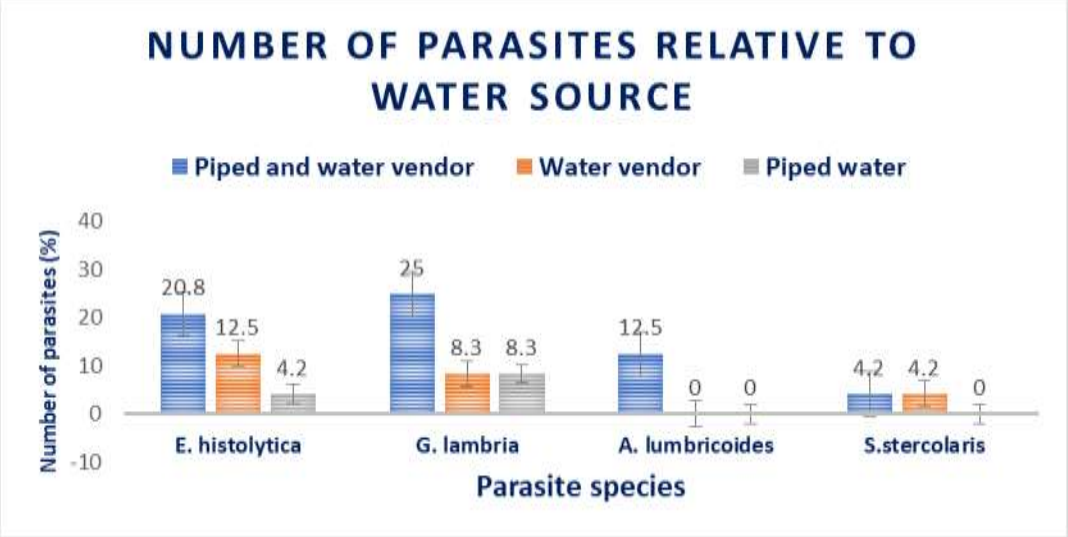


**Figure 4.14: Parasites isolated in relation to sources of water.**

### 4.3.5 Parasites found in relations with ways of storing water

Study sites with open water source found to harbor majority of the parasites. Of these parasites were isolated in areas where there was open water sources and water stored in the jerry cans. *E.* histolytica were mainly in sites with water stored in jerry cans, while, G. *lamblia* was common in sites where water was stored in open environment and water jerry cans.

**Table 4.7: Parasites isolated in relation to water storage methods**

| | **Water storage methods** | | | | **Total** |
|---|---|---|---|---|---|
| | **Open containers** | **Closed containment** | **Not applicable** | **Water jerry cans** | |
| E.histolytica | 8 | 0 | 0 | 4 | 9 |
| G.lamblia | 5 | 2 | 0 | 3 | 10 |
| A. lumbricoides | 2 | 0 | 0 | 1 | 3 |
| Strongyloides | 1 | 0 | 0 | 1 | 2 |
| None | 33 | 31 | 11 | 56 | 131 |
| **Total** | **43** | **33** | **14** | **65** | **155** |

