Occurrence of parasite eggs and oocysts in commonly consumed vegetables collected from selected markets in Zaria, Kaduna State Nigeria

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Abstract
A study was conducted with the objective of determining the occurrence of parasite eggs and oocysts in washed and unwashed vegetables sold in some selected markets in Zaria, Kaduna State. Cabbage (Brassica oleracea), Tomato (Lycopersicon esculentum), Lettuce (Lactuca sativa), Carrot (Daucus carota) and Spinach (Spinacea oleracea) were collected based on convenient sampling from 5 markets. Three hundred grams of each vegetable was purchased every week in the morning hours from each of the selected markets during the rainy and dry seasons. Floatation technique was used for processing of the vegetable samples. Unwashed vegetables (269) had more parasite eggs and oocysts than washed vegetables (209). Spinach (52.50%) had the highest contamination, followed by carrot (48.75%), cabbage (42.50%), lettuce (40.0%) and tomatoes (28.75%). There was a significant (p < 0.05) association between the occurrence of parasite eggs and oocysts and the washing of vegetables. Among the unwashed vegetables, lettuce was highly contaminated (58.75%) with parasite eggs and oocysts, followed by spinach (55.0%), carrot (55.0%), tomatoes (50.0%) and cabbage (39.75%). There was, however, no significant (p > 0.05) association between the occurrence of parasite eggs and oocysts on vegetables and the markets where the vegetables were purchased. The study showed that eggs and oocysts of various parasites mainly of human and animal faecal origin were present on vegetables marketed for human consumption even after washing. Therefore, people should properly wash their vegetables before consumption and indiscriminate defecation should be discouraged to prevent contamination and improve hygienic conditions.

Keywords: Eggs, Oocyst, Market, Parasite, Vegetable, Zaria
**Introduction**

Fresh vegetables are regarded as an important part of a healthy diet. Fresh vegetables are essential for good health and they play a major role in the nutritional human diet. They are vital energy contributors that are depended upon by all ages as food supplements or nutrients (Duckworth, 1996). In many countries, such leafy plants are eaten raw or lightly cooked to preserve taste and this may also favor the likelihood of one being infected with foodborne parasites (Ozlem & Sener, 2005).

Consumption of contaminated fruits, vegetables, other food stuff, and water can lead to intestinal parasitic infection (Al-Binali et al., 2006). Consumption of contaminated, raw, or undercooked fruits and vegetables is one of the channels through which the spread of intestinal parasitic infections is propagated (Slifko et al., 2000). Fruits and vegetables act as a means of spread of parasitic infections when contaminated either in the field, during harvesting, transportation, storage, market chain, or at home (Idahosa, 2011; Omowaye & Abdu, 2012).

The extent of contamination of vegetables depends on several factors such as, use of untreated waste water and water supplies contaminated with sewage for irrigation, post-harvest handling, transportation and unhygienic conditions of preparation in food service or home settings (Simoes et al., 2001; Beuchat, 2002; Amoah et al., 2007). Post-harvest faecal contamination of vegetables may also occur during handling and transport of vegetables which occur through splashing of contaminated water on vegetables in order to keep the vegetables fresh (Wafa & Almegrin, 2010).

Consumption of vegetables has been a major way of transmitting contaminants, particularly parasitic organisms, leading to the increase of the number of food-borne illnesses (Su et al., 2012).

With the increasing global water scarcity and pollution of water bodies, vegetable farmers resort to the practice of using waste water for irrigating vegetables. Wastewater reuse in agriculture is an ancient practice that has been generally implemented worldwide (Hussain et al., 2001). These sources are probably heavily contaminated and may pose a high risk to the health of the farmers and to the consumers if hygienic standards are not maintained.

