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Original Article

Evaluation of vegetables grown in dry mountainous regions for soil transmitted helminths contamination

Avaliação de vegetais para contaminação por helmintos transmitida pelo solo em quatro distritos da divisão de Malakand: noroeste do Paquistão

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Abstract

Infection caused by geo-helminth parasites are called geohelminthiasis are one of the global health problems. Vegetables eaten raw is the principal source of transmission of geo-helminth parasites. Pakistani people believe that eating raw vegetables are a significant source to get important vitamins and minerals. Based on the high incidence of pathogenic parasites and cultivating different vegetable types in the study areas, we conducted this study to evaluate the geo-helminth contamination of raw vegetables in northwest Khyber Pakhtunkhwa, Pakistan. This is a descriptive study comprised, 1942 samples of 25 various types of vegetables. The samples were examined in physiological saline solution using sedimentation and centrifugation methods. The findings were analyzed by Graph-Pad version 5. P value less than 0.05 (95% CI) was considered significant. Results showed that 16.5% (n=322) of all vegetables were contaminated with one or more type of geo-helminth parasites. Garlic was the highest (35%) and cauliflower the lowest (4%) contaminated samples respectively. *Ascaris lumbricoides* was the most common geo-helminth found followed by hook worm species while *Trichuris trichura* was the least in all the vegetable samples. Leafy vegetables were highly contaminated 25.3% than vegetables with root parts 21.2% and fruity 9.09%. More than half of the contaminated vegetables were contaminated with single species of geo-helminth ($P<0.05$) while less than half with multiple **types of** geo-helminth contamination. Ninety two vegetables samples were contaminated with 2 species of parasites ($P<0.05$) and 45 with 3 ($P>0.05$) species of geo-helminth parasites. Education level of vendors and means of display were not significantly associated while types of vegetable used were significantly associated with the prevalence of parasites. The findings of this study provide evidence that consumption of raw vegetable has a high risk of acquiring geo-helminth infections. The authors believe that preventing the human to enter to the vegetable farmland for defecation, avoiding the **irrigation** of agricultural fields via night soil, and educating the people on proper washing and cooking of vegetables may be useful in reducing parasitic infections.

Keywords: raw vegetables, geo-helminths, helminths of public health significance, parasitic contamination, poor sanitation.

Resumo

As infecções causadas por parasitas geo-helmínticos são chamados de geohelmintíases e são um dos problemas de saúde globais. Os vegetais comidos crus são a principal fonte de transmissão dos parasitas geo-helmínticos. O povo paquistanês acredita que comer vegetais crus é uma fonte significativa para obter vitaminas e minerais importantes. Com base na alta incidência de parasitas patogênicos e no cultivo de diferentes tipos de vegetais nas áreas de estudo, conduzimos este estudo para avaliar a contaminação por geo-helmintos de vegetais crus no noroeste de Khyber Pakhtunkhwa, Paquistão. Trata-se de um estudo descritivo composto por 1942 amostras de 25 tipos diversos de vegetais. As amostras foram examinadas em solução salina fisiológica utilizando métodos de sedimentação e centrifugação. Os achados foram analisados pelo Graph-Pad versão 5. O valor de P menor que 0,05 (IC 95%) foi considerado significativo. Os resultados mostraram que 16,5% (n = 322) de todas as hortaliças estavam contaminadas com um ou mais tipos de parasitas geo-helmínticos. O alho foi a amostra mais contaminada (35%) e a couve-flor a menos (4%), respectivamente. Ascaris lumbricoides foi o geo-helmíntico mais comum encontrado,