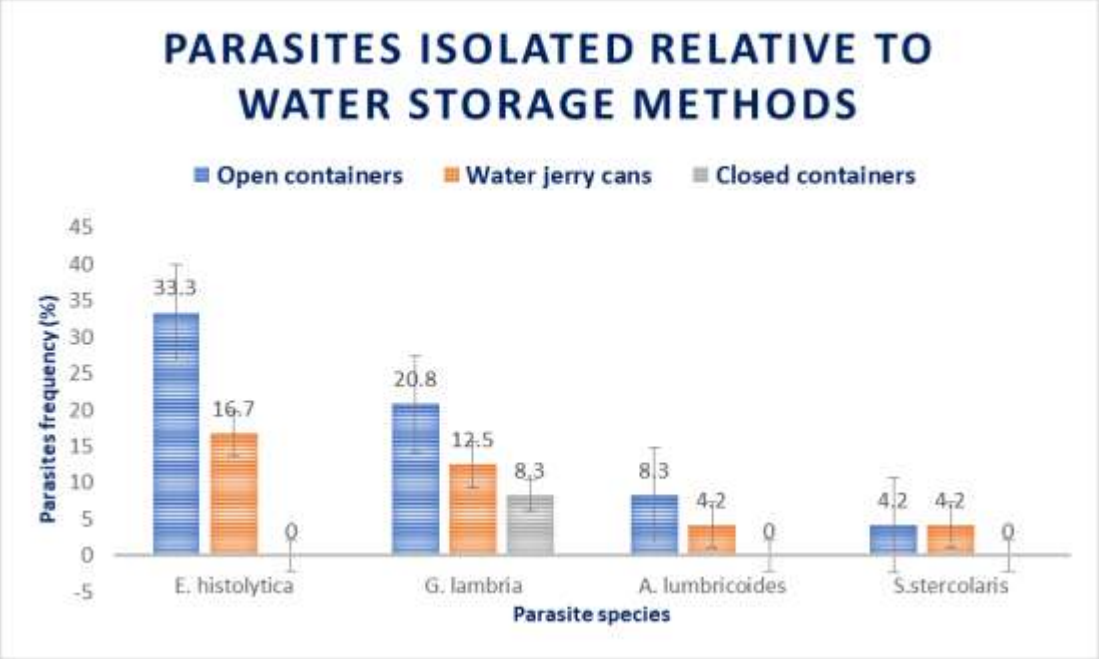


**Figure 4.15: Parasites isolated in relation to methods of water storage.**

Table 4.9 shows the selected study site characteristics and associated 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 4.8: The selected study site characteristics and associated 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 | | | | |
| On table-top | | | | |
| In paper bags | | | | |
| Types of wastes | | | | |
| Human feces | 26.844 | 0.416 | 0.208 | 0.043 |
| General wastes | | | | |
| Animal feces | | | | |
| General, human, animal | | | | |
| Water sources | | | | |
| Piped | 10.970 | 0.266 | 0.154 | 0.532 |
| Wells | | | | |
| Water vendors | | | | |
| Piped/ vendors | | | | |
| Water storage methods | | | | |
| Open environment (open buckets) | 15.278 | 0.314 | 0.181 | 0.227 |
| Closed drums | | | | |
| Water jerry cans | | | | |
| Types of toilets | | | | |
| Public toilet | 18.123 | 0.342 | 0.171 | 0.579 |
| Personal toilets | | | | |
| Open sharing toilets | | | | |

# CHAPTER FIVE

# DISCUSSION, CONCLUSION AND RECOMMENDATIONS

## 5.1 Discussion

The study population were vendors of *C. edulis* in selected parts of Nairobi County where usage of *C. edulis* leaves has 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. edulis* 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, *et al.,* (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 established 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 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 feces, animal feces 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 fecal-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. histolytica, A. lumbricoides, and strongyloides*. The findings were in agreement with a study by Masese *et al.,* (2012) which indicated that the most common pathogens which are transmitted via fecal-oral rout and can easily cause diarrheal among khat consumers were *G. lamblia, E. histolytica, A. lumbricoides, and strongyloides*.

In among the sites where parasites were isolated, *G. lamblia* was the most prevalent at 6.5%, followed by *E. histolytica* at 5.8%, *A. lumbricoides* 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. Histolytica* 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 *Strongyloides* was isolated in two sites both in Kibra.

Majority of the parasites mainly found in sites where *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 in all the sites. Similarly, all the parasites were isolated in sites with stagnation wastes. This indicated that such wastes could be major source of contamination of *C. edulis* leaves and therefore no vending should take place in such areas. Further, the study established a statistically significant association between the isolation of parasites and presences of wastes in the study sites. 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.