In most northern part of Nigeria including Zaria, production of vegetables during the dry season is mostly through the traditional (Fadama) system whose main source of water supply and fertilizer is the domestic sewage (Adamu et al., 2012). The unhygienic condition of the soil environment which is due to defecation by both human and grazing animals can contaminate water sources. When such contaminated water is used for irrigation of vegetable farms, the produce becomes contaminated as well. The objective, therefore, of the study is to determine the presence of parasite eggs and oocysts in some washed and unwashed vegetables marketed in some selected markets in Zaria, Kaduna State.

**Materials and Methods**

**Study area**

The study was carried out in Zaria which is a major city in Kaduna State, Nigeria (Inobeme & Ayanwole, 2009), with a total population of 695,069 (11.5% of the state population) people (NPC, 2006). It is approximated that about 40-75% of its working population derive their principal means of livelihood from agriculture (Nsangu & Redwood, 2009). Horticulture is the second most prevalent agricultural activity in Zaria with vegetables being mostly produced, but in some cases fruits are sandwiched among cereal crops.

**Study design**

The vegetable samples were purchased from the selected markets as washed (by the retailer) and unwashed vegetables and wrapped in new, sterile, clean polythene bags and transported to the Helminthology laboratory of Ahmadu Bello University, Zaria. In the laboratory, each of the vegetable samples both washed and unwashed were weighed appropriately. The washed and unwashed vegetable samples were washed in clean plastic containers, processed and examined immediately. In addition, the same vegetable samples were soaked, processed and examined after 24 hours.

**Sample size**

The sample size was determined according to Mugo (2008) using the formula:

\[ N = \frac{Z^2 \times Pq}{d^2} \]

\[ Z = \text{appropriate value for the standard normal deviation for the desired confidence} \ 1.96 \]
\[ P = \text{prevalence which is} \ 57.8\% \ (Maikai et al., 2012) \]
\[ q = 1 - p \]
\[ d = \text{desired absolute precision} = 0.05 \]
\[ N = 1.96 \times 0.578 \times (1-0.578) \]
\[ 0.05^2 \]

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Floatation technique for 24 hours processing of vegetable samples: A modification of the method by Abougrain et al. (2010) and Bailenger (1962), was used as follows. Each vegetable sample was weighed (250g) and soaked in distilled water (1500mls) in a plastic container for 24 hours. After 24 hours, the vegetables were removed and the wash was left in the plastic container for 10 hours to sediment. The supernatant was discarded and the residue was agitated gently in sucrose floatation medium of specific gravity 1.21 and then sieved through a gauze placed on a funnel in a test tube. Each test tube was topped to the brim with the floatation media to form a convex meniscus. A cover slip was placed on the test tube for 3 minutes and this was removed and placed on a clean glass slide and viewed under the microscope using ×40 and ×10 objectives for the presence of parasite eggs and oocysts.

**Data analysis**

Data was analysed using SPSS version 17 (Inc. Chicago, USA). Data obtained were reduced into percentages and summarized into tables and charts. Chi-square was used to test for association between the occurrence of parasite eggs and oocysts on vegetables in different markets and factors such as types of vegetables, markets and period of sampling. Values of P ≤ 0.05 were defined as significant.

**Results**

**Occurrence of parasite eggs and oocysts on the different vegetable type**

The level of contamination varied with vegetable types, Spinach had the highest parasite egg and oocysts contamination (53.75%), followed by carrot (51.88%), lettuce (49.38%), cabbage (45.63%) and tomatoes (39.38%). However, there was no statistical significant (p > 0.05) association between the occurrence of parasite eggs and oocysts and the vegetable types (Table 1).