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seguido por espécies de verme-anzol, enquanto Trichuris trichura foi o menos encontrado em todas as amostras de vegetais. Os vegetais folhosos foram altamente contaminados 25,3% do que os vegetais com partes de raiz 21,2% e frutados 9,09%. Mais da metade dos vegetais contaminados estavam contaminados com uma única espécie de geo-helmintos (P <0,05), enquanto menos da metade com vários tipos de contaminação com geo-helmintos. Noventa e duas amostras de vegetais estavam contaminadas com 2 espécies de parasitas (P <0,05) e 45 com 3 (P> 0,05) espécies de parasitas geo-helmínticos. O nível de escolaridade dos vendedores e os meios de exibição não foram significativamente associados, enquanto os tipos de vegetais usados foram significativamente associados à prevalência de parasitas. Os resultados deste estudo fornecem evidências de que o consumo de vegetais crus tem um alto risco de adquirir infecções por geo-helmintos. Os autores acreditam que impedir que o ser humano entre na terra de hortaliças para defecação, evitar a irrigação de campos agrícolas via solo noturno e educar as pessoas sobre a lavagem e cozimento adequados de vegetais pode ser útil na redução de infecções parasitárias.

Palavras-chave: vegetais crus, geo-helmintos, helmintos de importância para a saúde pública, contaminação parasitária, saneamento deficiente.

1. Introduction

Soil-transmitted helminthiasis is one of the most reluctant global health problems, against which the people have no satisfactory defense. Above one billion people have been infected by one type of helminth (Mascarini-Serra, 2011). Almost 819 million people have been infected by *Ascaris lumbricoides*, 439 million by hookworm, and 465 million by *Trichuris trichiura* (Pullan et al., 2014) throughout the world. Sub-Saharan Africa, America and East Asia are the endemic areas (DGDP, 2013). Disease caused by soil-transmitted helminthes can lead to declining health conditions, lowering nutritional status of the population and intelligence, productivity, causing loss of carbohydrates, protein and blood, lowering the quality of human resources, so many causes economic losses and much more (Shumbej et al., 2015; Suchdev et al., 2014). Due to the consumption of raw vegetables outbreaks of human infections have occurred in the past decade (Blackburn and McClure, 2002). Studies indicated that humans subjects that consumes uncooked or improperly washed vegetables and fruits may be infected with *Ascaris lumbricoides*, hookworm, and *Trichuris trichiura* (Kozan et al., 2005). Soil transmitted helminthes require soil for development of immature stages i.e infective eggs in case of ascaris and trichuris and larvae in case of hookworm species to be transmitted to their hosts through different agencies like soil, water and others. It is therefore named soil transmitted helminthes or STH.

Pakistan has a wide range of climatic conditions which makes the environment suitable for developmental stages of all the three geo-helminth parasites. According to a survey on soil-transmitted helminthiasis conducted by WHO (2017) in Pakistan, the highest prevalence was 37.5% in Northern Dry Mountains (parts of northern KPK, northern Federally Administered Tribal Areas and Gilgit-Baltistan). The inhabitants of the Barani Lands (parts of northern Punjab, Islamabad Capital Territory, and two non-contiguous regions of KPK) were reported to be infected 25.3%. The lower prevalence rates of soil transmitted helminthes was ranging from 12.2% in the Wet Mountains (Azad Jammu & Kashmir and parts of north eastern KPK), while no positive case was reported for the Western Dry Mountains (north-eastern Balochistan, southern FATA and central KPK). The environmental factors, socio-economic condition and personal hygiene of inhabitants of northern parts of Pakistan favors STHs.

According to a baseline survey of WHO (2017) on soil-transmitted helminthiasis in Pakistan, the highest prevalence was reported in northern parts of Khyber Pakhtunkhwa, northern Federally Administered Tribal Areas and Gilgit-Baltistan. They use raw vegetables containing pesticide contamination risk or helminth eggs. Farmers of these areas also frequently use night soil to increase soil fertility, which leads to progress helminth eggs infection (Do et al., 2007). According to Kaliappan et al. (2013) the risk of helminth eggs infection will increase when working in direct contact with the soil. Vegetable vendors are in direct contact with the vegetables. In Buner, Malakand, Lower Dir and Swat districts most of the people are engaged in vegies selling and farming. Agriculture is a potential sector in all these districts. However, based on the preliminary survey conducted by Khan et al.(2017), majority of farmers use night soil to fertilize crops.

