INVESTIGATION ON COMMUNITY AWARENESS AND LEVEL OF CONTAMINATION WITH GASTROINTESTINAL PARASITES ON FRUITS AND VEGETABLES SOLD AT SELECTED MARKETS IN ZANZIBAR

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A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN PARASITOLOGY OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

2022

EXTENDED ABSTRACT

Consumption of contaminated fruits and vegetables could be one of the ways that community can be infected with gastrointestinal parasites. A cross-sectional study was conducted between March and April 2021 (i) to assess the community awareness on the knowledge of aetiology, clinical signs, transmission and control practices towards gastrointestinal parasites in fruits and vegetables (ii) to determine the prevalence of gastrointestinal parasites contaminating fruits and vegetables sold at five central public markets in Zanzibar. A random sampling method was adopted for the selection of respondents. Semi-structured questionnaires were administered to 400 respondents to assess their awareness on gastrointestinal parasites. Similarly, a random sampling method was adopted for the collection of 300 samples of fruits and vegetables from the markets, then samples were processed and microscopically examined for detection of gastrointestinal parasite contamination on fruits and vegetables. The results indicated that, 75.5% of the respondents higher awareness on gastrointestinal parasites. Specifically, the respondents had good knowledge on control practices (85.3%), followed by transmission (80.5%), clinical signs (69.5%) and aetiology (56.4%). Out of 300 samples of fruits and vegetables, 24 samples were identified to be contaminated with gastrointestinal parasites at the prevalence rate of 8%. The detected gastrointestinal parasites included; larvae and eggs of *Strongyloides stercoralis* (5.7%), larvae of hookworm spp (1.0%), eggs of *Ascaris lumbricoides* (0.7%), larvae of *Bunostomum* spp (0.7%), cyst of *Entamoeba* spp (0.33%) and larva of *Haemonchus* spp (0.33%).The findings of this study have indicated that community in Zanzibar were aware on transmission and control practices for fruits and vegetables contamination with gastrointestinal parasites. Moreover, the study has indicated that fruits and vegetables sold at the markets were contaminated with gastrointestinal parasites.

DECLARATION

I, Sadiki Suleiman Kakomo do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

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ACKNOWLEDGEMENTS

First of all, I would like to take this opportunity to thank the ALMIGHTY GOD for granting me life, good health, strength, tolerance and giving me an opportunity of pursuing the Master degree of Parasitology which was a great dream of my destiny. I would like to express my deepest gratitude to my supervisors Dr. J. S. Nzalawahe and Dr. E. M. Mafie for their guidance, consultation, constructive comments and advice based on how I could reach my research goals and come out with good findings. My sincere gratitude to Dr. A. M. Lupindu for allocating his time giving me incredible advice and constructive comments that resulted to be among the catalysts for achieving my research work. Most sincere thanks to Mr. Salim Omar Bwata and Ms. Ester C. Shija for their technical support during sample analysis.

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DEDICATION

This research work is dedicated to my late parents Mr. and Mrs. Suleiman Kakomo for their ethical upbringing and support exposed to me during their life time until their demises. I also dedicate this work to my wife Jokha Abeid Ali for her tolerance, taking care of the family and withstanding all life challenges that happened during the whole period of my studies at Sokoine University of Agriculture. Furthermore, the dedication of this work is to my son Abubakar Sadiki for his support, prayers and encouragement during my studies. In addition, I dedicate this work to my late daughter, Maryam Sadiki who passed away while I was undertaking master's degree.

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LIST OF ABBREVIATIONS

CDC	Centre for Disease Control
CHAM	Chakechake Market
DAM	Darajani Market
FAO	Food Agricultural Organization
GDP	Gross Domestic Product
GIT	Gastrointestinal tract
MOM	Mombasa Market
MWM	Mwanakwerekwe Market
NPHC	National Population and Housing Census
OCGS	Office of the Chief Government Statistician- Zanzibar
PCR	Polymerase Chain Reaction
SPSS	Statistical Package for Social Sciences
SUA	Sokoine University of Agriculture
WEM	Wete Market
WHO	World Health Organization
ZNZ	Zanzibar

CHAPTER ONE

1.0 GENERAL INTRODUCTION

1.1 Back ground information

The consumption of fruits and vegetables are significant entities that provide a human with various nutritional components such as minerals, vitamins and fibre. Phytochemicals such antioxidants that are obtained from consumption of fruits and vegetables tend to protect the human body from different infectious pathogens including gastrointestinal parasites (Ozlem and Sener, 2005). On the other hand, fruits and vegetables act as media for the spread of infectious agents such as gastrointestinal parasites to the community (Izadi *et al*., 2006).

1.1.1 Sources of contamination on fruits and vegetables with gastrointestinal parasites

Fruits and vegetables get contaminated in various levels that include farm, packaging, transportation, market and household. At farm level, contamination happens when untreated human, animal feces and waste water are used for cultivation (Tefera *et al.*, 2014). During packaging, when the producers/farmers are packing their produces in the carrying tools while their hands and packaging materials are contaminated with pathogens, will in turn contaminate the fruits and vegetables in that way (Salamandane *et al*., 2020). Furthermore, contamination can occur during transportation, when the fruits and vegetables are transported in non-hygienic boxes or straw bags, wheel barrows and even using the public transport will eventually become contaminated with pathogens including gastrointestinal parasites (Quansah *et al*., 2018). At the market level, this

happens when vendors are non-hygienic themselves, sharing of public toilets that are in a bad conditions and washing hands without soap after toilets (Marburg *et al*., 2007). The poor health practice of vendors who display their produces on the floor especially along the road side can also lead to the contamination of the produces by flies and dusts that act as vectors for transportation of pathogens including gastrointestinal parasites (Shiras *et al.*, 2018). Similarly, poor availability of water source at the markets might hinder the market and vendor hygiene and sanitation that may lead to the contamination of fruits and vegetables they sell (Salamandane *et al.*, 2020). At household level, contamination can occur when the fruits and vegetables are not stored in refrigerators and kept on the floor and general poor housing condition tend to facilitate the gastrointestinal parasites contamination on fruits and vegetables through houseflies (Mascie-Taylor *et al*., 2003).

1.1.2 Risk factors for gastrointestinal parasites infections in human

Inadequate availability of clean water, poor hygiene and consuming unwashed fruits and improperly cooked vegetables are the risk factors for acquiring the gastrointestinal parasites (Erismann *et al.*, 2016). Likewise, the lack of personal hygiene of vendors of fruits and vegetables may promote the parasitic contamination of their produces and hence infecting the consumers (Bekele and Shumbej, 2019). Poor sanitation of the city and its surrounding environments including markets where fruits and vegetables are displayed for sale may also perpetuate the contamination of the food stuffs as a result consumers become infected in that chain (Bekele and Shumbej, 2019). Furthermore, poor defecation practices such as defecation in the bushes, disposal of feces around households will create a chance for food-borne diseases emergence and as a result human beings become infected (Ayer *et al*., 1992). Moreover, malnutrition is also one among the risk

factors for acquisition of gastrointestinal parasites. For example the tendency of the iron and zinc deficient children and pregnant women to consume soil so that they can restore those nutrients that have been lost from their bodies eventually that tendency leads to the infection with gastrointestinal parasites that are soil transmitted (Young *et al*., 2010). Furthermore, flies abundance, flies have been highly recognized as vectors for transmitting foodborne diseases. The place which is full of flies meaning that hygiene is absent as a result the flies could transmit various kinds of infectious pathogens such as gastrointestinal parasites to contaminate the food stuffs including fruits and vegetables and in turn will infect human through consumption process (Ogunniyi *et al*., 2015). Ignorance is also among the risk factor that can lead to the gastrointestinal parasitic infections to human. For example lack of public health education provision in a particular community tends to put the community into risk of being frequently infected by gastrointestinal parasites (Adefioye *et al*., 2011). Furthermore, the increasing of food consumption patterns, this means that the increasing number of people who eat in various sources such eating from the street food vendors, restaurants, canteens who do not consider food hygiene principles and regulations may end up by consuming contaminated food and hence leading to gastrointestinal parasites infection (WHO, 2007).

1.1.3 Control of gastrointestinal parasites infections in human

Provision of clean water to the communities is one approach to control of gastrointestinal parasites infection in human. It has been observed that gastrointestinal parasites are most prevalent in poor communities which cannot even afford the access to clean water. Gastrointestinal parasites tend to contaminate water which is not well controlled and preserved for human uses and using of contaminated water leads to gastrointestinal parasites infections to human (Harhay *et al*., 2010). Moreover, the provision of health

education to the community is also among the control strategy against gastrointestinal parasites that can create awareness to the community on how to avoid gastrointestinal parasites infections. Furthermore, better housing and general hygiene and sanitation, effective sewage disposal, provision of better health care and the use of footwear are among the control factors against gastrointestinal parasites. In addition, the provision of anthelmintics is an important instrument in control of gastrointestinal parasites. These drugs include albendazole, mebendazole, levamisole, pyrantel, ivermectin and praziquantel that tend to reduce the prevalence and intensity of infections of gastrointestinal parasites in human (Gillian *et al.,* 2006).

1.1.4 Importance of awareness on gastrointestinal parasite contamination in controlling the infections in human

Awareness on gastrointestinal parasite contamination can help the vendors to understand the importance of washing the fruits and vegetables before selling. This practice tends to minimize the chance of parasitic contamination to the food stuffs and hence preventing parasitic infections to consumers (Adamu *et al*., 2012). The awareness on gastrointestinal parasite infections also enables a person to understand the importance of washing hands with water and soap before eating and after toilets. This helps a person to be fee from gastrointestinal parasites infection (Bekele *et al.,* 2017). Furthermore, awareness can enable the people to implement food hygiene regulations which are not considered by most of them due to ignorance. Implementation of food hygiene regulations can rescue the people from gastrointestinal parasites infections (Ogunniyi *et al*., 2015). Moreover, awareness on gastrointestinal parasites infections can help the people to know the importance of having latrines around their households. This situation can stop the poor methods for faecal disposition such as open defecation that facilitate pollution of water,

crops and soil and hence limiting the chain of epidemiology and infections of gastrointestinal parasites to the communities (Omowaye and Audu. 2012). Furthermore, provision of community health education can help the people to be aware of good health practices such as washing of fruits and hands before eating, washing hands with clean water and soap after toilets and avoidance of indiscriminate defecation as proper means of controlling gastrointestinal parasites infections to human (Harhay *et al*., 2010).

1.1.5 Detection of gastrointestinal parasite contamination on fruits and vegetable

The recovery of gastrointestinal parasites in contaminated fruits and vegetables involves various techniques. However, all recovery techniques start with the process of washing the fruits and vegetables (Li *et al.,* 2020). The washing process involves various washing solutions to isolate the parasites from contaminated fruits and vegetables. These solutions include normal saline (Alemu *et al.,* 2019), phosphate buffered saline (Sim *et al.,* 2017), sodium dodecyl sulphate (Ranjbar *et al.,* 2013) and alconox (Shields *et al.,* 2012). Different techniques that are used to detect gastrointestinal parasites in contaminated fruits and vegetables include sediment smear stained in lugol's iodine and observed under light microscopy (Rodrigues *et al.,* 2020), Trichrome stain (Ayeh-Kumi *et al.*. 2014), Modified Ziehl-Neelsen Stain (Caradonna *et al.,* 2017), Modified Acid Fast Stain by light microscopy (Tram *et al.,* 2008), PCR amplification (Ferreira *et al*., 2018), Immunofluorescence Assay (Ortega *et al.,* 1997) and Zinc sulphate floatation method (Dada, 1979).