**Occurrence of parasite eggs and oocysts on the different types of washed and unwashed vegetables**

Unwashed vegetables 214 (53.50%) had more parasite eggs and oocysts when compared to washed vegetables 170 (42.50%). Among washed vegetables, spinach (52.50%) harboured more parasite eggs and oocysts followed by washed carrot (48.75%). Unwashed lettuce (58.75%) had more...
Table 1: Occurrence of parasite eggs and oocysts on vegetable types

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Total number</th>
<th>No positive for parasites (%)</th>
<th>Washed vegetables positive n= 80, (%)</th>
<th>Unwashed vegetables positive n= 80, (%)</th>
<th>Chi square ($\chi^2$) and P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomatoes</td>
<td>160</td>
<td>63 (39.38)</td>
<td>23 (28.75)</td>
<td>40 (50.0)</td>
<td>* $\chi^2 = 8.33$ P = 0.801</td>
</tr>
<tr>
<td>Spinach</td>
<td>160</td>
<td>86 (53.75)</td>
<td>42 (52.50)</td>
<td>44 (55.0)</td>
<td>P = 0.0272</td>
</tr>
<tr>
<td>Carrot</td>
<td>160</td>
<td>83 (51.88)</td>
<td>39 (48.75)</td>
<td>44 (55.0)</td>
<td>** $\chi^2 = 10.95$ P = 0.7081</td>
</tr>
<tr>
<td>Cabbage</td>
<td>160</td>
<td>73 (45.63)</td>
<td>34 (42.50)</td>
<td>39 (48.75)</td>
<td>*** $\chi^2 = 2.151$ P = 0.0272</td>
</tr>
<tr>
<td>Lettuce</td>
<td>160</td>
<td>79 (49.38)</td>
<td>32 (40.0)</td>
<td>47 (58.75)</td>
<td>P = 0.0272</td>
</tr>
</tbody>
</table>

Total 800 384 (48) 170 (42.50) 214 (53.50)

Note: * Chi square for positive parasites on vegetables
** Chi square for positive parasites on washed vegetables
*** Chi square for positive parasites on unwashed vegetables

Table 2: The Occurrence of parasite eggs and oocysts based on markets where the vegetables were purchased in Zaria

<table>
<thead>
<tr>
<th>Markets</th>
<th>Total number</th>
<th>Number positive (%)</th>
<th>Number positive for washed vegetables</th>
<th>Number positive for unwashed vegetables</th>
<th>Chi square ($\chi^2$) and P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dan magaji</td>
<td>160</td>
<td>82(51.25)</td>
<td>34</td>
<td>48</td>
<td>* $\chi^2 = 3.275$ P = 0.5129</td>
</tr>
<tr>
<td>Zaria city</td>
<td>160</td>
<td>78(48.75)</td>
<td>36</td>
<td>42</td>
<td>P = 0.7943</td>
</tr>
<tr>
<td>Tudunwada</td>
<td>160</td>
<td>79(49.38)</td>
<td>38</td>
<td>41</td>
<td>** $\chi^2 = 1.680$ P = 0.4810</td>
</tr>
<tr>
<td>Sabongari</td>
<td>160</td>
<td>78(48.75)</td>
<td>32</td>
<td>46</td>
<td>*** $\chi^2 = 3.480$ P = 0.0272</td>
</tr>
<tr>
<td>Samaru</td>
<td>160</td>
<td>67(41.88)</td>
<td>30</td>
<td>37</td>
<td>P = 0.7943</td>
</tr>
</tbody>
</table>

Total 800 384(48) 170 214

Note: * Chi square for positive vegetables in the markets
** Chi square for positive washed vegetables in the markets
*** Chi square for positive unwashed vegetables in the markets

parasite eggs and oocysts, followed by unwashed spinach (55.0%) and unwashed carrots (55.0%) (Table 1).

Occurrence of parasite eggs and oocysts on the different types of washed vegetables

Spinach (52.50%) had the highest parasite eggs and oocysts contamination, followed by carrot (48.75%), cabbage (42.50%) then lettuce (40.0%). Tomatoes, however, had the least contaminated (28.75%). There was a significant ($p < 0.05$) association between the occurrence of parasite eggs and oocysts and the washed vegetables (Table 1).