Vegetables in one hand are the leading source of essential nutrients, vitamins, minerals, proteins, and fibers but on the other hand when consume raw and improperly washed can transmit pathogens to humans. Vegetables can easily contaminated with parasites during planting, harvesting, packing, transportation and storage due to poor hygienic practices (Sia Su et al., 2012). Unhygienic and low living conditions in developing nations lead to increase the risk of acquiring geohelminth infections.

Many studies have been conducted throughout the world to assess the role of eating fresh uncooked and unwashed vegetables in the transmission of soil-transmitted helminths as: Amol, North of Iran (Siyadatpanah et al., 2013); Kurramabad, Iran (Ezatpour et al., 2013); Zahedan, Iran (Ebrahimzadeh et al., 2013); Benha, Egypt (Eraky et al., 2014) and Lahore, Pakistan (Shafa-Ul-Haq et al., 2014); Jimma Town, Southwest Ethiopia (Tefera et al., 2014); Manglore (Dias et al., 2014); Ebonyi state, Nigeria (Ani and Urom, 2015); Ebonyi state, Nigeria (Iyabo and Oluchi, 2015); Tehran, Iran (Valipour Nouroozi, 2015); Khartoum, state, Sudan (Mohamed et al., 2016); Iran (Mehrnejat et al., 2015) and Lower and Upper Dir districts (Khan et al., 2017). To the best of our knowledge, the data on geo-helminth contamination of vegetables is lacking in province Khyber Pakhtunkhwa, Pakistan, however geohelminth parasites have also been reported in the human beings of different parts of Malaknd region as Pal and Subhani (1989), Nisa et al. (2012), Khan et al. (2011, 2015, 2016, 2017a, b, 2019a, b). The assessing of vegetables contamination and their disinfection has remained a major concern of health

and therapeutic organizations. Therefore, this study was designed to determine the prevalence of STH contamination of vegetables used raw in the region.

2. Materials and Methods

2.1. Study area

This research was conducted in Malakand Division, the northwest of Pakistan which comprised an area of nearly 29,800 km^2 and has a population of about 6.0 million people. Malakand Division lies latitudes of 35° 29' 59.99" North and longitudes of 72° 00' 0.00" East with 1420m in elevation. Of the 7 districts in Malakand division four namely Malakand, Lower Dir, Upper Dir and Swat were selected for the present study. This is a mountainous region with high peaks in the north reaching up to a height of 6000 meters above sea level and the height decreases slowly from north toward south along river Panjkora and river Swat. Karakorum, Hindu Kush and Himalaya form a boundary between the temperate climate, Palearctic zone and subtropical oriental region So the Malakand region is situated in the temperate zone where winters are cold with temperature reaching below the freezing point, while summers are hot and humid due to heavy monsoon rains and the temperature may reach up to 32°C. The winter season is from mid-November to March and snowfall continues in the upper parts from December to March during which the peaks remain under snow cover.

2.2. Sample collection

Twenty five different type of vegetables including: (1) *Allium sativum* (garlic) (2) *Capsicum annum* (coriander) (3) *Brassica compastris* (mustard) (4) *Lactuca sativa* (lettuce salad) (5) *Mentha longifolia* (mint) (6) *Daucus carota* (carrot) (7) *Allium cepa* (onion) (8) *Spinacia oleracea* (spinach) (9) *Raphanus raphanistrum* (raddish) (10) *Zingiber officinale* (ginger) (11) *Solanu tuberosum* (potato) (12) *Brassica olerace* (cabbage) (13) *Capsium annum* (Chilli) (14) *Brassica rapa* (turnip) (15) *Pisum sativam* (peas) (16) *Lycopersicon esculentum* (Tomato) (17) *Colocasia esculenta* (taro) (18) *Abelmoschus esculantum* (Lady finger) (19) *Momordica charanjtia* (bitter gourd) (20) *Solanum melongena* (Brinjal) (21) *Praecitrullus fistulosus* (round gourd) (22) *Capsicum annum* (green pepper) (23) *Cucumis sativus* (Cucumber) (24) *Luffa cylindrica* (vegetable sponge) and (25) *Brassica oleracea* (cauliflower) were purchased from the selected vegetable markets in all the four districts. A questionnaire comprised on the questions such as educational status of the vendors, type of vegetables, means of display, washed before display was used. In this study fifty vendors participated.