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 were 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. 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 statistically significant association between the presence of parasites and sources of water. 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

## 5.2 Conclusions

- The main parasites isolated from the leaves of *C. edulis* were *G. lamblia*, and *E. histolytica* and hence were the main contaminants. Other trace parasites isolated were *A. lumbricoides* and *strongyloides.*
- Generally, there was a wide spread of various parasites across the study areas. *E. histolytica* 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. *Strongyloides* was only found in Kibera. Kawangware had only one site where *G. lamblia* was isolated and hence was the least contaminated study area.
- 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. 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)

## 5.3 Recommendation

1. Vending of *C. edulis* within Nairobi city should be regulated and should strictly be done where hygienic standard are properly by having designated stall for sale of khat this will not only benefit consumers but revenue allocation to county government. There should be good sanitation services, treated water distributed through taps and not from vendors.
2. 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),
3. 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.

4. Value addition on khat should be emphasized by government hence minimize transmission
5. Further research be done to ascertain the source of contaminant from source of kat production to market place

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## APPENDICES

**Appendix I: Questionnaire in Swahili**

**Nambari Ya Dodoso……**

LUGHA YA SWAHILI

1. Mahali……

2. Miraa uwekwa wapi

**a**) Katika ardhi iliyofunikwa **b**)katika ardhi iliyo wazi **c**) bainisha nyingine

3. Unahisi vipi kuhusu usafi wa mazingira yako? **a**) vyema **b**) sawa **c**) Mbaya

4. Ni taka gani inayopatikana katika mazingira haya?

**a**) Kinyezi cha binadamu **b**) taka iliyo tapakaa **c**) kinyezi cha mnyama d) yote haya

5. Ni vyoo vya aina gani vilivyo katika eneo la utafiti?

**a**) vyoo vya umma **b**)choo binafsi **c**)choo wazi

6. Unapata wapi maji? **a**) Mifereji ya manispaa **b**) kisima **c**)wanouza maji

7) Unaeka maji wapi? **a**)mazingira yaliyowazi **b**) mazingira yaliyolindwa **c**) isiyo husika

**Appendix II: Questionnaire in English**

**[N.B, Investigator will pose as potential consumer without antagonizing seller.]**

**Questionnaire Number……**

**(QUESTIONAIRE FOR VENDORS)**

Information requested herein is for study purpose only and will be taken in confidence

1. Residence/location ……

2. Sex. Male …….Female ……..

3. Age……

4. Where do you keep c. *edulis* leave?

a) In ground covered b) in ground uncovered c) others specify

**Tick Where Applicable**

**(Principle investigator will tick where applicable as he buys the leaves from vendor)**

5. How do you feel that the cleanness in your local environment?

a) Good b) Ok c) Bad

6. What kind of waste found in environment?

a) Human feces b) Stagnation of waste c) Animal feces d) All of these

7. What kind of toilets is in study area?

a) Public toilet b) Personal toilet b) Open/sharing toilet

8. Where do you get water?

a) Municipal taps b) well c) Water vendors

9. Where do you keep water?

a) Open environment b) Protected environment c) Not applicable

***This section to be filled in the lab***

10. Identification of isolated pathogens

| **Sample ID** | **Area or location the sample was collected from** | **Method used for isolation of the pathogens** | **Pathogens Isolated** |
|---|---|---|---|
| | | | 1.<br>2.<br>3.<br>4. |

**Appendix III: Consent form**

**Title of study….** Investigation on human parasites associated with contaminated *Catha edulis* leaves sold in Nairobi County, Kenya

**Principle investigator** : JACOB N. NTHIGA….. (JKUAT)

**Supervisors** Dr. AMOS MBUGUA..... (JKUAT)

DR CHRISTOPER ANJILI (KEMRI)

Dear Participant,

My name is Jacob N. Nthiga, a Masters student at Jomo Kenyatta University of Agriculture and Technology, pursuing Master of Medical Laboratory Science (Parasitology and Entomology option). The purpose of this consent form is to give you the information you need to know in order to decide whether you would like to take part in this study. Please read (Listen) carefully and be free to ask me to explain anything that you do not understand.

**Purpose**

The study aims to determine human parasite associated with contaminated *c.edulis* leaves sold in Nairobi County. The findings will help in providing evidence best ways of preventing of infections arising from such contaminations.

