Parasite Epidemiology and Control 22 (2023) e00313

Contents lists available at ScienceDirect

Parasite Epidemiology and Control

journal homepage: www.elsevier.com/locate/parepi

Parasitological assessment of some fruits and vegetables commonly sold in retail outlets in the Mfoundi Division of Cameroon

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ARTICLE INFO

Keywords:
Fruits
Vegetables
Microbial contaminants
Markets
Yaoundé
Cameroon

ABSTRACT

Background: Fruits and vegetables are very important for human diet as they provide all the nutrients needed to be healthy with just a daily-recommended intake of 400 to 600 mg. However, they constitute one of the major sources of human infectious agents. Thus monitoring of the microbial contaminants of the fruits and vegetables is very crucial for human safety.
Method: A cross sectional study was conducted on fruits and vegetables in four markets (Mfoundi, Mokolo, Huitième and Acacia) of the Yaoundé city from October 2020 to March 2021. In all, 528 samples were purchased (carrots, cucumbers, cabbages, lettuces, leeks, green beans, okra, celeries, pepper, green peppers and tomatoes) and processed for infective agents using the centrifugation methods (Formalin, distilled and saline water). Seventy-four (74) soil/water samples collected from the sale environment were analysed using the same technics.
Results: Overall, 149/528 (28.21%) were contaminated by at least one infective agent: 130 (24.62%) and 19 (3.6%) having one and two pathogen species respectively. Vegetables had high contamination rate (22.34%) than fruits (5.87%). Lettuce (52.08%), carrot (41.66%) and cabbage (35.41%), were the most contaminated while okra was the least (6.25%). *Candida* spp. (14.01%) and larva of *Strongyloides stercoralis* (7.76%) were more observed while Hookworms (1.13%) was the least. Frequency of *Strongyloides stercoralis* ($p = 0.001$) and *Candida* spp. ($p = 0.01$) were statistically high than other pathogens. Contamination rates were similar for washed (27.65%) and unwashed (28.78%) samples before sale. *Candida* spp. ($p = 0.001$), *Strongyloides stercoralis* ($p = 0.01$) and *Entamoeba histolytica/dispar* ($p = 0.017$) showed significant contamination rates by month. Contamination trends were high in the rainy season (42.6%) than the dry season (15.1%). Correlation between environment and products sold revealed same pathogens in both cases.
Conclusion: The study highlights that the sale environment and products constitute potential source of microbial contamination. These data raised the concern of stakeholders about health risk related to vegetables and fruits sold in some local markets in Cameroon. Thus the necessity for them to development more appropriate policies on the surveillance of sale environment and on the management of these products during the different process phases by the population.

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https://doi.org/10.1016/j.parepi.2023.e00313
Received 19 January 2023; Received in revised form 11 June 2023; Accepted 12 June 2023
Available online 14 June 2023

1. Introduction

Fruits and vegetables are edible parts of plants excluding starchy roots, tubers, cereals, nuts, seeds, medicinal herbal plants and stimulants (WHO, 2003). Fruits and vegetables are important components of diet for their health promoting properties (Slavin and Lloyd, 2012; Amissah-Reynolds et al., 2020). They supply vitamins, minerals, fibers, antioxidants, phytoestrogens and anti-inflammatory agents that help in preventing major diseases (WHO, 2003). According to FAO (Slavin and Lloyd, 2012; Amissah-Reynolds et al., 2020), increasing fruits and vegetables consumption is a major public health challenge nowadays. To achieve relevant health outcomes a target of at least 400–600 g/adult/day is recommended (Amissah-Reynolds et al., 2020; Food and Agriculture Organization of the United Nations, 2017). Paradoxically they constitute one of the major sources of infectious agents including enteric viruses, bacteria, and parasites (Olza et al., 2017; Bouzid et al., 2018; Getaneh et al., 2020).

Contamination, which occurs either during cultivation using untreated irrigated water and human or animal fertilizer, during harvesting, processing, distribution, and sale and during consumption, has resulted too many foodborne human diseases (Shafa-ul-Haq et al., 2014; Temgoua et al., 2015; Bekele et al., 2017). Similarly, vegetables directly supplied by farmers to vendors have shown to be more prone for contamination as compared to those supplied by large-scale vendors (Getaneh et al., 2020).