1.1.6 Prevention and control of gastrointestinal parasites contamination on fruits and vegetables

It is important to establish control programmes aiming at delivering education to the producers, vendors and consumers of fruits and vegetables on the basis of maintaining personal, food and environmental hygiene that can restrict the transmission of parasites (Fagbenro *et al.,* 2016). Human excreta, animal manures as well as waste water should not be used for crops cultivation unless they are treated thoroughly (Hikal and Said-Al Ahl, 2017). Likewise, proper washing of fruits and vegetables before eating and washing of hands with water and soap after toilets should be considered effectively (Fallah *et al*., 2012). Efforts should be done for the implementation of secure ways of faeces disposal in order to limit the chain of parasitic distributions and transmission to the fruits, vegetables and other food stuffs (Thein *et al.,* 1991). Provision of proper health education is the fundamental approach to be implemented time to time for the improvement of surrounding community's awareness on the effects of contaminated fruits and vegetables with gastrointestinal parasites (Agbalaka *et al.,* 2019). Frequent inspection routine accompanied with strong supervision should be practiced by food security officers to the farmers and vendors of fruits and vegetable. This can make them to be aware on the importance of food hygiene maintenance so as to control gastrointestinal parasites epidemiology and transmission in fruits and vegetables (Agbalaka *et al*., 2019).

1.2 Problem Statement and Study Justification

In Zanzibar, gastrointestinal parasites have been reported as public health problem after clinical evaluation in school-aged children. The reported gastrointestinal parasites were *Trichuris trichiura, Ascaris lumbricoides,* hookworms *and Strongyloides stercoralis* (Bogoch *et al.,* 2019). These parasites could be probably transmitted through

consumption of improper washed or unwashed fruits and poorly cooked and consumption of raw vegetables. However, in Zanzibar there was limited information about contamination of gastrointestinal parasites on fruits and vegetables sold at different markets. Similarly, there was scarce information on community awareness on the knowledge of aetiology, clinical signs, transmission and control practices related to gastrointestinal parasites contamination on fruits and vegetables. Thus, this study was designed to address that gap in knowledge. The obtained information serves as the baseline data that could be used to design appropriate measures for control of gastrointestinal parasites in Zanzibar.

1.3 Objectives of the Study

1.3.1 General objective

To generate the baseline information on awareness and the level of contamination with gastrointestinal parasites on fruits and vegetables marketed in Zanzibar for developing proper control measures.

1.3.2 Specific objectives

i. To assess the community awareness on transmission and control practices towards gastrointestinal parasites in fruits and vegetables in Zanzibar.

ii. To determine the prevalence of gastrointestinal parasites contaminating fruits and vegetables in Zanzibar.

CHAPTER TWO

MANUSCRIPT ONE

Assessment of the community awareness on transmission and control practices towards gastrointestinal parasites in fruits and vegetables in Zanzibar

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Submitted to American Journal of Public Health Research

2.0 Abstract

Community can be at risk of being infected with gastrointestinal parasites due to lack of awareness. The semi-structured questionnaires were administered randomly to 400 respondents (vendors and consumers of fruits and vegetables) at the five purposively selected public markets in Zanzibar. The markets were Mwanakwerekwe, Mombasa, Darajani, Chakechake and Wete. The data that were collected included demographic characteristics of the study respondents and their awareness on the knowledge of aetiology, clinical signs, transmission and control practices with regard to gastrointestinal parasites contamination on fruits and vegetables marketed in Zanzibar. The results showed that, 75.5% of the respondents were aware on gastrointestinal parasites. The respondents were found to have good knowledge of control practices (85.3%), followed by transmission (80.5%), clinical signs (69.5%) and knowledge of aetiology (56.4%) on gastrointestinal parasites. The findings of this study have indicated that community in Zanzibar were aware on transmission and control practices for fruits and vegetables contamination with gastrointestinal parasites.

Key words: Awareness, community, gastrointestinal parasites, fruits and vegetables, Zanzibar.

2.1 Introduction

Fruits and vegetables have significant role in contributing nutrients such as minerals, vitamins, nutritional fibers and phytochemicals especially antioxidants that defend the human body against various infectious and non-infectious diseases (Poiroux-Gonord *et al*., 2010). Despite their nutritional values, fruits and vegetables have been reported as media for transmitting infectious agents such as gastrointestinal parasites that cause various diseases to the people (Agbalaka *et al*. 2019). In this case, strong awareness of the communities related to transmission and control of gastrointestinal parasites is highly needed. However, different studies indicated that, some communities are not aware of gastrointestinal parasites and how these parasites can be transmitted and controlled (Al-Binali *et al.,* 2006). Different studies have been conducted to assess awareness of the communities on gastrointestinal parasites, for example, a study conducted in Nigeria to assess the awareness of retailers and consumers of fruits and vegetables towards gastrointestinal parasites, the findings indicated that, the retailers and consumers had poor awareness regarding gastrointestinal parasites (Fagbenro *et al*., 2016). Similarly, a study conducted in Saudi Arabia indicated poor awareness of the community with regard to gastrointestinal parasites (Sara *et al*., 2018). Therefore, poor health education awareness of the communities is the risk factor for acquiring gastrointestinal parasites infections (Kiani *et al*., 2016). In Zanzibar, gastrointestinal parasites have been reported as public health problem after clinical evaluation in school-aged children. The reported gastrointestinal parasites were *Trichuris trichiura, Ascaris lumbricoides,* hookworms *and Strongyloides stercoralis* (Bogoch *et al.,* 2019). These parasites could be probably transmitted through consumption of improper washed or unwashed fruits and poorly cooked and consumption of raw vegetables. However, in Zanzibar there was scarce information on community awareness on the knowledge of aetiology, clinical signs,

transmission and control practices related to gastrointestinal parasites contamination on fruits and vegetables. Thus, this study was designed to address that gap in knowledge.

2.2 Materials and methods

2.2.1 Description of the study area

The study was conducted in Zanzibar and specifically at five selected public markets. Zanzibar has two major islands of Unguja and Pemba. Unguja is larger than Pemba with a total area of 1,554km^2 compared to 990km^2 for Pemba (Mchenga and Abubakar, 2016). Zanzibar has a population of approximately 1.3 million with an annual growth rate of 2.8% (NPHC, 2012).The major economic activities in Zanzibar are agriculture, tourism and fishing. Agriculture is the first backbone to Zanzibar economy and it accounts for 31% GDP (Mchenga and Abubakar, 2016).

2.2.2 Study design

A cross-sectional study design was adopted in this study.

2.2.3 Sample size determination

The population size of people residing in four selected districts of urban, west “B”, Chakechake and Wete in Zanzibar where five central public markets are found is 536,147 (NPHC, 2012). Therefore, the sample size of respondents to be interviewed was determined by using Slovin’s equation (Tejada and Punzalan, 2012) with 95% confidence level. $n=N/(1 + Ne^2)$. Where; n = estimated sample size, N= the size of population and e = the acceptable error that was 5 % (0.05). Therefore the estimated sample size was 399.7 which was approximated to 400 respondents.

2.2.4 Sampling procedures and data collection

The target study population was vendors and consumers of fruits and vegetables at five purposively selected public markets. Lists of vendors and consumers were obtained by the help of markets' leaders. Then random selection was adopted for selection of vendors and consumers to assess their awareness on fruits and vegetables gastrointestinal parasites contamination. Each respondent was provided with a consent form (Appendix 2) to ask for his/her willingness to participate in the study. The Swahili translated semi-structured questionnaire (Appendix 1) after being piloted to check its accuracy, was administered to the respondents to collect information that included: demographic information (sex, age, educational level, occupation and location), knowledge of aetiology, transmission, clinical signs, prevention and control practices of gastrointestinal parasites.

2.2.5 Data analysis

The data were entered, coded, validated and stored into the spread sheet of Microsoft Excel Window 2007 and analysed using Statistical Package for Social Sciences (SPSS) version 16.0. Chi-square test was used to determine if there were statistically significant differences between respondents' awareness and their demographic characteristics, where p-value of ≤ 0.05 was used as a cut-off point of significance. Descriptive data analysis such as means, frequencies and proportions were performed.

2.2.6 Ethical consideration

The research clearance and ethical protocols of this study were approved by Sokoine University of Agriculture (Ref. No. SUA/ADM/R.1/8/733) and (Ref. No. DPRTC/SUA/R/186/F.9) respectively. Also a permission to conduct this study in Zanzibar was granted by the Office of the Second Vice President of Zanzibar (Ref. No. OMPR/M.95/C.6/2/VOL.XII/12) and the consent form was also used to seek for

willingness of the respondents to participate in the study prior to the start of data collection**.**

2.3 Results

2.3.1 Demographic characteristics of the study respondents

A total of 400 respondents were interviewed in this study of which 60% and 40% were from Unguja and Pemba respectively. The higher proportions of the respondents were females (56.23%). Consumers constituted 85% and vendors of fruits and vegetables comprised the remaining 15%. The mean age of the respondents was 32.9 years and higher proportions of them were aged 18-25 years (33%). In terms of education, higher proportion of the respondents had secondary education (69.25%) as shown in Table 1.

Table 1: Demographic characteristics of study respondents

Characteristics	N	(%)
Sex		
Male	175	43.75
Female	225	56.23
Location		
Unguja	240	60.0
Pemba	160	40.0
Occupation		
Vendors	60	15.0
Consumers	340	85.0
Age		
18-25	132	33.0
26-33	106	26.5
34-41	72	18.0
42-49	53	13.25
50-57	24	6.0
58+	13	3.25
Education		
Primary	90	22.5
Secondary	277	69.25
Diploma	13	3.25
Degree	5	1.25
Informal	15	3.75

Education Level	Vendors	Consumers
Primary	22(36.7)	68 (20)
Secondary	27 (45)	250 (73.5)
Diploma	-	13 (3.8)
Degree	-	5 (1.5)

Informal	11(18.3)	4 (1.2)

2.3.2 Awareness on gastrointestinal parasites

The awareness level of the community towards gastrointestinal parasites was high (75.5%). Considering the categories of awareness, the respondents had higher knowledge on control practices (85.3%) followed by transmission (80.5%), clinical signs (69.5%) and aetiology (56.4%) as summarized as summarized in Table 2.

Table 2: General knowledge on aetiology, clinical signs, transmission and control practices of gastrointestinal parasites of respondents

Awareness regarding gastrointestinal parasites	**Correct answers**	
	N = 400	**(%)**
Knowledge on aetiology		
People heard of gastrointestinal parasites.	396	99.00
Those were able to mention the types of GIT parasites.	55	13.75
Knowledge on clinical signs		
Symptoms of having GIT parasites infections.	278	69.5
Knowledge on transmission		
How can a person be infected with gastrointestinal parasites?	322	80.5
Knowledge on control practices		
Wash/should wash the food stuffs before selling.	347	86.75
Washing of fruits with running water before eating.	353	88.25
Washing of hands with water and soap after toilet.	363	90.75
Cooking of vegetables properly.	301	75.25

2.3.3 Awareness on gastrointestinal parasites according to locations

Generally, a high proportion of respondents from Unguja (77%) were aware on gastrointestinal parasites compared to those from Pemba where the proportion was 73.44%. Specifically, respondents from Unguja were more aware with regard to the questions concerning clinical signs and washing/should wash the fruits and vegetables before selling compared to the respondents from Pemba, . On the other hand, respondents

from Pemba were more aware on the question about the awareness on the knowledge of control practices concerning the cooking of vegetables properly compared to those respondents from Unguja. The difference in awareness between these two locations was statistically significant (p-value < 0.05) (Table 3).

Table 3: Awareness on gastrointestinal parasites according to locations

Awareness regarding gastrointestinal parasites	**Correct answers**		
	Unguja n=240 (%)	**Pemba n=160 (%)**	**P- value**
Knowledge on aetiology			
People heard of gastrointestinal parasites.	240 (100)	156 (97.5)	0.140
Those were able to mention the types of GIT parasites.	28 (11.7)	27 (16.9)	0.274
Knowledge on clinical signs			
Symptoms of having GIT parasites infections.	191(79.58)	87 (54.4)	**0.000**
Knowledge on transmission			
How can a person be infected with gastrointestinal parasites?	198 (82.5)	124.(77.5)	0.216
Knowledge on control practices			
Wash/should wash the food stuffs before selling.	215 (89.6)	132 (82.5)	**0.041**
Washing of fruits with running water before eating.	218 (90.83)	135 (84.4)	0.146
Washing of hands with water and soap after toilet.	218 (90.8)	145 (90.6)	0.944
Cooking of vegetables properly.	167 (69.6)	134 (83.8)	**0.001**

Significant p-values (<0.05) are in bold based on Chi-square test.