**Procedure**

If you are willing to participate in the study, you will meet with the researcher or research assistant who will give you a questionnaire to fill/ or will ask you questions as already prepared in the questionnaire. You are free not to answer any question that you may feel uncomfortable with. Please do not hesitate to contact me (The researcher) or my supervisor on the telephone numbers provided below for further clarification. No

invasive procedure will be employed. You will only be required to answer the questions as shall be posed to you by the researcher or the research assistant.

**Participation**

Participation in this study is voluntary you have the right to refuse to be in this study or if you decide to participate and change your mind you can withdraw any time. You may skip question that you feel uncomfortable with or discontinue participation at any time without any penalty. Anything that is not clear or if you need further information we shall be ready and willing to provide it to you.

**Risks and Benefits**

There are no foreseeable risks and no direct benefits incentives or favor to participate in this study. However your participation in this study might help in preventing infections that may occur as a result of contamination of Khat being consumed by the public

**Benefits of taking part in the study**

There may be no direct benefit to you for taking part in the study. The information we will gather from this exercise will help us in the possible sources of contamination which may lead to human infection. This will provide us with the opportunity to address these factors.

**Research related injury**

The study is not invasive and there is no chance of getting an injury in the course of our study.

**Confidentiality**

The information gathered about you during the research will be viewed by the principal investigator and will be treated as confidential and only used for the purpose of the

study. Any information about you will have a number on it instead of your name. Only the researchers will know what your number is and we will protect the information from unauthorized access by keeping it in lockable cabinet. Any publications or presentations arising from this study will not include any information that will make it possible to identify you as a subject. However officials from JKUAT may view your record for the study. If the records are viewed the officials will protect your privacy.

**Who to contact**

Any questions that you may have about this study should be directed to Jacob N. Nthiga Principal Investigator P.O. Box 75424- 0202 422 NRB Tel. 0715089535 or my supervisor Dr Amos Mbugua .Tel Contacts 0702961963 Or Secretary KNH/UON ERC KNH/UON ERC,

P.O BOX 20723-00202, Tel.

**Certificate of Consent**

I have read the information or it has been read and explained to me and voluntarily agree to join in this study. I understand the objective of the study and what will be required of me. The risks and benefits have been explained to me. I have had the opportunity to ask questions about it and any questions that I have asked have been answered to my satisfaction. I understand that at any time that I may wish to withdraw from this study I can do so without giving any reasons and without affecting my access to care. I consent voluntarily to participate in this study.

Participant Name……..

Participant Signature……

Date…….

**Illiterate**

Thumb print of the participant

Name of the person taking consent …….

Signature……

## Appendix IV: KNH-UoN Ethics and research committee approval

UNIVERSITY OF NAIROBI
COLLEGE OF HEALTH SCIENCES
P O BOX 19676 Code 00202
Telegrams: varsity
Tel:(254-020) 2726300 Ext 44355

KNH-UON ERC
Email: uonknh_erc@uonbi.ac.ke
Website: http://www.erc.uonbi.ac.ke
Facebook: https://www.facebook.com/uonknh.erc
Twitter: @UONKNH_ERC https://twitter.com/UONKNH_ERC

KENYATTA NATIONAL HOSPITAL
P O BOX 20723 Code 00202
Tel: 726300-9
Fax: 725272
Telegrams: MEDSUP, Nairobi

KENYATTA NATIONAL HOSPITAL APPROVED 04 FEB 2019 KNH/UoN-ERC P. O. BOX 20723 - 00202 NAIROBI

Ref: KNH-ERC/A/38

4th February, 2019

Jacob Njeru Nthiga
Reg. No.TM300-5262/2015
Dept. of Medical Laboratory Sciences
School of Biomedical Sciences
J.K.U.A.T

Dear Jacob

**RESEARCH PROPOSAL – AN INVESTIGATION ON AND ISOLATION OF HUMAN PARASITES ASSOCIATED WITH CONTAMINATED *CATHA EDULIS* LEAVES SOLD IN SELECTED PARTS OF NAIROBI CITY COUNTY, KENYA (P636/08/2018)**

This is to inform you that the KNH- UoN Ethics & Research Committee (KNH- UoN ERC) has reviewed and approved your above research proposal. The approval period is 4th February 2019 – 3rd February 2020.

