**INTRODUCTION**

Vegetables contain valuable food components which have been strongly associated with maintenance of good health and prevention of diseases (Hanif et al., 2006; Keatinge et al., 2010). Vegetables can become contaminated with enteric parasitic pathogens throughout the process of planting to consumption and parasites from contaminated vegetables can pose potential health risk to humans; therefore food safety irrespective of the specific food item should be of utmost concern to everybody involved in the food chain (Amoah et al., 2006; Kays, 2011). Vegetables are sometimes eaten raw or parboiled to retain the natural taste and preserve heat labile nutrients (Said, 2012; Sifiko et al., 2009). This practice favours the likelihood of food-borne parasitic infections in humans (Sunil et al., 2014). The level of contamination depends on numerous factors which include the use of untreated waste water and water supplies contaminated with sewage for irrigation (Simoes et al., 2011; Beuchat, 2002; Amoah et al., 2006). The contamination of vegetables with geohelminths and food borne protozoa can occur at any time during the food chain, this can be pre-harvest: occurring on farms which include soil, faeces (human and animal origin) and water (irrigation, cleaning) (Halablab et al., 2011; Amoah et al., 2009). Also, contamination may be post-harvest, occurring during transportation and in market places which include rinsing and sprinkling with contaminated water (Mensah et al., 2002; Alade et al., 2013; Olyaei &...
Hajivandi, 2013). Over the years, very few studies have been conducted on parasitic contamination of vegetables in Nigeria (Obetta et al., 2011; Elom et al., 2012; Alade et al., 2013). All these studies focused on vegetables from open markets (during post-harvest periods). However, none has considered the assessment of pre and post-harvest parasitic contamination of vegetables from farms and markets in Nigeria. This present study was therefore conducted to assess parasitic contamination on vegetables from selected farms and markets in Ibadan. Information obtained from this assessment may help in the development of preventive and control strategies that will raise people’s awareness and safeguard the health and welfare of the community. This information is also required to assist the local health authorities to be able to take the proper actions to improve the quality of vegetables being sold to the populace for consumption.

MATERIALS AND METHODOLOGY

Study Design and Sample Collection
200 vegetables were sampled from three major farms from which 55 farmers practice olericulture and from five main commercial markets from six Local Government areas in Ibadan, Southwestern, Nigeria. Eight common vegetables eaten by the people in the area were used for this study. The vegetables used are Tomatoes (Lycopersicum sativus), Water leaf (Talinium triangulare), Quill grass (Celosia argenta), African spinach (Amaranthus hybridus) White jute (Corchorus olitorius), Fluted pumpkin leaf (Telfaria occidentalis) Garden eggplant leaf (Solanium macrocarpon) and Pepper (Capsicum Chinese). These were chosen because they are the major vegetables eaten by the residents of Ibadan. A total of 1100 vegetables strands pooled into 20 strands per sample making 55 samples were collected from farms while a total of 2900 vegetables strands pooled into 20 strands per sample making 55 samples were purchased from sellers in each of the open markets selected for the study making a total of 200 samples of vegetables.

Parasitological Analysis

Floatation Method
100-200 g samples of each vegetable were washed in 0.85% saline solution in a plastic container for 10-24 h for the removal of parasitic ova, larva or cysts. The suspension was strained through a sterile sieve to remove debris and then centrifuged at 4000 rpm for 5 min and the supernatant discarded into the disinfectant jar. The sediment obtained was re-suspended in sodium chloride floatation fluid and re-centrifuged. The floatation fluid was added to fill to the brim and a cover slip was superimposed on it. The cover slip was lifted, placed on the glass slide and examined under microscope using X100 and X400 objectives (Nyarango et al., 2008). The parasite eggs was identified on the basis of their morphological characteristics shape and size, and compared with standard eggs on charts using The Bench Aid for the Diagnosis of Intestinal Parasites.

Sedimentation method
100-200 g samples of vegetable was washed in 0.85% saline solution in a 15 ml test tube for 5 h and then centrifuged at 3500 rpm for 5 min (Damen et al., 2008). A drop of the sediment was mixed with two drops of lugol’s iodine solution. The process was systematically repeated until the mixture in each test tube was exhausted and examined under a light microscope using X100 and X400 objectives (Garcia, 2007). Ova, oocysts and larvae of parasites found under the light microscope were identified as previously described by (Downes & It& 2001).

Statistical Analysis
Data was entered into a Microsoft excel spread sheet and analyzed using descriptive analysis. Graphs and tables were used to calculate distribution frequency of geohelminths with regards to vegetable species, locations sampled and method of irrigation.