Foodborne diseases continue to be a common and serious threat to public health all over the world and these diseases are a major cause of morbidity. Numerous reports have recently emerged from various parts of the world linking an increased number of foodborne illnesses (especially gastroenteritis caused by helminthes and protozoans) to the consumption of raw vegetables in both developed and developing countries due to poor hygiene and inadequate personal cleanliness (Mohamed et al., 2016; Utaaker et al., 2017; Alemu et al., 2020; Rodríguez-Valderrama et al., 2020).

In Cameroon, one of the most income-generating activities is based on the cultivation on fruits and vegetables. Data on the biosafety of these food items are scarce despite the increasing desire in consumption and cultivation (Asongwei et al., 2014). Recent studies have reported the use of contaminated water for vegetable irrigation (Temgoua et al., 2015; Tsama et al., 2015). This highlights the need to assess the microbiological safety of fruits/vegetables sold in Cameroon markets.

This study was designed to characterize microbial contamination of some selected fruits and vegetables and the sale environment in some popular markets in the city of Yaoundé.

2. Material and methods

2.1. Study design and area

A cross sectional study was carried out in four markets of Yaoundé city from October 2020 to March 2021. Yaoundé city, the political capital of Cameroon, is located in the Mfoundi Division, Centre Region, also called the city of seven hills. It is crossed by small streams among which the Mfoundi, Biyeme and Mefou rivers. In terms of climate, the city of Yaoundé is subject to an equatorial type climate. The climate is characterised by two dry seasons, from December to March and from June to August, alternating with two rainy seasons from March to June and from September to November (Communes et Villes Unies Du Cameroun (CVUC), 2014). Yaoundé is subdivided into seven districts-urban communities (Ngambi, 2015). According to the Central Office of Censuses and Population Studies (BUCREP), the city of Yaoundé had approximately 2,638,648 inhabitants in 2010 (Bureau Central des Recensements et des Etudes de Populations (BUCREP), 2012). The average temperature is 23.5 °C, ranging between 16 and 31 °C depending on the season, with an average annual rainfall of 1747 mm. The average humidity varies during the day between 35% and 98%, with an average value of 80%. The climate and temperature is favourable for the cultivation of fruits and vegetables. However, most of these products sold in markets by whole sellers from other regions of the country.

The study was conducted in four markets (Mfoundi, Huitième, Mokolo and Acacia) of three of the seven districts that make of the Mfoundi Division. These markets were chosen because of the high variety of vegetables and fruits sold by whole sellers. Mfoundi (3°51′48"N 11°31′16″E), Huitième markets (3°53′03“ N 11°30'15"E) are located in Yaoundé I and Mokolo market (3°52′18"N 11°30′33″E) in Yaoundé II are markets where most whole sellers supply food stuffs to retailers who either buy and sell in the same markets or transport them to other markets. The markets are characterised by poor level of water canalisation and most people display vegetables and fruits on the ground before selling. Multiple waste dumpsites are implanted inside the markets and the waste often extend to the area that foodstuffs are sold. The Acacia market (3°50′25"N 11°29′12″E) located in Yaoundé VI is characterised a good drainage system with waste dumpsites implanted along the roadside. Retailers sell most vegetables and fruits.

2.2. Samples collection

Samples were collected at the four markets each month over six months between 7 and 10 am. Approximately 500 g of each vegetable and fruit washed and unwashed were purchased from the different stall sites (floor and tables) in each market; i.e. for each fruit and vegetable we have four samples. Fruit and vegetable samples were collected in black, sterile polyethylene bags. We also collected the soil around the vendors' counters in sterile plastics and stagnant water, which were introduced into sterile plastic bottles of 1 L capacity. For all water samples, 2–3 drops of 10% diluted formalin were added to preserve the microorganisms present. Information about each collection point (market name, collection date, and sample number) was marked on each bottle and bag. All samples were transported in a cooler maintained at −4 °C to the Laboratory of Microbiology, Infectious diseases and Immunology of the Centre for Health and on Priority Pathologies for processing.

2.3. Samples preparation and processing

The fruit and vegetable samples were divided into three batches (one batch for washing with physiological water and two batches for washing with distilled water). For each batch, 100 g were immersed in 500 mL of physiological saline, distilled water in graduated beakers, and vigorously agitated using a shaker for adequate washing.