This approval is subject to compliance with the following requirements:

a) Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
b) All changes (amendments, deviations, violations etc.) are submitted for review and approval by KNH-UoN ERC before implementation.
c) Death and life threatening problems and serious adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH-UoN ERC within 72 hours of notification.
d) Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH- UoN ERC within 72 hours.
e) Clearance for export of biological specimens must be obtained from KNH- UoN ERC for each batch of shipment.
f) Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (*Attach a comprehensive progress report to support the renewal*).
g) Submission of an *executive summary* report within 90 days upon completion of the study. This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/ or plagiarism.

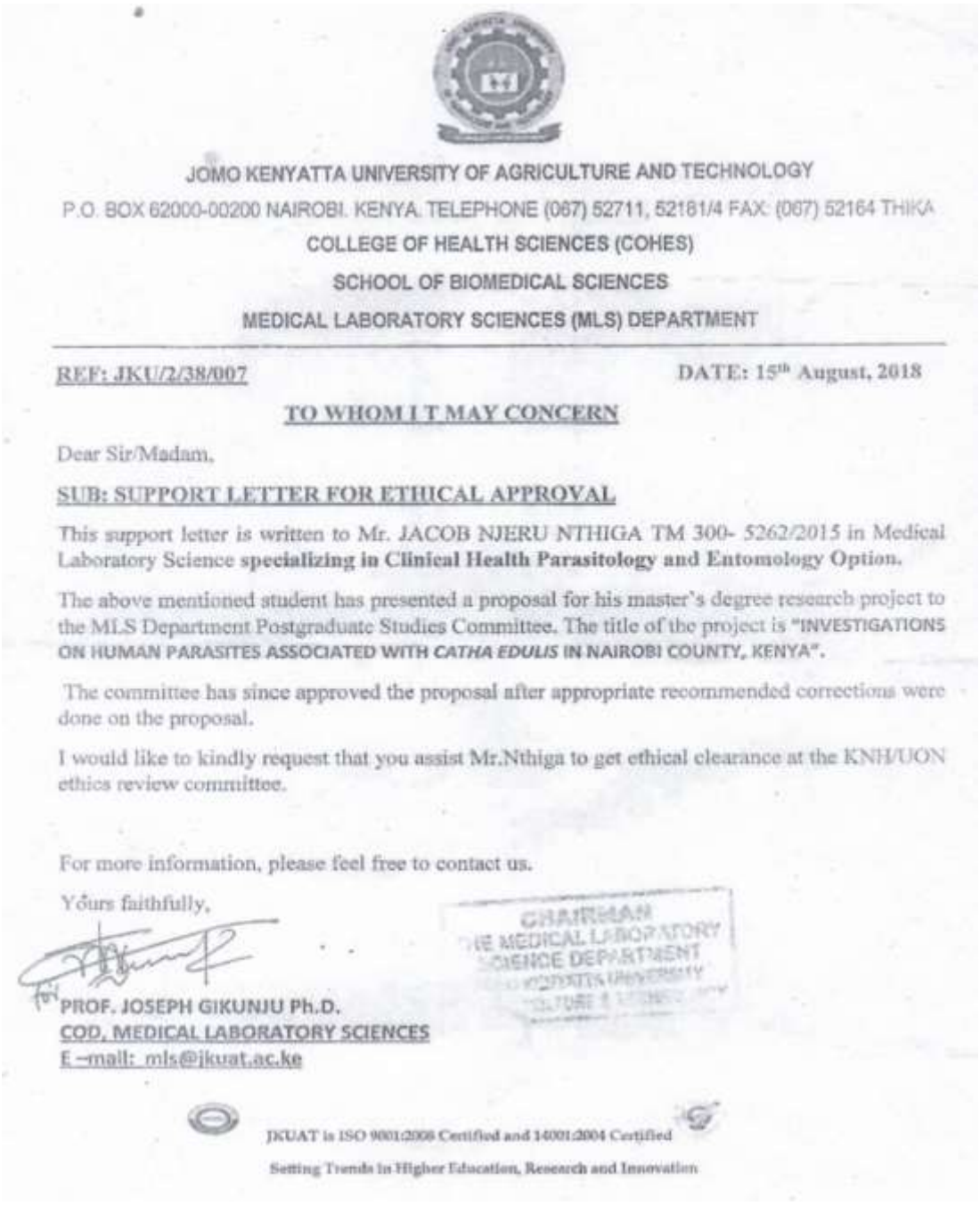
For more details consult the KNH- UoN ERC website **http://www.erc.uonbi.ac.ke**