2.3. Sample processing for parasites

The collected specimens of vegetables were placed in isolated plastic bags. Each of the bags containing vegetable samples were labeled with a unique number with date of collection. All the samples were brought to the Parasitology Laboratory, Department of Zoology, University of Malakand for screening of parasites. Of about 200 grams of each specimen of vegetables was kept for atleast 15 minutes in physiological solution of one liter in volume. After that the samples were shaken gently with the help of mechanical shaker for upto 20 minutes. After sedimentation about 10 millilitres of the sediment was separated in to a centrifuge tube. The centrifuge tube was centrifuged at 3000 rpm as to get concentrated the parasitic stages (ova, larave and cysts) for about five minutes. After completion of centrifugation, the supernatant was decanted and the sediment was agitated slightly by hand to redistribute the parasitic stages. Finally, the sediment was examined under a light microscope [Labomed 400] using × 10 and × 40 objectives.

2.4. Statistical analysis

Graph Pad Prism (version-5) was used for the data analysis. The difference in parasitic contamination among the different categories was compared using one way ANOVA. The p- values were considered to be significant when less than 0.05.

3. Results

Current research pinpoints to understand the prevalence of geo-helminth parasites in vegetable samples commonly sold at main vegetable markets of all the 4 districts of Malakand division, Pakistan. A total of 1942 vegetable samples were screened for the presence of any geo-helminth parasite eggs or larval form. Of the examined vegetables only 16.5% were found contaminated with one or more than one species of geo-helminth parasites. Percentage of each contaminated sample is given according to the order of contamination as: 35.0% *A.sativum* (garlic), 30% % *C. annum* (coriander), 27.2% *B.compastris* (mustard), 25.6% *L. sativa* (lettuce salad), 25.1% *M.longifolia* (mint), 26.1% *D.carota* (carrot), 23% *A.cepa* (onion), 20.1% *S.oleracea* (spinach), 20% *R.raphanistrum* (reddish), 18.5% *Z.officinale* (ginger), 15.6% *S.tuberosum* (potato), 13.5% *B.olerace* (cabbage), 13% *C. annum* (Chilli), 10.2% *B.rapa* (turnip), 10.1% *P.sativam* (peas), 9.80% *L. esculentum* (tomato), 9.33% *C. esculenta* (taro), 9.10% *A. esculantum* (Lady finger), 9.09% *M.charanjtia* (bitter gourd), 8.33% *S.melogena* (Brinjal), 7.69% *C. vulgaris* (round gourd), 6.94% *C. annum* (green bell pepper, 5.26% *C. sativus* (Cucumber), 4.16% *L.cylindrica* (vegetable sponge) and 4% *B.oleracea* (cauliflower). Leafy vegetables examined were found more contaminated 25.1% followed by root vegetables 21.2% while fruity veggies were the least contaminated vegetables 9.09% used. Vegetable samples collected from Malakand were highly contaminated 24.7% followed by those collected from Swat 18.1% while vegetable samples examined from Buner and Dir Lower were least contaminated 9.83% and 8.53% respectively (Table 1).

More than half of the total samples contaminated with single species of parasites ($P<0.05$) while the other half with multiple parasitic contamination were also have been investigated. 92 vegetables contained 2 species of parasites ($P<0.05$) and 45 with 3 ($P>0.05$) (Table 2).

A.lumbricoides was the commonest geo-helminth found in the studied vegetables followed by hook worm species

Table 1. Distribution of geo-helminth parasites in relation to the type of vegetables collected from vegetable markets in northwestern parts of Khyber Pakhtunkhwa, Pakistan.