2.3.4 Awareness on gastrointestinal parasites according to occupation

Results show that consumers (77.35%) were more aware of gastrointestinal parasites compared to vendors (64.74%). Consumers were more aware on clinical signs, washing of fruits and vegetables before selling, washing of fruits with running water before eating

and washing of hands with water and soap after toilets compared to vendors at statistically significant difference of p-values < 0.05 (Table 4).

Table 4: Awareness on gastrointestinal parasites according to occupation of the respondents

Awareness regarding gastrointestinal parasites	Correct answers		
	Vendors n=60 (%)	Consumers n=340 (%)	P-value
Knowledge on aetiology			
People heard of gastrointestinal parasites.	60 (100)	336 (98.8)	0.398
Those were able to mention the types of GIT parasites.	9 (15)	46 (13.5)	0.319
Knowledge on clinical signs			
Symptoms of having GIT parasites infections.	33 (55)	245 (72.1)	**0.008**
Knowledge on transmission			
How can a person be infected with gastrointestinal parasites?	46 (76.7)	276 (81.2)	0.416
Knowledge on control practices			
Wash/should wash the food stuffs before selling.	31(51.7%)	316 (92.9)	**0.000**
Washing of fruits with running water before eating.	45 (75)	308 (90.59)	**0.001**
Washing of hands with water and soap after toilet.	43 (71.7)	320 (94.1)	**0.000**
Cooking of vegetables properly	44 (73.33)	257 (75.59)	0.307

Significant p-values (<0.05) are in bold based on Chi-square test

2.3.5 Awareness on gastrointestinal parasites according to sex

Results show that females (76.67%) were more aware on gastrointestinal parasites compared to males (73.93%). Females were more aware on the knowledge of washing/should wash the food stuffs (fruits and vegetables) before selling and washing of

hands with water and soap after toilet compared to males. The difference was statistically significant (p-value < 0.05) (Table 5).

Table 5: Awareness on gastrointestinal parasites according to sex

Awareness regarding gastrointestinal parasites	**Correct answers**		
Knowledge on aetiology	**Male n=175 (%)**	**Female n=225 (%)**	**P-value**
People heard of gastrointestinal parasites.	174 (99.4)	222(98.6)	0.447
Those were able to mention the types of GIT parasites.	24 (13.7)	31(13.78)	0.25
Knowledge on clinical signs			
Symptoms of having GIT parasites infections.	128 (73.14)	150(66.67)	0.163
Knowledge on transmission			
How can a person be infected with gastrointestinal parasites?	141 (80.57)	181 (80.44)	0.975
Knowledge on control practices			
Wash/should wash the food stuffs before selling.	134 (76.57)	213(94.67)	**0.000**
Washing of fruits with running water before eating.	151 (86.3)	202(89.8)	0.216
Washing of hands with water and soap after toilet.	147 (84)	216(96)	**0.000**
Cooking of vegetables properly.	136 (77.71)	165(73.33)	0.314

Significant p-values (<0.05) are in bold based on Chi-square test

2.3.6 Awareness on gastrointestinal parasites according to age groups

The age group of 18-25 years (77.75%) had good knowledge of gastrointestinal parasites compared to 26-33 (75.94%) and 42-49 years (75.94%), 34-41 years (75%), 50-57 years (67.71%) and lastly was 58+ years (63.5%). Therefore the age groups under 50 years were more aware on the knowledge of washing/should wash the food stuffs before

selling, washing of fruits with running water before eating and washing of hands with water and soap after toilets compared to the age groups over 50 years at significant difference p-values of < 0.05 (Table 6).

Table 6: Awareness of gastrointestinal parasites according to the age groups of respondents

Awareness regarding gastrointestinal parasites	Correct answers (frequency and %)						
	18-25 n=132	26-33 n=106	34-41 n=72	42-49 n=53	50-57 n=24	58+ n=13	P-value
Knowledge on aetiology							
People heard of gastrointestinal parasites.	130 (98.5)	104 (98.1)	72 (100)	53 (100)	24 (100)	13 (100)	0.726
Those were able to mention the types of gastrointestinal parasites	19 (14.4)	16 (15.1)	12 (1.7)	3 (5.7)	4 (16.7)	1 (7.7)	0.335
Knowledge on clinical signs							
Symptoms of having GIT parasites infections.	90 (68.2)	75 (70.8)	51 (70.8)	42(79.2)	14(58.3)	6(46.2)	0.194
Knowledge on transmission							
How can a person be infected with gastrointestinal parasites?.	107(81.1)	80(75.5)	61 (84.7)	45 (84.9)	17 (70.8)	12(92.3)	0.327
Knowledge on control practices							
Wash/should wash the food stuffs before selling.	121 (91.67)	96 (90.6)	60(83.3)	47 (88.7)	17 (70.8)	6 (46.2)	**0.000**
Washing of fruits with running water before Eating	120 (91)	96(90.6)	63 (87.5)	48(90.6)	15 (62.5)	11(84.6)	**0.000**
Washing of hands with water and soap after toilet.	125(94.7)	99(93.4)	65(90.3)	47(88.7)	19(79.2)	8 (61.5)	**0.001**
Cooking of vegetables properly	109(82.6	78(73.6	48(66.7	37(69.8	20(83.3	9 (69.2)	0.12

)	)	)	)	)

Significant p-values (<0.05) are in bold based on Chi-square test

2.3.7 Awareness of gastrointestinal parasites according to educational level

The results indicated that, those respondents with degree level of education (82.5%) were highly knowledgeable on gastrointestinal parasites compared to diploma level (77.9%), secondary level (77.7%), primary level (70.97%) and informal education (57.5%). Respondents with high educational levels (degree, diploma and secondary) were more aware on the knowledge of clinical signs, washing/should wash the food stuffs before selling, washing of fruits with running water before eating and washing of hands with water and soap after toilets compared to those with low educational levels (primary and informal) at significant difference p-values of < 0.05 (Table 7).

Table 7: Awareness of gastrointestinal parasites according to educational levels

Awareness regarding gastrointestinal parasites	Correct answers (frequency and %)					
	Primary n=90	Secondary n=277	Diploma n=13	Degree n=5	Informal n=15	P-value
Knowledge on aetiology						
People heard of gastrointestinal parasites	89 (98.9)	274 (98.9)	13 (100)	5 (100)	15 (100)	0.985
Those were able to mention the types of gastrointestinal parasites	8 (8.9)	40 (14.4)	1 (7.7)	2 (40)	4 (26.7)	0.167
Knowledge on clinical signs						
Symptoms of having GIT parasites infections	60 (66.7)	201 (72.6)	9 (69.2)	4(80)	4 (26.7)	**0.005**
Knowledge on transmission						
How can a person be infected with gastrointestinal parasites?	69(76.7)	229 (82.7)	11 (84.6)	4 (80)	9 (60)	0.212
Knowledge on control practices						
Wash/should wash the food stuffs before selling	74(82.2)	248 (89.5)	13 (100)	5 (100)	7 (46.7)	**0.000**
Washing of fruits with running water before Eating	70(77.8)	255 (92.1)	13 (100)	5 (100)	10 (66.7)	**0.002**
Washing of hands with water and soap after toilet	79(87.8)	258 (93.1)	13 (100)	4 (80)	9 (60)	**0.000**
Cooking of vegetables properly	62(68.88)	\216 (77.98)	8 (61.54)	4 (80)	11 (73.33)	0.347

Significant p-value (<0.05) are in bold based on Chi-square test

2.4 Discussion

This is the first study carried out to assess the community awareness on the knowledge of aetiology, clinical signs, transmission and control practices towards gastrointestinal parasites in Zanzibar.

The findings showed that, the level of awareness of the respondents (75.5%) on gastrointestinal parasites was high. This was in agreement with the findings from similar study in Nigeria whereby more than half of the respondents were aware on gastrointestinal parasites (Abe *et al*., 2016). Similarly, in a study conducted in South Africa and Zimbabwe 91% and 81% respectively indicated the highest awareness on the two communities studied on gastrointestinal and urinary parasites (Mbereko *et al*., 2020). The high level of awareness found in this study and other reported studies suggest that the community members had good health education on gastrointestinal parasites since these parasites are endemic in their communities (Magaisa *et al*., 2015).

Apart from general awareness, this study also indicated the respondents' awareness on gastrointestinal parasites in relation to the specific variables that assessed the categories of awareness. The results showed that, about 99% of the respondents in this study had already heard of gastrointestinal parasites. This was in contrast to findings reported in Malaysia (61.4%) and Nigeria (35%) according to Nasr *et al*. (2013) and Abe *et al*. (2016) respectively. The disparity on response to whether heard or not heard of gastrointestinal parasites might be due to the difference in activeness of the health education strategies taking place in the studied communities to sensitize the communities that gastrointestinal parasites are existing in this world as living organisms (Williams-Blangero *et al*., 2020).

This study observed that community awareness (knowledge) on type of gastrointestinal parasites was low as only 13.75% of the respondents were aware. However, the only mentioned type of gastrointestinal parasites in this study was *Ascaris lumbricoides*. This might be due to the fact that, according to the respondents, the most frequently adult gastrointestinal parasites come out either through the mouth, nose or during defecation is *Ascaris lumbricoides*. But in reality, gastrointestinal parasites range from helminths including *Ascaris lumbricoides* to protozoan parasites (Kiani *et al.,* 2016). Similar findings have been reported in Malaysia where only one-tenth of the respondents were aware on the types of gastrointestinal parasites (Nasr *et al*., 2013). However, different findings have been reported in Nepal where high proportion of respondents were more aware on the types of gastrointestinal parasites (Williams-Blangero *et al*., 2020). The difference in the knowledge of knowing various types of gastrointestinal parasites might be due to existing differences in efforts to build awareness through public health education campaigns (Williams-Blangero *et al*., 2020).

Furthermore, about 69.5% of the respondents were aware of signs and symptoms of a person having gastrointestinal parasitic infections. This was in agreement with the studies conducted in Cote d'lvore, Brazil and Nigeria reported high awareness on clinical signs concerning gastrointestinal parasitic infections among the respondents (Acka *et al*., 2010: Midzi *et al*., 2011; Abe *et al*., 2016) respectively. In contrast findings from Malaysia showed poor knowledge on clinical signs (Nasr *et al*., 2013). The discrepancy in awareness on clinical signs towards gastrointestinal parasites might be contributed to the fact that, gastrointestinal parasites differ in terms of infestations where some of the parasites seemed to be symptomatic and others are non-symptomatic (Kamunvi *et al*., 1993).

Likewise, knowledge on transmissions was high (80.5%) in this study. This level of awareness was in contrast to report from Bangladesh (Mascie-Taylor *et al*., 2003) and Malaysia (Nasr *et al*., 2013) where only quarter of their respondents were able to mention the ways that lead to the transmissions of gastrointestinal parasitic infections to human. Having high level of knowledge on how gastrointestinal parasites can be transmitted in the communities is advantageous weapon in controlling gastrointestinal parasites in the communities while low level of knowledge on how these parasites can be transmitted substantiate that, the communities are at risk of acquiring gastrointestinal parasitic infections (Kiani *et al*., 2016).

Additionally, in the present study a high proportion of respondents (86.75%) recognized the importance of washing fruits and vegetables before selling/eating. This was in contrast to studies by Salamandane *et al*. (2020) and Tefera and Mebrie. (2014) which reported 53.3% and 26.9% of the vendors were washing the fruits and vegetables before selling respectively. Having knowledgeable vendors with regards to control practices is the significant factor for reducing fruits and vegetables contamination at market level (Oranusi and Braide, 2012).