Yours sincerely,

**PROF. M. L. CHINDIA**
**SECRETARY, KNH-UoN ERC**

c.c. The Principal, College of Health Sciences, UoN
The Director, CS, KNH
The Chairperson, KNH- UoN ERC
The Assistant Director, Health Information, KNH
Supervisors: Dr. Amos Mbugua (J.K.U.A.T), Dr. Christopher Anjili (KEMRI-CBRT)

## Appendix V: JKUAT support letter for ethical approval



JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY

P.O. BOX 62000-00200 NAIROBI. KENYA. TELEPHONE (067) 52711, 52181/4 FAX: (067) 52164 THIKA

COLLEGE OF HEALTH SCIENCES (COHES)

SCHOOL OF BIOMEDICAL SCIENCES

MEDICAL LABORATORY SCIENCES (MLS) DEPARTMENT

REF: JKU/2/38/007 DATE: 15th August, 2018

**TO WHOM I T MAY CONCERN**

Dear Sir/Madam,

**SUB: SUPPORT LETTER FOR ETHICAL APPROVAL**

This support letter is written to Mr. JACOB NJERU NTHIGA TM 300- 5262/2015 in Medical Laboratory Science **specializing in Clinical Health Parasitology and Entomology Option.**

The above mentioned student has presented a proposal for his master's degree research project to the MLS Department Postgraduate Studies Committee. The title of the project is **"INVESTIGATIONS ON HUMAN PARASITES ASSOCIATED WITH *CATHA EDULIS* IN NAIROBI COUNTY, KENYA".**

The committee has since approved the proposal after appropriate recommended corrections were done on the proposal.

I would like to kindly request that you assist Mr.Nthiga to get ethical clearance at the KNH/UON ethics review committee.

For more information, please feel free to contact us.