	Buner	Malakand	Dir(L)	Swat	Total	%
Vegetable type						
Leaf						
B. compastris (mustard)	14/4	35/14	18/4	32/5	99/27	27.2
L.sativa (lettuce)	20/3	35/12	23/5	0	78/20	25.6
S. oleracea (spinach)	19/2	35/13	23/3	32/4	109/22	20.1
C. annum (coriander)	16/3	35/13	19/5	0	70/21	30
M.longifolia (mint)	16/4	35/15	18/3	32/3	101/25	25.1
Sub-total	**85/17**	**175/67**	**101/20**	**96/12**	**457/116**	**25.3**
Fruit						
L. esculentum (tomato)	12/0	35/7	19/2	32/ 1	98/10	9.80
C. annum (chilli)	13/1	35/8	20/0	32/4	100/13	13
C. sativus (cucumber)	11/0	35/4	17/0	32/3	95/5	5.26
A. esculantum (lady finger)	14/1	35/6	18/1	32/1	99/9	9.10
P.sativam (peas)	24/1	35/8	30/0	0	89/9	10.1
B.olerace (cabbage)	13/1	35/5	11/2	0	59/8	13.5
S.melogena (brinjal)	10/1	35/6	19/0	32/1	96/8	8.33
B.oleracea (cauliflower)	9/0	0	9/0	32/2	50/2	4
C. vulgaris (round gourd)	13/0	0	20/0	32/5	65/5	7.69
M.charanjtia (bitter gourd)	10/1	0	13/1	32/3	55/5	9.09
L.cylindrica (vegetable sponge)	9/0	0	15/1	0	24/1	4.16
C. annum (green bell pepper)	17/1	0	23/2	32/2	72/5	6.94
Sub-total	**155/7**	**245/44**	**215/9**	**288/22**	**902/82**	**9.09**
Root						
Z.officinale (ginger)	17/3	35/8	20/2	0	72/13	18.5
A.sativum (garlic)	13/2	35/10	17/1	32/21	97/34	35.0
C. esculenta (taro)	19/1	35/5	21/2	0	75/7	9.33
A.cepa (onion)	16/2	35/6	17/1	32/14	100/23	23
D.carota (carrot)	16/1	35/9	18/1	32/15	101/26	26.1
S.tuberosum (potato)	16/1	0	16/0	32/9	64/10	15.6
B.rapa (turnip)	19/2	0	20/2	0	39/4	10.2
Reddish	0	35/7	0	0	35/7	20
Sub-total	**116/11**	**210/45**	**129/9**	**128/59**	**583/124**	**21.2**
Grand-total	356/35	630/156	445/38	512/93	1942/322	16.5
%	9.83	24.7	8.53	18.1		

while *T.trichura* was the least counted nematode in all the vegetable samples. *A.lumbricoides*, *T.trichura* and Hookworm was noted 52.1%, 14.0% and 33.8% (P>0.05); 55.1%, 12.9% and 31.9% (P>0.05) and 55.1%, 9.33% and 35.5% (P>0.05) in leaf, fruit and root respectively.

In present study interviews of the vendors have conducted to evaluate the association of parasitic contamination of vegetables in the markets. Vendors were asked about their educational status and it was revealed that 25% of the vendors had no formal education, 15.1% had primary education and 13.1% had secondary education. No significant association was noted between the education level of vendors and the parasitic contamination rate of the vegetables they were selling (see Table 3). The association between vegetable collected and that of infected was non-significant (Table 3). Compared to type of vegetable collected garlic was highly infected 35% while cauliflower showed least 4% of the parasitic contamination. Significant

Table 2. Pattern of distribution of geo-helminth contamination of vegetables collected from the vegetable markets in northwestern parts of Khyber Pakhtunkhwa, Pakistan.