Large proportion of respondents (88.25%) understood the need of washing fruits particularly with running water before eating. This concurs with findings of similar studies in various countries (Sharif *et al*. 2010; Abe *et al*., 2016; Rakshna *et al*., 2020). However, these findings did not emphasize on washing the fruits with running water style like our study. Washing of fruits and vegetables is very significant in minimizing the chances of parasitic transmission to consumers, since gastrointestinal parasites have been observed to contaminate the fruits and vegetables (Ogun State, 2016). Habit of eating fruits and vegetables that are not properly washed and cooked respectively, can trigger the spread of parasitic diseases to human (CDC, 2014).

The present study found that a very high proportion of respondents (90.75%) were aware that hand washing with water and soap after visiting toilets is the means of reducing or avoiding parasitic contamination of fruits and vegetables. This was in agreement with similar studies reported by Vivas *et al*. (2010), Nee *et al*. (2011), Tegegne and Phyo. (2017), Sara *et al*. (2018), Ajibo *et al*. (2020) and Rakshna *et al.* (2020). However, this knowledge level was higher than 45% of respondents who acknowledged the same aspect of knowledge as reported by Tosin *et al*. (2017). Habits of proper hand washing with water and soap may assist to prevent and control infectious diseases caused by microorganisms including gastrointestinal parasites (Gelaw and Anagaw. 2013)

Awareness on cooking style of vegetables was also observed in this study where high proportion (75.25%) of respondents confirmed that they cook the vegetables thoroughly. This is consistent with findings reported by Abe *et al*. (2016) where a very high proportion of respondents (97%) substantiated that they cook their vegetables properly before eating. Proper cooking of vegetables is of paramount importance since it assists to kill infectious pathogens that are found on vegetables and making the vegetables to be fit for human consumption (Okoli *et al*., 2018).

In accordance to locality, the findings indicated that a large proportion of respondents from Unguja (77%) were more aware in most of the aspects probed with respect to gastrointestinal parasites compared to Pemba (73.44%). This could be due to differences in terms of social and economic status of the people between communities (Nasr *et al*., 2013).

This study reported that consumers (77.35%) were more aware of gastrointestinal parasites compared to vendors (64.74%) of fruits and vegetables. The high level of awareness shown by consumers could be attributed probably due to their high level of

education compared to vendors. Therefore high level of awareness shown by consumers could help them to be free from gastrointestinal parasites infections that can be attributed by consumption of contaminated fruits and vegetables (Tosin *et al*., 2017).

Based on the sex, females (76.67) were more aware of gastrointestinal parasites compared to males (73.93%). The high level of awareness shown by females in this study is probably due to the fact that, females are the ones that take care of the families and prepare the food for the families. Also, more women stay indoors than men and this factor probably may prioritize the women to have enough time to listen and watching different public health education programmes through radio and television concerning personal hygiene, environmental hygiene and food hygiene as powerful tools to combat against epidemiology and transmission of parasitic diseases to the community.

The age groups of respondents under 50 years were found to be more aware of gastrointestinal parasites compared to over 50 years. This could be probably attributed due to the fact that respondents may differ in terms of educational level, ownership of radio and personal exposure to social media.

This study indicated that, awareness was increased with increased level of education and it was decreased with decreased level of education. Similar study conducted in Malaysia (Nasr *et al*., 2013) showed that more educated respondents were more aware of gastrointestinal parasites compared to illiterate individuals. Similarly, the study carried out in Bangladesh showed the same results that respondents with high levels of education were more aware of the knowledge and practices concerning gastrointestinal parasites (Bath *et al*., 2010). Furthermore, a previous study conducted in Iran confirmed that higher education of mothers was associated with reduction of infection rate to their children (Nematian *et al*., 2004). In addition, a study conducted in Kenya indicated that

respondents with high educational levels were more aware of intestinal worms (Kamunvi *et al*., 1993). Educational level is the significant factor in understanding health protocols in the struggle for controlling gastrointestinal parasitic diseases in the community (Agbalaka *et al*., 2019).

2.5 Conclusion

The findings of this study indicated the high level of awareness of the community on transmission and control practices with regard to gastrointestinal parasites contamination on fruits and vegetables. However, the awareness seemed to differ in terms of geographical locations (Unguja and Pemba), occupation (vendors and consumers), sex (males and females), age groups and educational level. Therefore, a good level of community awareness with regard to gastrointestinal parasites in this study has been documented to determine the success of gastrointestinal parasites control programmes worldwide, hence global development and attainment of millennium development goals.

2.6 Recommendations

Public health education should continue to be provided in order to remind the community frequently that, washing the fruits with running water before eating, washing hands before and after meals, washing hands with water and soap after visiting toilets and cooking the vegetables properly are very important factors to avoid parasitological, bacterial and viral infectious diseases.

Personal hygiene and sanitation, washing the fruits and vegetables with clean water before selling and to avoid selling the food stuffs on the floor especially along the road sides should be considered and practiced by all vendors to avoid infectious diseases to the community.

Municipal council officers should make sure that clean water is available all the time at the markets that can be utilized by vendors and buyers for various purposes to safeguard the public health.

There should be a special public health awareness campaign to educate the school-aged children about the transmission and control of gastrointestinal parasites through consumption of fruits and raw vegetables since children are vulnerable group to GIT parasites infections in the community.

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CHAPTER THREE

MANUSCRIPT TWO

Investigation on contamination with gastrointestinal parasites on fruits and vegetables sold at selected public markets in Zanzibar

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3.0 Abstract

Consumption of unwashed fruits and raw vegetables are the risk factors for acquiring gastrointestinal parasites. A cross-sectional study was conducted between March and April 2021 to determine parasitic contamination on fruits and vegetables. A random sampling method was adopted for the collection of 300 samples of fruits and vegetables from five purposively selected public markets in Zanzibar. Then, the samples were processed and microscopically examined for detection of gastrointestinal parasite contamination on fruits and vegetables. Out of 300 samples of fruits and vegetables, 24 samples were identified to be contaminated with gastrointestinal parasites at the prevalence rate of 8%. The detected gastrointestinal parasites included; larvae and of *Strongyloide stercoralis* (5.7%), larvae of hookworm spp (1.0%), eggs of *Ascaris lumbricoides* (0.7%), larvae of *Bunostomum* spp (0.7%), cyst of *Entamoeba* spp (0.33%) and larva of *Haemonchus* spp (0.33%).. The contaminated samples were spinach (*Spinacia oleracea*) 16%, cucumber (*Cucumis sativus*) 16% and onion (*Allium cepa*) 16% followed by avocado (*Persea americana)* 12%, cabbage (*Brassica oleracea*) 8%, banana (*Musa acuminata*) 8% and pawpaw (*Carica papaya*) 8%, sweet potato leaves (*Ipomoea batatas)* 4%, mango (*Mangifera indica*) 4% and orange (*Citrus sinensis*) 4%. The study has indicated that fruits and vegetables sold at the markets were contaminated with gastrointestinal parasites except tomato (*Solanum lycopersicum*) and chinese (*Brassica rapa*)

Key words: Contamination, gastrointestinal parasites, fruits and vegetables, markets, Zanzibar

3.1 Introduction

Gastrointestinal parasites are worldwide distributed (Asadpour *et al.,* 2016). More than three billion people around the world reported to be infected, more than four hundred million people are at risk of being infected and two hundred thousand people die annually from these pathogens through consumption of contaminated food including fruits and vegetables (Wegayehu *et al*., 2013; Stofer. 2014). These parasites are associated with poverty and hence are highly prevalent in low and middle income countries of sub-Saharan Africa, Asia, Latin America and the Caribbean. However they also are still found in North America and Europe (Brooker *et al.,* 2006; Hotez and Kamath, 2009). The predominant gastrointestinal parasites that infect people who eat contaminated fruits and vegetables include *Ascaris lumbricoides, Cryptosporidium* species, *Strongyloides stercoralis, Entamoeba histolytica, Enterobius vermicularis, Fasciola* species (*Faciola hepatica* and *Faciola gigantica*), *Giardia intestinalis,* hookworms (*Ancyclostoma duodenale* and *Necator americanus*), *Taenia* species (*Taenia solium*), *Trichuris trichiura, Toxoplasma gondii* and *Toxocara* species (Bekele *et al.,* 2017; Kayombo and Mayo, 2018). Infections with these parasites lead to various health problems in human that include blood deficiency, malnutrition, frequent diarrhea, dysentery, constipation, abdominal pain, vomiting, loss of body weight, loss of appetite, general body weakness, poor growth development, decreased level of intelligence and even death especially in children and immunocompromised people (Kiani *et al*., 2016). In Zanzibar, gastrointestinal parasites have been reported as public health problem after clinical evaluation in school-aged children. These parasites could be probably transmitted through consumption of improper washed or unwashed fruits and poorly cooked and consumption of raw vegetables. However, in Zanzibar there was limited information about

contamination with gastrointestinal parasites on fruits and vegetables. Thus, this study was designed to address that gap in knowledge.

3.2 Materials and methods

3.2.1 Description of the study area

The study was conducted in Zanzibar which is surrounded by Indian Ocean between latitude of 04°50’ to 06°30’S and longitude 39°10’ to 39°50’E. Zanzibar has two major islands of Unguja and Pemba. Unguja is larger than Pemba with a total area of 1,554km^2 compared to 990km^2 for Pemba (Mchenga and Abubakar, 2016). Zanzibar has a population of approximately 1.3 million with an annual growth rate of 2.8% (NPHC, 2012). The major economic activities in Zanzibar are agriculture, tourism and fishing. Agriculture is the first backbone to Zanzibar economy and it accounts for 31% GDP (Mchenga and Abubakar, 2016). Sample collection was conducted in five purposively selected central public markets that included Mwanakwerekwe, Darajani, and Mombasa (Unguja Island), Chakechake and Wete (Pemba island) as shown in Figure 1.

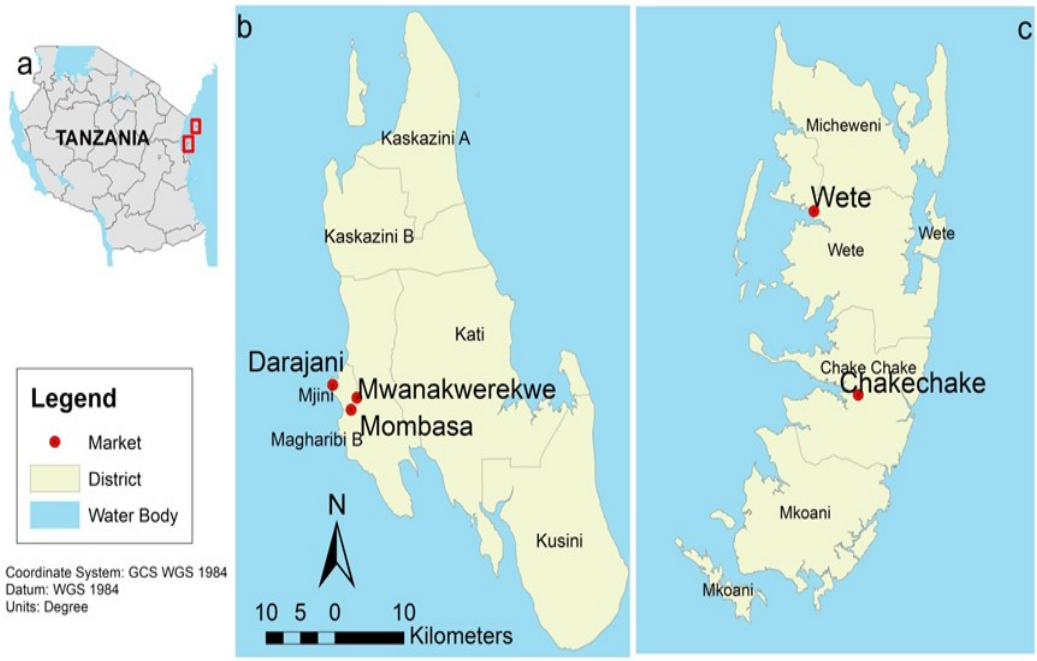

Figure 1: The distribution of five central public markets in Zanzibar where "b" represents Unguja Island and "c" represents Pemba Island