Yours faithfully,

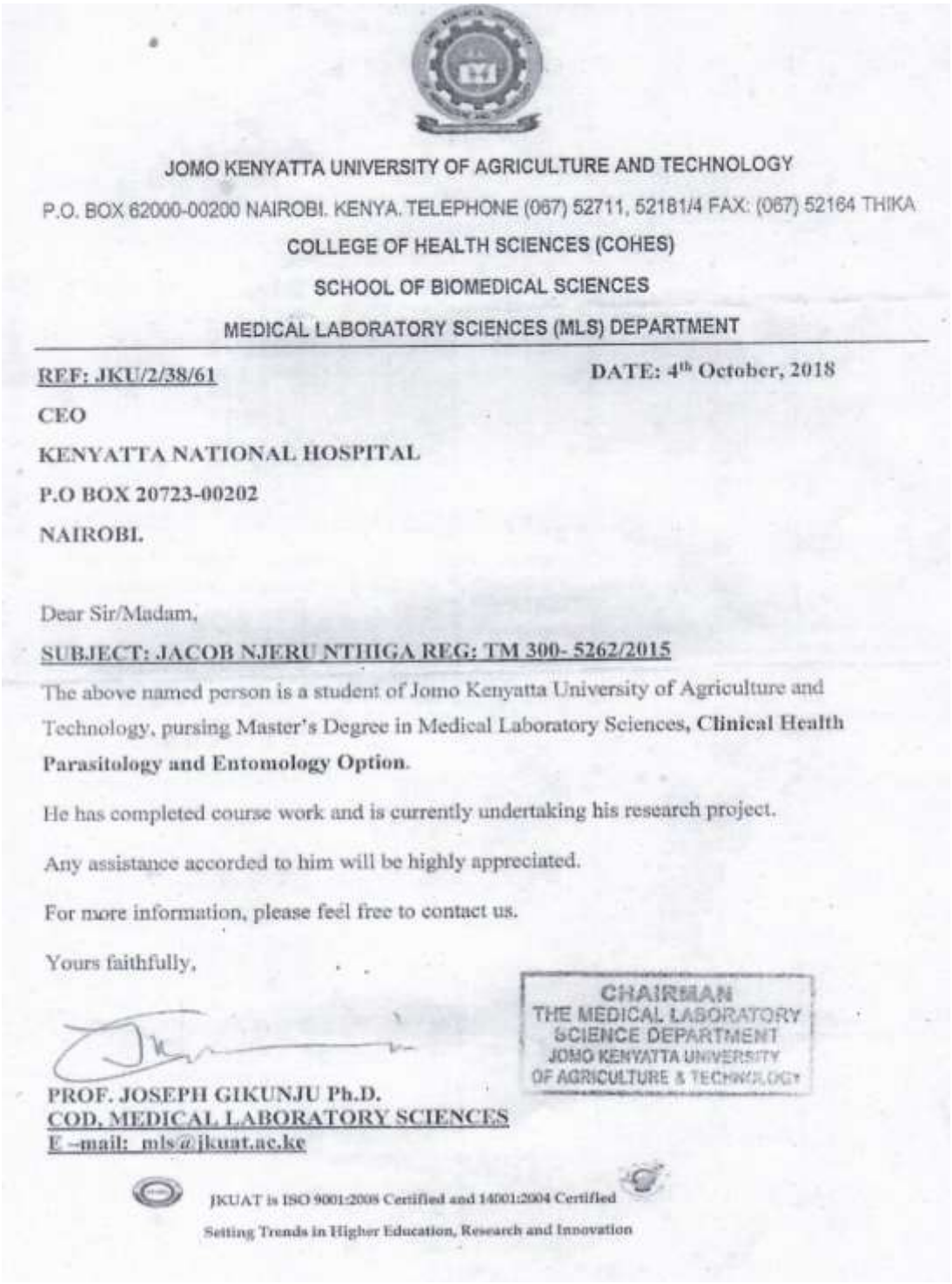
CHAIRMAN
E MEDICAL LABORATORY
CIENCE DEPARTMENT

PROF. JOSEPH GIKUNJU Ph.D.
COD, MEDICAL LABORATORY SCIENCES
E-mail: mls@jkuat.ac.ke

JKUAT is ISO 9001:2008 Certified and 14001:2004 Certified

Setting Trends in Higher Education, Research and Innovation

## Appendix VI: JKUAT letter of introduction



JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY

P.O. BOX 62000-00200 NAIROBI. KENYA. TELEPHONE (067) 52711, 52181/4 FAX: (067) 52164 THIKA

COLLEGE OF HEALTH SCIENCES (COHES)

SCHOOL OF BIOMEDICAL SCIENCES

MEDICAL LABORATORY SCIENCES (MLS) DEPARTMENT

REF: JKU/2/38/61 DATE: 4th October, 2018

CEO

KENYATTA NATIONAL HOSPITAL

P.O BOX 20723-00202

NAIROBI.

Dear Sir/Madam,

SUBJECT: JACOB NJERU NTHIGA REG: TM 300- 5262/2015

The above named person is a student of Jomo Kenyatta University of Agriculture and Technology, pursing Master's Degree in Medical Laboratory Sciences, **Clinical Health Parasitology and Entomology Option**.

He has completed course work and is currently undertaking his research project.

Any assistance accorded to him will be highly appreciated.

For more information, please feel free to contact us.

Yours faithfully,

CHAIRMAN
THE MEDICAL LABORATORY
SCIENCE DEPARTMENT
JOMO KENYATTA UNIVERSITY
OF AGRICULTURE & TECHNOLOGY

PROF. JOSEPH GIKUNJU Ph.D.
COD, MEDICAL LABORATORY SCIENCES
E –mail: mls@jkuat.ac.ke

JKUAT is ISO 9001:2008 Certified and 14001:2004 Certified

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