Pattern of parasitism	Districts (No. examined /No. infected)				Total	P value at 95% CI
	Peshawar	Malakand	Dir (L)	Swat		
Mono-parasitism						
Leaf	9	42	12	8	71 (22.0)	0.0126
Fruit	4	24	5	14	47 (14.5)	
Root	7	27	5	28	67 (20.8)	
Sub-total	**20**	**93**	**22**	**50**	**185 (57.4)**	
Polyparasitism						
Double						
Leaf	4	17	5	3	29 (9.00)	0.0313
Fruit	2	14	2	5	23(7.14)	
Root	3	15	3	19	40(12.4)	
Sub-total	**9**	**46**	**10**	**27**	**92(28.5)**	
Triple						
Leaf	4	8	3	1	16(4.96)	0.4031
Fruit	1	6	2	3	12(3.72)	
Root	1	3	1	12	17(5.27)	
Sub-total	**6**	**17**	**6**	**16**	**45(13.9)**	
Grand-total	35	156	38	93	322 (16.5)	
Total samples studied	356	630	445	512	1942	

Table 3. Overall prevalence of geo-helminth parasites in fresh vegetables collected from vegetable markets in northwestern parts of Khyber Pakhtunkhwa, Pakistan.

Type of vegetable	Districts (No.examined /No.infected)				Total	P value at 95% CI
	Peshawar (n=340)	Malakand (n=630)	Dir (L) (n=445)	Swat (n=512)		
Leaf						
Ascaris lumbricoides	13	61	25	12	111(52.1)	0.0906
Trichuris trichura	6	14	5	5	30 (14.0)	
Hook worm	16	37	13	6	72 (33.8)	
Sub-total	**35**	**112**	**43**	**23**	**213 (36.4)**	
Fruit						
Ascaris lumbricoides	7	38	10	26	81 (55.1)	0.0693
Trichuris trichura	2	13	2	2	19 (12.9)	
Hook worm	5	28	6	8	47 (31.9)	
Sub-total	**14**	**79**	**18**	**36**	**147 (25.1)**	
Root						
Ascaris lumbricoides	11	39	10	64	124 (55.1)	0.1652
Trichuris trichura	4	4	1	12	21 (9.33)	
Hook worm	10	29	9	32	80 (35.5)	
Sub-total	**25**	**72**	**20**	**108**	**225 (38.4)**	
Grand-total	**74**	**263**	**81**	**167**	**585**	

association was found among the each type (part) of vegies and parasitic contamination. Regarding the factor means of display of the vegetables (0.0561,P<0.05) wash before display 0.1777 (see Table 4).

4. Discussion

As the names indicated that soil transmitted helminthes are those that require soil for the development of their

Table 4. Factors associated with geo-helminth contamination of vegetables sold at vegetable markets in northwestern parts of Khyber Pakhtunkhwa, Pakistan.

Variable	Results of geo-helminth analysis			
	Total	Positive (%)	95% Cl (level)	P value
Educational status of vendors				
No formal education	367	92(25.0)	-195.86 to 1275.9	0.1113
Primary education	1172	177(15.1)		
Secondary education	403	53(13.1)		
Total				
Vegetable				
Leaf				
Brassica compastris (mustard)	99	27 (27.2)	51.057 to 85.743	< 0.0001
Lectuca sativa (lettuce salad)	78	20 (25.6)		
Solanum oleracea (spinach)	109	22 (20.1)		
Corriandrum annum (coriander)	70	21 (30)		
Mentha longifolia (mint)	101	25 (25.1)		
Fruit				
L. esculentum (tomato)	98	10 (9.80)	53.518 to 83.482	< 0.0001
C. annum (chilli)	100	13 (13)		
C. sativus (cucumber)	95	5 (5.26)		
A. esculantum (lady finger)	99	9 (9.10)		
P.sativam (peas)	89	9 (10.1)		
B.olerace (cabbage)	59	8 (13.5)		
S.melogena (brinjal)	96	8 (8.33)		
B.oleracea (cauliflower)	50	2 (4)		
C. vulgaris (round gourd)	65	5 (7.69)		
M.charanjtia (bitter gourd)	55	5 (9.09)		
L.cylindrica (vegetable sponge)	24	1 (4.16)		
C. annum (green bell pepper)	72	5 (6.94)		
Root				
Z.officinale (ginger)	72	13 (18.5)	35.931 to 78.819	< 0.0001
A.sativum (garlic)	97	34 (35.0)		
C. esculenta (taro)	75	7 (9.33)		
A.cepa (onion)	100	23 (23)		
D.carota (carrot)	101	26 (26.1)		
S.tuberosum (potato)	64	10 (15.6)		
B.rapa (turnip)	39	4 (10.2)		
Reddish	35	7 (20)		
Means of display				
On the floor	1041	193 (18.5)	-22.665 to 1102.7	0.0561
On the top of tables	487	78 (16.0)		
On the wheel barrow	414	51 (12.3)		
Washed before display				
Yes	1366	193 (14.1)	-895.25 to 2515.	0.1777
No	576	129(22.3)		