3.2.2 Study design

A cross-sectional study design was adopted in this study

3.2.3 Sample size determination

The sample size of fruits and vegetables to be collected was estimated by using the formula for infinite population as proposed by (Kothari and Garg, 2014) $n= Z^2P (1-P)/e^2$. Whereby n= sample size, Z= standard normal deviation set at 95% confidence level (1.96), P=confidence level for this study, that was 75% (0.75) based on previous study and e = acceptable error that was 5% (0.05). Therefore, the estimation was as follow; 1.96^2 X 0.75 (1 – 0.75)/ 0.05^2 = 288 which was approximated to 300 batches of fruits and vegetables**.**

3.2.4 Sampling procedures and data collection

Random sampling method was adopted for selection of fruits and vegetables where a total of 300 batches of twelve types of fruits and vegetables were purchased from the central public markets in Zanzibar. The fruit samples (Figure 2) included: mango (*Mangifera indica*), orange (*Citrus sinensis*), banana (*Musa acuminata*), cucumber (*Cucumis sativus*), avocado (*Persea americana*) and pawpaw (*Carica papaya*). Vegetables included: spinach (*Spinacia oleracea*), cabbage (*Brassica oleracea*), sweet potato leaves (*Ipomoea batatas*), tomato (*Solanum lycopersicum*), onion (*Allium cepa*) and chinese (*Brassica rapa*). Individual samples were packed in sterilized plastic bags and labeled with a unique number, name of the sample, name of the market, name of the collector and date of collection. Then all collected samples were packed into cool boxes and transported to the

parasitological laboratory at the College of Veterinary Medicines and Biomedical Sciences of Sokoine University of Agriculture for parasitological examination.

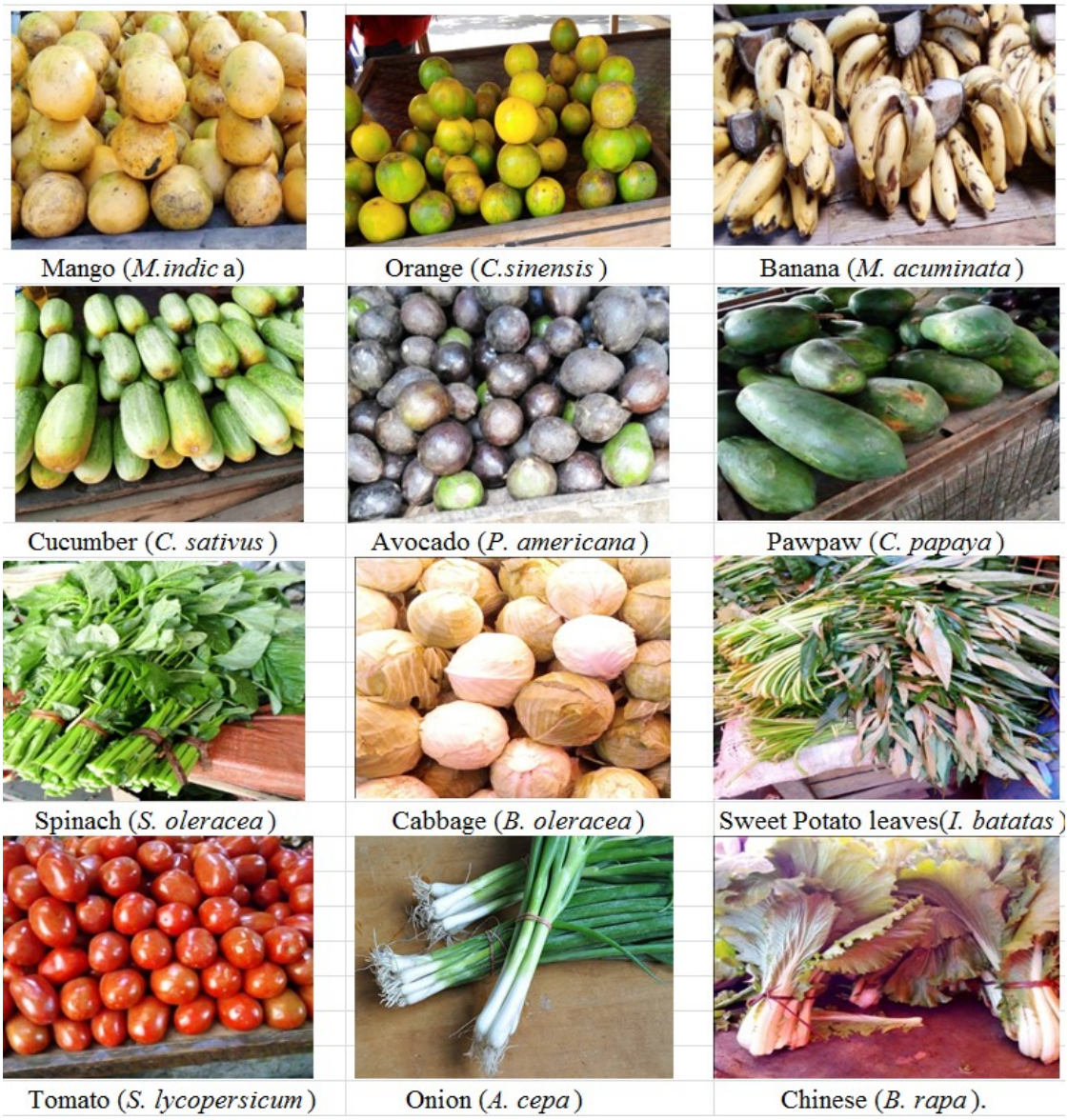

Figure 2: The fruits and vegetables displayed for sale at the markets

3.2.5 Laboratory samples' processing and parasitological examination

Samples of fruits and vegetables were soaked in containers of 500ml and 700ml of normal saline (0.85% Nacl) depending on the size and washed for two minutes followed by vigorous shaking and left to stand for 20 minutes (Ismail, 2016: Alemu *et*

al., 2019). Then each sample was sieved into the sedimentation flask using a tea strainer to remove undesirable matters.

The filtrate in sedimentation flasks was left for overnight for the sedimentation to take place. After overnight sedimentation the supernatants were decanted carefully without shaking. Then 15ml of the sediments were transferred to the centrifuge tubes (Falcon tubes) and placed into the centrifuge machine for centrifugation at 3000 rpm for five minutes in order to concentrate the parasitic stages of ova, larvae, cysts and oocysts (Bekele *et al.,* 2017). After centrifugation, the supernatants were decanted carefully without shaking the tubes that contained the centrifuged filtrates (Bekele *et al.*, 2017). Thereafter, two slides for each sample were prepared. The first slide was smeared with only sediment and the second slide was smeared with sediment and a drop of lugols iodine was added. Both slides were covered with a clean cover slip and observed under microscope at x10 and x40 magnification (Auta *et al.*, 2017). The identification of the detected gastrointestinal parasites was based on the published morphological identification key of parasitic eggs, larvae and cyst (Hansen and Perry, 1994; Garcia, 2006; Van Wyk, and Mayhew, 2013; Hendrix and Robinson, 2016; Leventhal and Cheadle, 2019).

3.2.6 Data analysis

The data for parasitic contamination were collected and stored in Microsoft Excel Window 2007. Then, the data were uploaded into Statistical Package for Social Sciences (SPSS) version 16.0 for analysis. The prevalence of parasitic contamination rate on fruits and vegetables was calculated according to Mitchell *et al.* (2000). Chi-square test was used to determine if there was significant difference between parasitological contamination of fruits and vegetables and locations where p-value of ≤ 0.05 was

considered as statistically significant. In addition, descriptive data analysis such as frequencies and proportions were performed.

3.2.7 Ethical consideration

The research clearance and ethical protocols of this study were approved by Sokoine University of Agriculture (Ref. No. SUA/ADM/R.1/8/733) and (Ref. No. DPRTC/SUA/R/186/F.9) respectively and a permission to conduct this study in Zanzibar was granted by the Office of the Second Vice President of Zanzibar (Ref. No. OMPR/M.95/C.6/2/VOL.XII/12) prior to the start of data collection**.**

3.3 Results

Out of 300 samples of fruits and vegetables, 24 samples were identified to be contaminated with gastrointestinal parasites. The overall contamination rate was 8%. The highest contamination rate was observed in spinach (*Spinacia oleracea*) 16%, cucumber (*Cucumis sativus*) 16% and onion (*Allium cepa*) 16% followed by avocado (*Persea americana)* 12%, cabbage (*Brassica oleracea*) 8%, banana (*Musa acuminata*) 8% and pawpaw (*Carica papaya*) 8%, sweet potato leaves (*Ipomoea batatas)* 4%, mango (*Mangifera indica*) 4% and orange (*Citrus sinensis*) 4%. However, both tomato (*Solanum lycopersicum*) and chinese (*Brassica rapa*) were not contaminated with parasites (Table 1).

Table 1: Frequency distribution of parasitological contamination of fruits and vegetable in the public markets in Zanzibar

Samples	Number examined N=300	Number of positive (%)	Number of parasite species detected One type (%)	Two type (%)
Fruits				
Mango	25	1(4)	1 (4)	0
Orange	25	1 (4)	1 (4)	0
Banana	25	2 (8)	2 (8)	0
Cucumber	25	4(16)	3 (12)	1 (4)
Avocado	25	3(12)	2 (8)	1 (4)
Pawpaw	25	2 (8)	2 (8)	0
Vegetables				
Spinach	25	4(16)	4 (16)	0
Cabbage	25	2 (8)	2 (8)	0
Sweet potato leaves	25	1 (4)	1 (4)	0
Tomato	25	-	0	0
Onion	25	4(16)	4 (16)	0
Chinese	25	-	0	0
Total	**300**	**24 (8)**	**22 (7.33)**	**2 (0.7)**

The detected gastrointestinal parasites included larvae of *Strongyloide stercoralis*, ova of *Ascaris lumbricoides*, cyst of *Entamoeba* spp, larva of hookworm spp, larva of *Bunostomum* spp and larva of *Haemonchus* spp. *Strongyloides stercoralis* (5.7%) was the most frequently detected gastrointestinal parasite followed by larva of hookworm spp (1.0%), eggs od *Ascaris lumbricoides* (0.7%), *Bunostomum* spp (0.7%), *Entamoeba* spp (0.33%) and *Haemonchus* spp (0.33%). There was multiple contamination of parasitic species observed. In that way, cucumber (*Cucumis sativus*) was detected with larvae of *Strongyloides stercoralis* and larva of *Haemonchus* spp and avocado (*Persea americana)*

was detected with eggs of *Ascaris lumbricoides* and larvae of *Strongyloides stercoralis* (Table 2 and Figure 3).