RESULT
Of the total 200 vegetable samples examined, 70 (35%) were positive for geohelminths and protozoan parasite. The parasites detected were Strongyloides stercoralis, Ascaris spp., Trichuris spp., Oesophagostomum dentatum, Fasciola spp., Dicrocoelium spp., Entamoeba histolytica, Entamoeba coli and Eimeria spp. Strongyloides stercoralis has the highest prevalence 67 (33.5%), followed by Entamoeba coli 27 (13.5%), Ascaris spp. 24 (12%), Trichuris spp. 10 (5%), Filiariform 9 (4.5%), Dicrocoelium spp. 9 (4.5%), Oesophagostomum dentatum 7 (3.5%), Fasciola spp 7 (3.5%), Entamoeba histolytica 6 (3%) and Eimeria spp. 6 (3%) had the lowest prevalence (Figures 1 and 2). Out of the six local Government area investigated, Lagelu has the highest level of parasitic contamination 13 (100%) of the total 13 vegetables collected with Strongyloides stercoralis being the most prevalent 8 (61.5%). This is followed by Ibadan southwest 23 (57.5%), Ibadan north 22 (32.4%), Akinyele local government 11 (29%), while Ido local government has the lowest level of parasitic contamination 3 (8.8%) (Table 1). Of the six markets investigated, Oja Oba market has the highest level of parasitic contamination with 23 (57.5%), followed by Ojo market 10 (37.04%), Bodija market 13 (35.14%), Oje market 2 (28.6%) and Eleyele market 3 (8.82%) (Table 1). The highest level of contaminated was detected in African spinach 20 (35.1%), followed by White jute 15 (45.5%), Waterleaf 14 (51.9%), Quill grass 12 (24.5%), Garden eggplant leaves 4 (57.1%), while the least contamination was detected in Pepper 1 (50...
Figure 1: Percentage Prevalence of Parasites found in farms and markets.

Figure 2: showing some of the geohelminths egg and larva with protozoa oocyst detected in different vegetable species collected in Ibadan metropolis.

A: Oesophagostomum dentatum larvae, B: Ascaris spp, C: Trichuris spp.
D: Strongyloides stercoralis egg E: Eimeria spp. F: Strongyloides stercoralis larva (first stage)
reporting in Iran (Daryani et al., 2008; Pires et al., 2012). Out of all the farmers interviewed, 11 (20%) used animal faeces and chemical as fertilizers, 31 (56.4%) used animal faeces only as their fertilizer source while 13 (23.6%) used chemical as their source of fertilizer. Most farmers 44 (80%) used stream and waste water as their source of irrigation while 11 (20%) of the farmers used well and stream (Tables 1-3).

**DISCUSSION**

Consumption of fresh vegetables is an essential route of transmission of intestinal parasites of public health importance which have been incriminated as one of the main causes of foodborne outbreaks (Daryani et al., 2008; Pires et al., 2012). From this present study, the overall prevalence of geohelminths and protozoan parasites observed is similar to the findings of other authors in Vietnam (Uga et al., 2009) and in Nigeria (Damen et al., 2007). However, it is higher than that reported in Iran (Daryani et al., 2008), in Pakistan (ul-Haq et al., 2014) and in Yemen (Alsubaie et al., 2014). It is however lower than the observation of (Alade et al., 2013) in Nigeria and (Hajjami et al., 2013) in Morocco. The high level of contamination of African spinach observed in this present study might be due to their broad leaves and their development near ground level which provide large contact area with contaminated water and soil (ul-Haq et al., 2014). African spinach and other green leafy vegetables have uneven surfaces that make parasitic eggs, cysts and larvae attached to their surface more easily when washed with contaminated water either in the farm or in market (Damen et al., 2007). Strongyloides spp, Entamoeba coli, Ascaris suum and Trichuris spp, were among the intestinal parasites of public health importance detected in vegetables from farms and markets, as this is similar to the observations of previous authors in Ethiopia (Gimaye & Fedaku, 2014), in Pakistan (Anwar & Mckenry, 2012) and in Nigeria (Uneke, 2004; Baker, 2007). Strongyloides stercoralis is a common cause of morbidity and mortality particularly in developing countries, as this parasite has the ability to auto-infect the host which makes it a significant public health problem (Roxby et al., 2009). The risk of acquiring strongyloidiasis