infective stages as like that of eggs in case of A.lumbricoides and T.trichura and larvae in case of hookworm species. Vegetables play a significant role in sustaining and development and then transferring of these infective forms of parasites in to the consumers (Khan et al., 2017).

In current research, we screened 1942 samples of twenty five types of vegetables purchased from main vegetable markets in 4 districts of Khyber Pakhtunkhwa, Pakistan for the presence of any geo-helminth parasite contamination. Of the examined vegetables only 16.5% (n=322/1942) were found contaminated with single or multiple geo-helminths. Recently, Khan et al. (2017) examined 520 samples of thirteen different types of fresh vegetables from two main vegetable markets in lower Dir and Upper Dir districts in Khyber Pakhtunkhwa, Pakistan, of which 10.7% were positive for helminth eggs and *Entamoeba histolytica* cysts.

Current research agreed with the findings conducted in Khartoum, state, Sudan 13.5% (Mohamed et al., 2016) and Lower and Upper Dir districts 10.7% (Khan et al., 2017); Benha, Egypt 29.6% (Eraky et al., 2014) and Lahore, Pakistan 31.2% (Shafa Ul-Haq et al., 2014). Studies conducted in Jimma Town, Southwest Ethiopia 58.7% (Tefera et al., 2014); Amol, North of Iran 46.5% (Siyadatpanah et al., 2013); Zahedan, Iran 44.8% (Ebrahimzadeh et al., 2013); Manglore 42% (Dias et al., 2014); Iran 48.4% (Mehrnejat et al., 2015); Ebonyi state, Nigeria 60% (Ani and Urom, 2015); Kurramabad, Iran 52.7% (Ezatpour et al., 2013) and Ebonyi state, Nigeria 55% (Iyabo and Oluchi, 2015) showed highest rate of parasitic contamination. The research conducted in Tehran, Iran 8.5% (Valipour Nouroozi, 2015) revealed the low rate of parasitic contamination in fresh vegetables. Highest prevalence 73.2% of soil transmitted helmnthiasis in different occupational groups of Swat, Pakistan was reported by Khan et al. (2017).

In present study, 52.1%, 55.1% and 55.1% of the leaf, fruit and root respectively of fresh vegetables were found contaminated with *Ascaris lumbricoides* eggs, the most common parasite detected. Findings of the present research agrees with the studies conducted in Nigeria 54.5% (Elom et al., 2012); Tripoli-Libya 68% (Abougrain et al., 2010); Swat, Pakistan 53% (Khan et al., 2017); Lahore, Pakistan 37.1% (Shafa Ul- Haq et al., 2014); Lower and Upper Dir districts, Pakistan 26.7% (Khan et al., 2017). This geo-helminth parasite has wide range of distribution with variable rate of prevalence as Nigeria 23.8% (Iyabo and Oluchi, 2015); Manglore 23% (Dias et al., 2014); Eastern Showa, Ethiopia 22.2% (Benti and Gemechu 2014); Tabuk, Saudi Arabia 21.7% (Gabre and Shakir, 2016); and Ebonyi state, Nigeria 20.4% (Ani and Urom, 2015); Jimmu town Southeast Ethiopia 6.7% (Tefera et al., 2014); Zahedan Iran 6.1% (Ebrahimzadeh et al., 2013); Kogi state, Nigeria 5.6% (Lyaji and Agahiu, 2016); Khurram abad, Iran 4.7% (Ezatpour et al., 2013);); Khartoum state, Sudan 2.9% (Mohamed et al., 2016); Tukkey 2.0% (Avcioğlu et al., 2011) and Benha Egypt 0.6% (Eraky et al., 2014).