Table 2: The number, percentage and the corresponding parasite density of contaminated fruits and vegetables sold at the public markets in Zanzibar

Samples	N=300 (%)	*S. stercoralis*	*A. lumbricoides*	*Entamoeba*	Hookworm	*Bunostomum*	*Haemonchus*
Fruits		Frequency(%)	Frequency (%)	Frequency(%)	Frequency(%)	Frequency(%)	Frequency(%)
Mango	25	1 (4)	-	-	-	-	-
Orange	25	1 (4)	-	-	-	-	-
Banana	25	2 (8)	-	-	-	-	-
Cucumber	25	3 (12)	-	-	1 (4)	-	1 (4)
Avocado	25	2 (8)	1 (4)	-	1 (4)	-	-
Pawpaw	25	1 (4)	1 (4)	-	-	-	-
Vegetables							
Spinach	25	3 (12)	-	1 (4)	-	-	-
Cabbage	25	-	-	-	-	1 (4)	-
S. P. leaves	25	1 (4)	-	-	1 (4)	-	-
Tomato	25	-	-	-	-	-	-
Onion	25	3 (12)	-	-	-	1 (4)	-
Chinese	25	-	-	-	-	-	-
Total	300	17 (5.7)	2 (0.7)	1 (0.33)	3 (1.0)	2 (0.7)	1 (0.33)

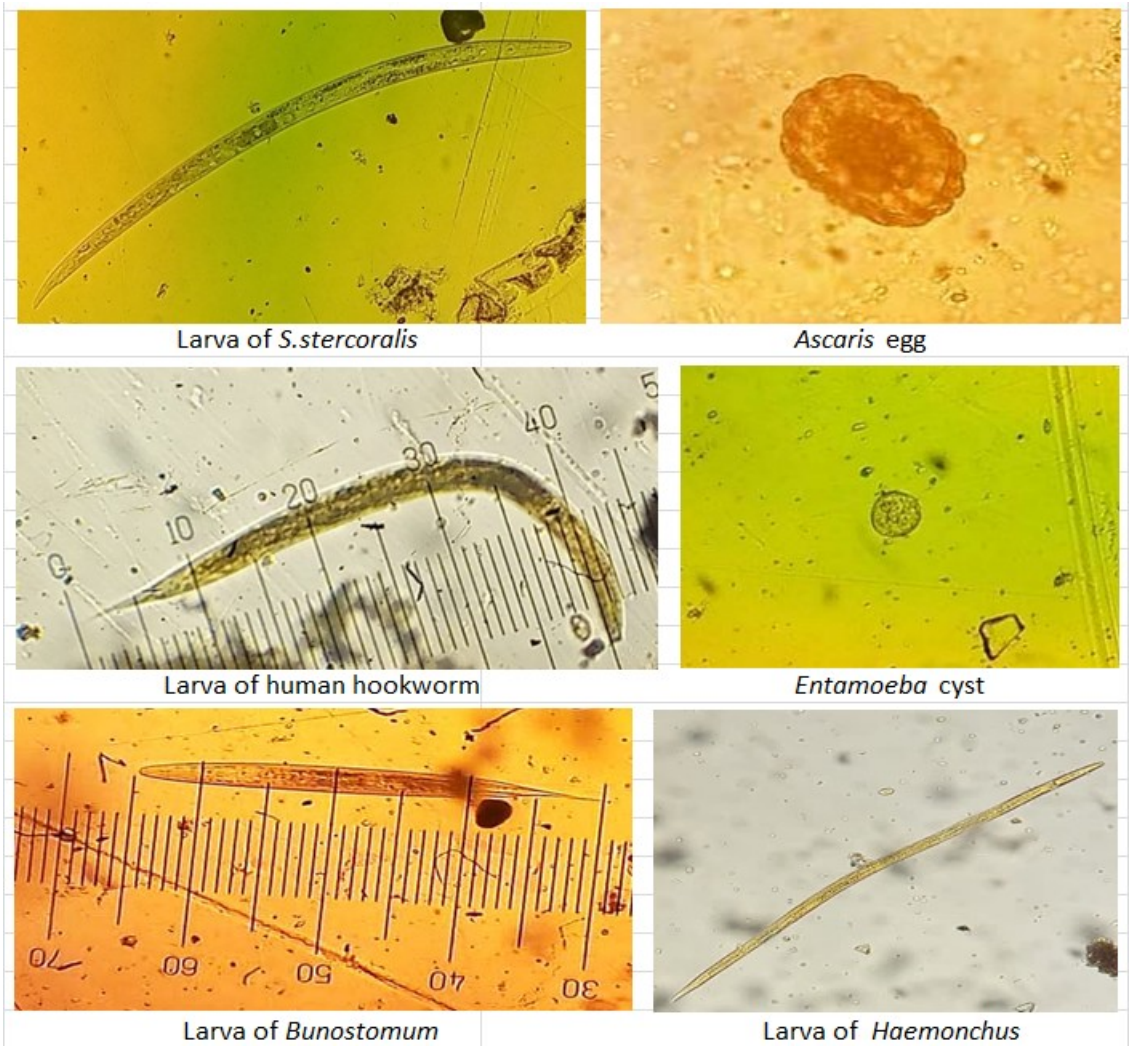

Figure 3: The images of the detected gastrointestinal parasites

Based on location, Pemba had higher parasitological contamination rate (5%) compared to Unguja (3%). However, the differences in parasitological contamination of each type of fruits and vegetables and the locations were not statistically significant as shown in Table 3.

Table 3: The percentage of parasitological contamination of fruits and vegetables according to localities (Unguja and Pemba)

Sample (N=300)	Unguja		Pemba		P-value
Fruits	**No. examined**	**Positive (%)**	**No. examined**	**Positive (%)**	
Mango	15	-	10	1 (10)	0.211
Orange	15	-	10	1 (10)	0.211
Banana	15	1 (6.7)	10	1 (10)	0.763
Cucumber	15	2 (13.3)	10	2 (20)	0.656
Avocado	15	1 (6.7)	10	2 (20)	0.315
Pawpaw	15	-	10	2 (20)	0.071
Vegetables					
Spinach	15	2 (13.3)	10	2 (20)	0.656
Cabbage	15	1 (6.7)	10	1 (10)	0.763
Sweet potato leaves	15	1 (6.7)	10	-	0.405
Tomato	15	-	10	-	-
Onion	15	1 (6.7)	10	3 (30)	0.119
Chinese	15	-	10	-	-
Total (N=300)		**9 (3)**		**15 (5)**	-

3.4 Discussion

This is the first study to be conducted in Zanzibar to determine the prevalence of contamination with gastrointestinal parasites on fruits and vegetables. The level of parasitic contamination observed was moderate in this study. This was in agreement with study reported in Iran by Matini *et al*. (2017) with contamination rate of 8.4%. However, it was lower compared to some similar studies conducted in various parts of the world including Egypt (Hassan *et al*., 2012), Nigeria (Auta *et al*., 2017, Alli *et al*., 2011 and Maikai *et al*., 2012), Ethiopia (Alemu *et al*., 2020, Bekele *et al*., 2017), Kenya (Nyarango *et al.*, 2008), Sudan (Mohamed *et al*., 2016), Ghana (Kudah *et al*., 2018), Brazil (Luz *et al.*, 2017), Saudi arabia (Al-Megrin, 2010) and Iran (Balarak *et al.*, 2016). In contrast contamination rate was higher compared to the study reported in India with parasitic contamination rate of 2.7% (Sunil *et al,* 2014) and Nigeria with parasitic contamination rate of 3.5% (Adamu *et al.,* 2012). The difference in awareness of the

producers and vendors in handling of the fruits and vegetables for marketing, geographical location, number of samples examined, various laboratory methods used, type of water used for irrigation and the type of water used for washing the fruits and vegetables before selling might be the important reasons for the variation in parasitic contamination on fruits and vegetables across the world (Abougrain *et al*., 2010).

In comparing vegetables in terms of contamination, the findings showed that spinach (*Spinacia oleracea*) and onion (*Allium cepa*) had high parasitic contamination rate followed by cabbage compared to the rest of the vegetables. The high contamination rate of spinach in this study was in line with what was reported by Maikai *et al.* (2012) with highest contamination rate of 84.6% and Agbalaka *et al*. (2019) with 40% contamination rate. This could be due to the fact that spinach is more likely to be sprinkled with water to keep them from shriveling where the water used for sprinkling the spinach was probably contaminated with gastrointestinal parasites (Uga *et al.,* 2009). The high contamination rate of onion (*Allium cepa*) in this study was in agreement with what was reported by Mohamed *et al*. (2016) with contamination rate of 13.9%, surprisingly green onion is one among the vegetables with smooth surface leaves that may reduce the chance of getting high contamination (Bekele and Shumbej, 2019) which was in contrast to observation in this study and the similar reported studies by other scholars. This would point out the possibility of sprinkling with contaminated water as this green vegetable is sprinkled to keep it from shriveling.

On the other hand, the higher parasitic contamination rate in fruits was represented by cucumber and avocado. The higher contamination rate of cucumber in this study was in line with the study reported by Hassan *et al*. (2013) with cucumber contamination rate of 22.22%. However, cucumber contamination rate was highest compared to other samples

in the study reported by Adamu *et al.* (2012) with contamination rate of 2.3%. The difference in contamination rate among various types of fruits and vegetables could be catalyzed according to their variations in plant structures and ways of handling them (Larkin *et al.*, 1978).The contamination was also observed in other examined fruits and vegetables except tomato (*Solanum lycopersicum*) and Chinese (*Brassica rapa*). The non-contamination rate in tomato might be due to the fact that, the smooth condition of tomato might reduce the chance of parasitic attachment and contribute to lower contamination rate and the awareness of the vendors in the handling of the food stuffs play the significant role in the contamination of the produces that they sell (Bekele and Shumbej, 2019). Also the non-contamination rate of chinese might be contributed by the awareness of the producers and vendors on washing the fruits and vegetables with clean water before selling (Larkin *et al.*, 1978).

Moreover, larvae of *Strongyloides stercoralis* (5.7%) was the most frequently detected gastrointestinal parasite followed by hookworm spp and *Ascaris lumbricoides*. The high frequency of detection of *Strongyloides stercoralis* larvae was in agreement with the study reported in Ethiopia (Tefera *et al.*, 2014). This might be due to the fact that this kind of parasite has both free living and parasitic stages in such away that it may occupy various kinds of habitats (Adeyeba and Essiet. 2002). The contamination rate potrayed by both hookworm spp and *Ascaris lumbricoides* might be due to their ability to resist a broad diversity of unfavorable habitats which might increase their chances of causing contamination to a large extent (Damen *et al.*, 2007).

The present study not only showed contamination with parasites of public health importance, parasites of veterinary importance were also detected. This might be due to the fact that the fruits and vegetables that were detected positive might be contaminated

with both human and animal manures (Moore *et al*., 2007). Likewise, the multiple contamination with more than one parasitic species in the samples collected was also recorded. In this case, cucumber (*Cucumis sativus*) was contaminated with larvae of *Strongyloides stercoralis* and larvae of *Haemonchus* spp and avocado (*Persea americana)* was contaminated with eggs of *Ascaris lumbricoides* and larvae of *Strongyloides stercoralis*. The multiple contamination with both public health and veterinary importance parasites on cucumber (*Cucumis sativus*) might occur during cultivation and irrigation where animal manure was probably used as fertilizers and during harvest, packaging, transport and marketing where human fecal contamination could occur (Cambaza *et al*., 2018). In the case of multiple parasite contamination on avocado (*Persea americana)* with eggs of *Ascaris lumbricoides* and larvae of *Strongyloides stercoralis* might be due to the fact that, the contamination might occur during harvesting, packaging, transportation, storage or marketing (Adenusi *et al*., 2015).

3.5 Conclusion

The findings of this study have revealed that the collected fruits and vegetables from selected public markets in Zanzibar were found to be contaminated with gastrointestinal parasites except tomato and chinese vegetables. This is suggestive that, fruits and vegetables were contaminated with faeces either directly or indirectly and therefore, this is an evidence that both fruits and vegetables play a vital role in distribution of parasitic diseases to the community.

3.6 Recommendations

Vendors and consumers of fruits and vegetables should be provided with health education time to time so that they can remember that parasitic diseases can be controlled with the practices of washing the fruits with clean running water before eating and selling,

washing hands before and after meals, washing hands with water and soap after visiting toilets and cooking the vegetables properly before eating.

Clean water should be available all the time at the markets that can be utilized by vendors and buyers for various purposes to safeguard the public health.