<table>
<thead>
<tr>
<th>LGA</th>
<th>Number Examined</th>
<th>No. (%) Parasite observed</th>
<th>Positive</th>
<th>Helminths</th>
<th>Protozoa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ibadan North</td>
<td>68</td>
<td>22 (32.4)强烈的 Ascaris spp., Dicrocoelium spp., Fasciola spp.</td>
<td></td>
<td>Entamoeba coli, Eimeria spp.</td>
<td></td>
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<tr>
<td>Akinyele</td>
<td>38</td>
<td>11 (28.5)强烈的 Ascaris spp., Dicrocoelium spp., Fasciola spp.</td>
<td></td>
<td>-</td>
<td>-</td>
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<tr>
<td>Ido</td>
<td>34</td>
<td>3 (8.2)强烈的 Ascaris spp., Dicrocoelium spp., Fasciola spp.</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lagelu</td>
<td>13</td>
<td>13 (100)强烈的 Ascaris spp., Dicrocoelium spp., Fasciola spp.</td>
<td></td>
<td>Entamoeba coli, Eimeria spp.</td>
<td></td>
</tr>
<tr>
<td>Ibadan southwest</td>
<td>40</td>
<td>23 (57.5)强烈的 Ascaris spp., Dicrocoelium spp., Fasciola spp.</td>
<td></td>
<td>Entamoeba coli, Eimeria spp.</td>
<td></td>
</tr>
<tr>
<td>Ibadan northeast</td>
<td>7</td>
<td>2 (28.6)强烈的 Ascaris spp., Dicrocoelium spp., Fasciola spp.</td>
<td></td>
<td>-</td>
<td>-</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Market</th>
<th>No. (%) examined</th>
<th>No. (%) positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bodija</td>
<td>37 (18.5)</td>
<td>13 (35.14)</td>
</tr>
<tr>
<td>Oje oba</td>
<td>40 (20)</td>
<td>23 (57.5)</td>
</tr>
<tr>
<td>Ono</td>
<td>27 (13.5)</td>
<td>10 (37.04)</td>
</tr>
<tr>
<td>Oje</td>
<td>7 (3.5)</td>
<td>2 (28.6)</td>
</tr>
<tr>
<td>Eleyele</td>
<td>34 (17)</td>
<td>3 (8.82)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vegetables</th>
<th>Common name</th>
<th>No. (%) examined</th>
<th>No. (%) positive</th>
<th>Parasite observed</th>
<th>Helminths</th>
<th>Protozoa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telfaria occidentalis</td>
<td>Fluted pumpkin</td>
<td>14 (7)</td>
<td>0 (0)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Solanum macrocarpon</td>
<td>Garden eggleaf</td>
<td>7 (3.5)</td>
<td>4 (57.1)</td>
<td>Strongyloides stercoralis</td>
<td>-</td>
<td>Entamoeba coli</td>
</tr>
<tr>
<td>Talinum triangulare</td>
<td>Waterleaf</td>
<td>27 (13.5)</td>
<td>14 (51.9)</td>
<td>Strongyloides stercoralis, Dicrocoelium spp, Fasciola spp., Ascaris spp., Oesophagotum</td>
<td>-</td>
<td>Eimeria spp.</td>
</tr>
<tr>
<td>Solanum lycopersicum</td>
<td>Tomato</td>
<td>10 (5)</td>
<td>3 (30)</td>
<td>Strongyloides stercoralis, Ascaris spp.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Capsicum chinense</td>
<td>Pepper</td>
<td>2 (1)</td>
<td>1 (50)</td>
<td>Ascaris spp.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Basella alba</td>
<td>English spinach</td>
<td>1 (0.5)</td>
<td>0 (0)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
is higher in rural areas, among people who work with soil and among lower socio-economic groups (Vadlamudi et al., 2006; Viney & Lok, 2007). It is important to note that the presence of these parasites may be due to lack of modern toilet facilities, poor sewage disposal and inadequate public health enlightenment which make people defecate indiscriminately in the environment resulting in pollution of water and soil (Tsado et al., 2013). The species of *Ascaris* detected in this study may probably be *Ascaris suum*, this is due to the usage of pig faeces as a major fertilizer as stated by one of the farmers. *Ascaris suum* has been known to be a zoonotic parasite causing visceral larva migrant in humans (Baker, 2007; Dutto & Petrosillo, 2013). The threat of infection with intestinal parasites in the community is increased because these contaminated vegetables are sometimes eaten raw or parboiled to retain the natural taste and preserve heat labile nutrients (Silfko et al., 2009). These findings may have an essential implication for food safety and emphasize the importance of raw vegetables in threatening public health by transmission of zoonotic parasites to humans in Ibadan. A greater percentage of the farms investigated in this study applied untreated organic manure (animal faeces) for the cultivation of their vegetables. Choice of fertilizer was dependent mainly on cost and availability, as the expensive nature of inorganic fertilizers makes farmers opt for untreated organic fertilizer. However, the use of untreated organic fertilizer pre-dispose vegetables to faecal helminthes contamination as humans can consequently be infected when these vegetables are consumed undercooked or raw (Daryani et al., 2008). Although vegetable farmers using wastewater as their source of irrigation in this study are aware of the fact that the use of wastewater can pose a major hazard to their health, however, inability to have access to potable water for irrigation, which is also expensive has restrained them to using wastewater. (Obuobie et al., 2006) noted that farmers practicing olericulture lack better options hence to using wastewater. (Obuobie et al., 2006) noted that farmers practicing olericulture lack better options hence the use of untreated organic fertilizer pre-dispose vegetables to faecal helminthes contamination as humans can consequently be infected when these vegetables are consumed undercooked or raw (Daryani et al., 2008). Although vegetable farmers using wastewater as their source of irrigation in this study are aware of the fact that the use of wastewater can pose a major hazard to their health, however, inability to have access to potable water for irrigation, which is also expensive has restrained them to using wastewater. (Obuobie et al., 2006) noted that farmers practicing olericulture lack better options hence the use of untreated organic fertilizer pre-dispose vegetables to faecal helminthes contamination as humans can consequently be infected when these vegetables are consumed undercooked or raw (Daryani et al., 2008).

References


Halablab MA, Sheet IH, Holail MM (2011). Microbiological quality of raw vegetables grown in