Hook worms species was the second most prevalent parasite 33.8%, 31.9% and 35.5% reported in the present study in leaf, fruit and root respectively, which was comparable with the findings of Abakaliki Nigeria, 23.8% (Elom et al., 2102); Ebonyi state, Nigeria 24.8% (Ani and Urom, 2015) and Ebonyi state, Nigeria 33.3% (Iyabo and Oluchi, 2015). Some variable rate of contamination was also been reported in different parts of the world as Manglore 9.52% (Dias et al., 2014); Accra, Ghana 13% Duedu et al. (2014) and Lahore, Pakistan 10.8% (Shafa Ul Haq et al., 2014); Kogi state, Nigeria 5.3% (Lyaji and Agahiu 2016) and Khartoum, state, Sudan 5.7% (Mohamed et al., 2016).

Contamination rate of *Trichuris trichura* was 14%, 12.9% and 9.33% in the present research, which can be compare with studies reported in Ebonyi state, Nigeria 18.6% (Ani and Urom, 2015); Lower and Upper Dir districts 19.6% (Khan et al., 2017) and Ebonyi state, Nigeria 9.52% (Iyabo and Oluchi, 2015); Manglore 9.52% larvae (Dias et al., 2014); Ebonyi state Southeast Nigeria 8.90% (Elom et al., 2012); Lahore, Pakistan 6.41% (Shafa Ul Haq et al., 2014). This nematode was observed in lowest rate of prevalence as Khartoum, state, Sudan 2.9% (Mohamed et al., 2016); Accra, Ghana 2% Duedu et al. (2014); Kogi state Nigeria 1.4% (Lyaji and Agahiu 2016); Zahidan Iran 1% (Ebrahimzadeh et al., 2013). This nematode is variable in prevalence with a wide range of geographic distribution.

Present study showed more than half 57.4% (n=185/322) of the vegetables were found contaminated with single geo-helminth species and multiple geo-helminthiasis revealed 28.5% (n=92/322) double and 13.9% (n=45/322) triple pattern of parasitic contamination. According to Beke et al., 2017 more than half 45.6% (n=164/360) of the vegetables screened for parasitic contamination were found contaminated with single while other 8.88% (n=32/360) were with more than one species of parasites. The multiple parasite contamination in vegetables used routinely is needed to be studied thoroughly.

Highest and lowest rate of parasitic contamination found in different vegetables screened in different parts of the world by different workers as garlic and cauliflower 35%and 4% (present study); coriander and ginger 14.2% and 1.78% Lower and Upper Dir districts, Pakistan (Khan et al., 2017); leek and green onion 80% and 34.5% Khoramabad, Iran (Ezatpour et al., 2013); lettuce and cucumber 28.6% and 11.1% Ebonyi State, Nigeria (Ani and Urom, 2015); lettuce and chilli 48% and 16% Lahore, Pakistan (Shafa-Ul-Haq et al., 2014); tomato and okro 20.9% and 10.2% Kogi State, Nigeria (Lyaji and Agahiu, 2016);cucumber and tomato 15.7% and 2.72% Tabuk, Saudi Arabia (Gabre and Shakir, 2016);lettuce and cabbage 61% and 18% Accra, Ghana (Duedu et al., 2014); lettuce and leek 45.5% and 10.5% Benha, Egypt (Eraky et al., 2014); spinach and coriander 17.2% and 3.2% Amol, North of Iran (Siyadatpanah et al., 2013) respectively.

5. Conclusions

This study evidenced that vegetables eating raw are the potential source of transmission for geo-helminth parasites to humans if and when consumed without proper cleaning and or cooking. A comprehensive health education should be given to vendors and farmers of vegetables and to the general population on the health risks associated with consumption of contaminated vegetables. The consumers should always observe the basic principle of food and personal hygiene that is thorough washing of vegetables before eating and washing hands before meal.

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