Hygiene and sanitation in all markets environment including toilets in both dry and wet seasons should be maintained to avoid infectious diseases to the community.

More studies should be conducted to evaluate the level of parasitic contamination on fruits and vegetables, water and soil at the farm level.

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CHAPTER FOUR

4.0 GENERAL DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

4.1 Discussion

The aims of the present study was to assess the community awareness (vendors and consumers) on transmission and control practices towards gastrointestinal parasites and determination of prevalence of gastrointestinal parasites contaminating fruits and vegetables in Zanzibar (Unguja and Pemba).

The present study has indicated that the level of awareness of the respondents (75.5%) on gastrointestinal parasites was higher. The higher level of awareness in this study was in line with the findings of similar study in Nigeria where more than half of the respondents were aware on gastrointestinal parasites (Abe *et al*., 2016). Similarly, in a study conducted in South Africa and Zimbabwe 91% and 81% respectively indicated the highest awareness on the two communities studied on gastrointestinal and urinary parasites (Mbereko *et al*., 2020). The high level of awareness found in this study and other reported studies suggest that the community members had good health education on gastrointestinal parasites since these parasites are endemic in their communities (Magaisa *et al*., 2015).

In comparison with locality, the findings of this study indicated that, a large proportion of respondents from Unguja (77%) were more aware in most of the aspects probed with respect to gastrointestinal parasites compared to Pemba (73.44%). This could be due to differences in terms of social and economic status of the people between communities (Nasr *et al*., 2013).

This study reported that consumers (77.35%) were more aware on gastrointestinal parasites compared to vendors (64.74%) of fruits and vegetables. The high level of awareness shown by consumers could be attributed probably due to their high level of education compared to vendors. Therefore high level of awareness shown by consumers could help them to be free from gastrointestinal parasites infections that can be attributed by consumption of contaminated fruits and vegetables (Tosin *et al*., 2017).

Based on the sex, females (76.67) were more aware on gastrointestinal parasites compared to males (73.93%). The high level of awareness shown by females in this study is probably due to the fact that, females are the ones that take care of the families and prepare the food for the families. Also, more women stay indoors than men and this factor probably may prioritize the women to have enough time to listen and watching different public health education programmes through radio and television concerning personal hygiene, environmental hygiene and food hygiene as powerful tools to combat against epidemiology and transmission of parasitic diseases to the community.

The age groups of respondents under 50 years were found to be more aware on gastrointestinal parasites compared to over 50 years. This could be probably attributed due to the fact that respondents may differ in terms of educational level, ownership of radio and personal exposure to social media.

This study indicated that, awareness was increased with increased level of education and it was decreased with decreased level of education. Similar study conducted in Malaysia (Nasr *et al*., 2013) showed that more educated respondents were more aware on gastrointestinal parasites compared to illiterate individuals. Similarly, the study carried out in Bangladesh showed the same results that respondents with high levels of education were more aware on the knowledge and practices concerning gastrointestinal parasites

(Bath *et al*., 2010). Furthermore, a previous study conducted in Iran confirmed that higher education of mothers was associated with reduction of infection rate to their children (Nematian *et al*., 2004). In addition, a study conducted in Kenya indicated that respondents with high educational levels were more aware of intestinal worms (Kamunvi *et al*., 1993). Educational level is the significant factor in understanding health protocols in the struggle for controlling gastrointestinal parasitic diseases in the community (Agbalaka *et al*., 2019).

On the other hand, the collected samples of fruits and vegetables were detected to be contaminated with gastrointestinal parasites at the prevalence of contamination of 8%. This prevalence was lower compared to some similar studies reported by other researchers around the world. The difference in awareness of the producers and vendors in handling of the fruits and vegetables for marketing, geographical location, number of samples examined, various laboratory methods used, type of water used for irrigation and the type of water used for washing the fruits and vegetables before selling might be the important reasons for the variation in parasitic contamination on fruits and vegetables across the world (Abougrain *et al*., 2010).

4.2 Conclusions

The findings of this study indicate the high level of awareness of the community with regard to the knowledge of aetiology, clinical signs, transmission and control practices on gastrointestinal parasites. However, the awareness seemed to differ in terms of geographical locations (Unguja and Pemba), occupation (vendors and consumers), sex (males and females), age groups and educational level. Therefore, a good level of community awareness with regard to gastrointestinal parasites in this study has been

documented to determine the success of gastrointestinal parasites control programmes worldwide, hence global development and attainment of millennium development goals.

On the other hand, the findings of this study have revealed that the collected fruits and vegetables from selected public markets in Zanzibar were found to be contaminated with gastrointestinal parasites except tomato and chinese vegetables. The parasitic contamination on fruits and vegetables observed in this study is suggestive that, fruits and vegetables were contaminated with faeces either directly or indirectly. Therefore, this study raised concern of community being at risk of infections with strongyloidiasis, ascariasis, amoebiasis, hookworm infections and others through consumption of contaminated fruits and vegetables.

4.3 Recommendations

i. Public health education should continue to be provided in order to remind the community frequently that, washing the fruits with running water before eating, washing hands before and after meals, washing hands with water and soap after visiting toilets and cooking the vegetables properly are very important factors to avoid parasitological, bacterial and viral infectious diseases.

ii. Personal hygiene and sanitation, washing the fruits and vegetables before selling and avoiding to sell the food stuffs on the floor especially along the road sides should be considered and practiced by all vendors to avoid infectious diseases.

iii. Municipal council officers should make sure that clean water is available all the time at the markets that can be utilized by vendors and buyers for various purposes to safeguard the public health.

iv. Hygiene and sanitation in all markets environment including toilets in both dry and wet seasons as well as periodic screening of fruits and vegetables sold at the markets should be considered to avoid infectious diseases to the community.

v. There should be a special public health awareness campaign to educate the school-aged children about the transmission and control of gastrointestinal parasites related to consumption of fruits and raw vegetables since children are vulnerable group to GIT parasites infections in the community.

vi. More studies should be conducted to investigate the awareness of the farmers on transmission and control practices with regard to GIT parasites and to evaluate the level of parasitic contamination on fruits and vegetables, water and soil at the farm level.

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APPENDICES

Appendix 1: Respondent's Questionnaire

Important Information:-

- Thank you for your willingness to participate in filling this important questionnaire as a part of my continuous assessment for the fulfillment of Master degree at SUA.
- We have designed this questionnaire in order to get right information on this neglected gastrointestinal parasitic diseases which associated with consumption of fruits and vegetables so that to advise the health stakeholders including public health officers to make emphasis on these diseases by providing education on the preventive measures, control and treatment to the people who have been infected with the diseases. So, our nation needs a man power with a good health in order to bring the social and economic development in our societies.
- The confidentiality of the information between two sides, you and I; therefore **NO** one has right to disclose the important information out of the two sides.
- When filling this questionnaire, please make sure you fill in all spaces provided.

Section One: Identification

Questionnaire number:

Date of interview:

Name of interviewer:

Name of the market:

Status of the respondent:

Section Two: Respondent's Details

Fill the blanks and put tick in the box provided below

- Age: 18-25( ) 26-33 ( ) 34-41( ) 42-49( ) 50-57( ) 58 and above ( )
- Sex : Male ( ) Female ( )
- Educational level: Primary ( ) Secondary ( ) Diploma ( ) Degree ( ) Informal education ( )

Section Three: (Assessment on awareness)

Put tick in the brackets and fill the blank spaces below

A: Knowledge of Aetiology

1. Have you heard about gastrointestinal parasites?
   a. Yes ( ) No ( )
2. If the answer is "Yes" in **Qn 1**, which source of information have you heard About GIT parasites?……
3. Mention any three types of gastrointestinal parasites that you know?
   a ……. b…… c……..

B: Knowledge of Clinical Signs

4. What are the symptoms of a person having gastrointestinal parasites infection?
   a. ……..b.…… C. ……..

C: Knowledge of Transmission

5. How can a person be infected with gastrointestinal parasites?
   ……..……..
   ……
   ……

D: Knowledge of Control Practices

6. Suppose/or you are a seller of fruits and vegetables, do/would you wash your produces before selling?
    a. Yes ( ) No ( ). Why……
7. Do you wash the fruits before eating? a. Yes ( ) b. No ( )
8. If the answer is "Yes" in **Qn 7**, how do you wash the fruits before eating?
    a. Soaking into the water ( ) b. Running water ( )
9. Do you wash your hands after toilet? a. Yes ( ) b. No ( )
10. If the answer in Qn **9** is **"Yes",** Pick one of the following
    a. With water and soap ( ) b. With water only ( )
11. With reference to **Qn 10**, Why?……
12. How do you cook your vegetables?
    a. Thoroughly cooking ( ) b. Moderate cooking ( )
13. With reference to **Qn 12**, please give reason. ……

This marks the end of our interview

Thank you very much for your maximum cooperation

Appendix 2: The informed consent form for research participants

The Informed Consent Form for the research of "Investigation on Awareness and Contamination of Gastrointestinal Parasites in Fruits and Vegetables Sold in Central public Markets in Zanzibar"

Section one: Invitation for Participant's Consent;

I am Sadiki Suleiman Kakomo, a Postgraduate student pursuing a Master's of Science in Parasitology at Sokoine University of Agriculture. I am conducting a Research with title "**Investigation on Awareness and Contamination of Gastrointestinal Parasites in Fruits and Vegetables Sold in Central public Markets in Zanzibar".** I am kindly inviting you to participate in this research by filling in a questionnaire with questions seeking to assess your awareness on Transmission and Control of Gastrointestinal Parasites in fruits and vegetables. Your information will be very significant in the formulation of proper control measures against Gastrointestinal parasites for improving the health status of the people in the society, hence better economic development of our nation. The participation in this study is voluntary and if you are not willing to take part in it, your unwillingness decision will be highly respected. I assure you that, your personal information will be confidentially and not to be disclosed to third parties. Upon completion of this study, the results will be published and shared to you through your relevant market institutions and to the public health stakeholders.

Section two: Declaration of Consent;

I, ……..hereby declare that "To the best of my knowledge with physical conscious, I have read the above information about invitation to participate in the study concerning the assessment of awareness on transmission and control of Gastrointestinal parasites infection in fruits and vegetables. Therefore, I agree to be a participant in this study.

Signature……Date…….. Tel…….

Section three: Declarative statement by the researcher

I, Sadiki Suleiman Kakomo hereby declare that **"**My participant was willing to be a part of my study and was able to fill in the whole questionnaire and he/she was not forced into giving out the consent but the consent was given out freely**".**

Signature…… Date……..

Section four: Communication

1. Sadiki Suleiman Kakomo (Researcher)
   Phone number: +255773109772 or +255672199796
   Email: sadikikakomo19@gmail.com

2. Dr. J.S.Nzalawahe (Research Supervisor)
   Phone number: +255755395176
   Email: nzalawahej@gmail.com

3. Dr. E.M.Mafie (Research Supervisor)
   Phone number: +255765074229
   Email: eliakunda.mafie@sua.ac.tz

Appendix 3: Research permit issued by the office of second vice president Zanzibar

SERIKALI YA MAPINDUZI YA ZANZIBAR
OFISI YA MAKAMU WA PILI WA RAIS,
SERA, URATIBU NA BARAZA LA WAWAKILISHI

P. O. Box 239
Vuga Street
Zanzibar-Tanzania

Tel. 024 22 30808
Fax. 024 22 30808
E-mail : ps 2vpo@zanzibar.go.tz

OMPR/M.95/C.6/2/VOL. XII/ **01/03/2021.**

MKURUGENZI,
BARAZA LA MANISPAA MJINI,
UNGUJA.

MKURUGENZI,
BARAZA LA MANISPAA MAGHARIBI "B",
UNGUJA.

MKURUGENZI,
BARAZA LA MJI CHAKECHAKE,
PEMBA.

MKURUGENZI,
BARAZA LA MJI WETE,
PEMBA.