Occurrence of parasite eggs and oocysts on the different type of unwashed vegetables

Among the unwashed vegetables,
lettuce was highly contaminated (58.75%) with parasite eggs and oocysts, followed by spinach (55.0%) and carrot (50.0%). While cabbage (39.75%) was least contaminated. There was however, no significant (p > 0.05) association between the occurrence of parasite eggs and oocysts and the unwashed vegetables (Table 1).

The occurrence of parasite eggs and oocysts based on the markets
The study showed that vegetables purchased from Dan Magaji market (51.25%) were highly contaminated with parasite egg and oocysts, followed by those purchased from Tudun Wada (49.38%), Sabongari (48.75%) and Zaria city (48.75%) markets. Vegetables purchased from Samaru market (41.88%) were the least contaminated with parasite eggs and oocysts. There was however, no significant (p > 0.05) association between the occurrence of parasite eggs and oocysts on vegetables and the markets where the vegetables were purchased (Table 2).

Discussion
It was established from the result that washed vegetables still had a lot of parasite eggs and oocysts. This may be due to the use of contaminated water in washing the vegetables and the use of the same container and water to wash the different types of vegetables. It could also be due to sprinkling or splashing of contaminated water to keep the vegetables moist and fresh (Al-Megrin, 2010).

There was a significant association between the occurrence of parasite eggs and oocysts and the washing of vegetables. This was as a result of the significant reduction in parasite eggs and oocysts after washing of tomatoes which showed that washing had an effect on tomatoes which could be as a result of the fresh, smooth, leathery surface which tend to reduce rate of parasitic attachment (Mba, 2000).

Based on vegetable types, spinach (Spinacia oleracea) commonly called “aleho” in the local parlance, was found to have the highest occurrence of parasite eggs and oocysts. This agrees with the findings of Uga et al. (2009) and Maikai et al. (2012). Uga et al. (2009) showed that contamination is usually high in leafy vegetables followed by root and fruity vegetables. Spinach is a readily available and affordable vegetable compared to the other types of vegetables in the study area. The high occurrence of parasite eggs and oocysts on spinach persisted in washed vegetables while it was found second to lettuce in the unwashed vegetables. Vegetables like lettuce have broad leaves and large surface areas which are in direct contact with the sewage contaminated soil surface (Larkin et al., 1978) and organic debris or due to the method of harvest. Cabbages have rough uneven surfaces that make parasite eggs and oocysts attach themselves easily to the surfaces of the vegetables either on the farm or when washed with contaminated water (Mara & Cairncross, 1989). Fresh vegetables like tomatoes have smooth leathery surfaces which tend to reduce the rate of parasitic attachment (Mba, 2000). However, there was no significant difference between occurrence of parasite eggs and oocysts for both washed and unwashed vegetables.

This study also showed that vegetables purchased from Dan-Magaji market had higher occurrence of parasite eggs and oocysts (51.25%) followed by Tudun-wada (49.38%), Zaria city and Sabongari (48.75%) while Samaru market had the least parasite eggs and oocysts occurrence at 41.88%. This is in contrast to Maikai et al. (2012) who showed that vegetables from Sabongari market had the highest contamination. The differences observed may be attributed to the fact that Maikai et al. (2012) did not include Dan-Magaji and Tudun-Wada markets in their study and hence may not have observed the occurrence above. Also, it had been observed that there was no potable water supply in Dan-Magaji and Tudun-Wada markets and these vegetables were washed with water from wells and water from water vendors in which the sources are unknown. The contamination may also be due to the poor hygienic practices in the markets, decreased level of health education of the retailers on the market product presentation and handling. Environmental factors may also play a role in the observed difference due to the fact that in some of these vegetable markets, there is unhygienic handling of vegetables by retailers who display their vegetables on the ground as observed during purchases which may have exposed the vegetables to direct contact with the soil and contaminants. Samaru market had the least contamination and may be due to the fact that it is located close to an academic environment with hygiene conscious individuals and also some of these retailers have some level of education.

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