KUH: RUHUSA YA KUFANYA UTAFITI

Kwa heshima, naomba uhusike na mada ya hapo juu.

Serikali ya Mapinduzi ya Zanzibar imemruhusu **Ndg. Sadiki Suleiman Kakomo** mtafiti mwanafunzi kutoka **Chuo Kikuu cha Kilimo cha Sokoine (SUA)** anaesomea Shahada ya **Uzamili** katika fani ya **Parasitilogy** kufanya utafiti katika mada inayohusiana na **"Investigation on Awareness and Contamination of Gastrointestinal Parasites Fruits and Vegetables sold in Markets in Zanzibar".** Utafiti huo utafanyika kwenye masoko ya Darajan, Mwanakwerekwe na Mombasa Unguja pamoja na masoko ya Chakechake na Wete Pemba kuanzia tarehe **01/03/2021** mpaka **01/06/2020.** Tunaomba asaidiwe ili aweze kukamilisha utafiti huo.

Kwa nakala ya barua hii mara baada ya kumaliza utafiti, mtafiti unatakiwa kuwasilisha nakala (copy) 3 za ripoti ya utafiti huo Ofisi ya Makamu wa Pili wa Rais- Zanzibar.

Naambatanisha na kivuli cha kibali cha kufanyia utafiti.

Wako mtiifu,
Khalid Bakari Hamran

KHALID B. HAMRANI,
/KATIBU MKUU,
OFISI YA MAKAMU WA PILI WA RAIS,
ZANZIBAR.

NAKALA: Ndg. Sadiki Suleiman Kakomo.

Appendix 4: Ethical clearance permit

DPRTC/SUA/R/186 F.9

STATEMENT OF RESEARCH ETHICAL APPROVAL

1. *This project has been considered and has been **Approved/Not Approved** by the Department/College Research and Publication Committee, Department/College/Unit

   Click here to the name of the unit or delete this guiding text and print and write by hand

   Signature: ..... Name: Click here to the name or delete this guiding text and print. Hashim J. Mgeni (PhD)

   Date: Click here and down arrow to select the date.

   (Chairperson, Research & Publication Committee)

2. This project has been considered and has been **Approved/~~Not Approved~~** by the Ethical Committee, DPRTC

   Signature:..... Name: Click here to the name. PROF. J.J. KASHAIGILI

   Date: Click here to select a date. 25/04/2021

   (Chairperson, Ethics Committee, DPRTC)

3. This project has been considered and **Approved/Not Approved** by the Senate Research and Publication Committee (SRPC), Sokoine University of Agriculture

   Signature: ..... Name: Click here to enter the name. PROF E.D. KAIMURIBO

   Date: Click here and down arrow to enter a date. 25/04/2021

   (Chairperson, SRPC)

Director
Postgraduate studies, Research,
Technology Transfer and Consultancy
Sokoine University of Agriculture
P.O. Box 3151, Morogoro
TANZANIA

Postal address:	Telephone:	Fax:	Telex:	e-mail Address:
P.O. Box 3151 Morogoro, Tanzania	+255 23 2640013	~~+255 56 4388~~	55308 UNIVMOG TZ	drpgs@suanet.ac.tz

* All special Projects (Undergraduate studies research be evaluated and approved by the Department/College Research and Publication Committee, Department/College/Unit and reported to REC/DPRTC. Only Applications from Postgraduate, Research Associates and Staff be forwarded to University wide REC

Appendix 5: Research clearance permit

CLEARANCE PERMIT FOR CONDUCTING RESEARCH IN TANZANIA

UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY.

SOKOINE UNIVERSITY OF AGRICULTURE
OFFICE OF THE VICE-CHANCELLOR

P.O Box 3000, CHUO KIKUU, MOROGORO, TANZANIA.
Phone: +255 (023) 2640006/7/8/9, Direct Line: +255 (023) 2640015,
E-mail:vc@sua.ac.tz, Website: https://www.sua.ac.tz

Please refer to:
Our Ref: SUA/ADM/R.1/8/733 **Date:** 16th February, 2021

The Second Vice President of Zanzibar,
Second Vice President's Office,
P. O. Box 239,
Vuga Street Zanzibar,
ZANZIBAR.

RE: UNIVERSITY STAFF, STUDENTS AND RESEARCHERS CLEARANCE

The Sokoine University of Agriculture was established by University Act No. 7 of 2005 and SUA Charter, 2007 which became operational on 1st January 2007 repealing Act No. 6 of 1984. One of the mission objectives of the University is to generate and apply knowledge through research. For this reason the staff and researchers undertake research activities from time to time.

2. To facilitate the research function, the Vice Chancellor of the Sokoine University of Agriculture (SUA) is empowered to issue research clearance to staff, students, research associate and researchers of SUA on behalf of the Tanzania Commission for Science and Technology.

3. The purpose of this letter is to introduce to you **Mr. Sadiki Suleiman Kakomo** a bonafide **MSc. (Parasitology)** student with Registration number **MPA/D/2019/0005** of SUA. By this letter **Mr. Sadiki Suleiman Kakomo** has been granted clearance to conduct research in the country. The title of the research in question is "**INVESTIGATION ON**

CLEARANCE PERMIT FOR CONDUCTING RESEARCH IN TANZANIA

AWARENESS AND CONTAMINATION OF GASTROINTESTINAL PARASITES IN FRUITS AND VEGETABLES SOLD IN MARKETS IN ZANZIBAR".

4. The period for which this permission has been granted is from **March, 2021** to **April, 2021**. The research will be conducted in **Unguja and Pemba Markets.**

5. Should some of these areas/institutions/offices be restricted, you are requested to kindly advice the researcher(s) on alternative areas/institutions/ offices which could be visited. In case you may require further information on the researcher please contact me.

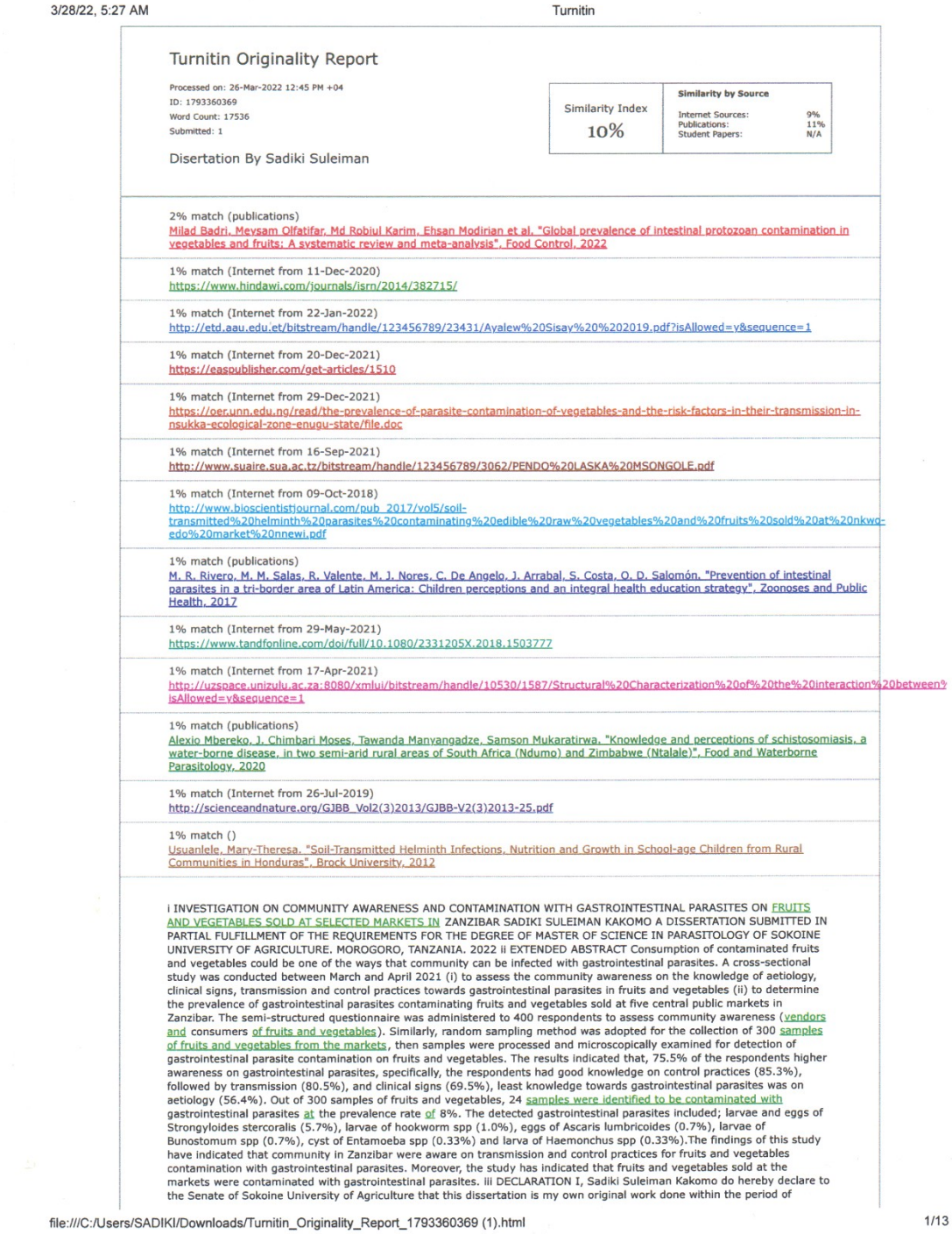
6. We thank you in advance for your cooperation and facilitation of this research activity.

Yours sincerely,

Prof. Maulid W. Mwatawala
FOR: VICE-CHANCELLOR

c.c. Director, DPRTC, SUA. - To note in file.
c.c. Student – **Mr. Sadiki Suleiman Kakomo**

Appendix 6: Plagiarism checkup report



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i INVESTIGATION ON COMMUNITY AWARENESS AND CONTAMINATION WITH GASTROINTESTINAL PARASITES ON FRUITS AND VEGETABLES SOLD AT SELECTED MARKETS IN ZANZIBAR SADIKI SULEIMAN KAKOMO A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN PARASITOLOGY OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA. 2022 ii EXTENDED ABSTRACT Consumption of contaminated fruits and vegetables could be one of the ways that community can be infected with gastrointestinal parasites. A cross-sectional study was conducted between March and April 2021 (i) to assess the community awareness on the knowledge of aetiology, clinical signs, transmission and control practices towards gastrointestinal parasites in fruits and vegetables (ii) to determine the prevalence of gastrointestinal parasites contaminating fruits and vegetables sold at five central public markets in Zanzibar. The semi-structured questionnaire was administered to 400 respondents to assess community awareness (vendors and consumers of fruits and vegetables). Similarly, random sampling method was adopted for the collection of 300 samples of fruits and vegetables from the markets, then samples were processed and microscopically examined for detection of gastrointestinal parasite contamination on fruits and vegetables. The results indicated that, 75.5% of the respondents higher awareness on gastrointestinal parasites, specifically, the respondents had good knowledge on control practices (85.3%), followed by transmission (80.5%), and clinical signs (69.5%), least knowledge towards gastrointestinal parasites was on aetiology (56.4%). Out of 300 samples of fruits and vegetables, 24 samples were identified to be contaminated with gastrointestinal parasites at the prevalence rate of 8%. The detected gastrointestinal parasites included; larvae and eggs of Strongyloides stercoralis (5.7%), larvae of hookworm spp (1.0%), eggs of Ascaris lumbricoides (0.7%), larvae of Bunostomum spp (0.7%), cyst of Entamoeba spp (0.33%) and larva of Haemonchus spp (0.33%).The findings of this study have indicated that community in Zanzibar were aware on transmission and control practices for fruits and vegetables contamination with gastrointestinal parasites. Moreover, the study has indicated that fruits and vegetables sold at the markets were contaminated with gastrointestinal parasites. iii DECLARATION I, Sadiki Suleiman Kakomo do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of

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