For soil sample, three grams of soil were mixed with 10 mL of distilled water. Solid particles were removed by sieving the mixture using a fine-mesh 180-μM sieve. Sediments from soil and water samples were obtained by pouring the supernatant after 24 h. Samples prepared were processed using the distilled water, saline solution and formalin ether technics.

2.4. Parasite identification techniques

2.4.1. Distilled and saline water technics

5 mL of each sediment was put into a 15 mL conical bottom tube and completed with distilled water and saline solution till the limit followed by centrifugation at a speed of 2500 rpm for 5 min for the fruit and vegetable samples and a speed of 3000 rpm for 5 min for the soil/water samples. The supernatant was discarded and the pellet was homogenized using a Pasteur pipette. A drop of pellet on to which 1% lugol was added examined between slide and coverslip using 10× and 40× objectives under an optical microscope to identify pathogens forms (Alemu et al., 2020).

2.4.2. Formalin ether technic

After 24 h of sedimentation, the supernatant liquid was discarded and the sediment obtained from distilled water was homogenized. The sediment was diluted by 10% formalin. 12 mL of the sediment were then poured into 15 mL conical tubes and completed with 3 mL ether were. After homogenising for one minute it was then centrifuged at a speed of 1500 rpm for 5 min. At the end of the centrifugation, the supernatant was discarded by inversion. A drop of pellet on to which 1% lugol was added examined between slide and coverslip using 10× and 40× objectives under an optical microscope to identify pathogens forms. For quality assurance, three slides were observed for each sample (Lucia et al., 2021).

2.5. Data analysis

The parasitological data obtained were expressed in terms of contamination rate expressed in percentage for each pathogenic species. They were compared according to the type of sample, the place of collection and the month of collection.

The data was entered in a Microsoft Excel version Windows 2016 file and analysed with SPSS version 25. The statistical test used was the X^2 test (chi-square test) for the comparison of the contamination rate according to the collection site, the month and the type of sample. Significance level was set at $p \leq 0.05$.

3. Results

3.1. Fruit and vegetable samples contamination frequency

A total of eleven fruits and vegetable was collected: carrots, lettuce, green peppers, cucumbers, cabbage, celery, tomatoes, leeks, okra, peppers, and green beans. 48 fruit and vegetable samples, 24 washed table and 24 unwashed (ground and table) were collected each month from the different displacement sites in each market giving an overall total of 528 samples collected during six months. Parasitological analysis revealed 149/528 (28.21%) were contaminated by at least one infective agent with 130 (87.24%) and 19 (12.75%) contaminated with one and two pathogen species respectively.

Vegetables had significant high contamination rate 22.34% than fruits 5.87% with $p = 0.001$. As shown in Table 1, among

Table 1
Frequency distribution of microbial contamination of vegetables and fruits sold in Yaoundé city markets from October 2020 to March 2021.

Kind of product	Item	Number examined	Number positive (%)	Number of pathogens identified	
				One	Two
Fruits	Tomato	48	10 (20.83)	8 (80.0)	2 (20.0)
	Green pepper	48	11 (22.91)	8 (72.72)	3 (37.5)
	Pepper	48	7 (14.58)	6 (85.71)	1(14.28)
	Cumcumber	48	10 (20.83)	8 (80.0)	2 (20.0)
Vegetables	Green beans	48	17 (35.41)	13 (76.47)	4 (23.52)
	Carrots	48	20 (41.66)	16 (80.0)	4 (20.0)
	Lettuce	48	25 (52.8)	20 (80.0)	5 (20.0)
	Cabbages	48	17 (35.41)	15 (88.23)	2 (11.76)
	Okra	48	3 (6.3)	3 (100)	0.0
	Leeks	48	13(27.08)	13 (100)	0.0
	Celery	48	16 (33.33)	13 (81.25)	3 (18.75)
Total		**528**	**149 (28.21)**	**130 (24.62%)**	**19 (3.6%)**

vegetables, lettuce (52.08%) was the most frequently contaminated followed by carrot (41.66%), cabbage (35.41%), green beans (35.41%) and celery (33.33%) while leek (27.08%) was the least contaminated. Green pepper (22.91%) was the fruit with highest contamination rate while cucumber (20.83%), tomatoes (20.83%) and pepper (14.58%) had similar contamination trend and the least observed for okra (6.25%) (Table 1). Helminths (11.40%), Protozoa (2.84%) and *Candida* spp. (14.01%) were identified as fruits and vegetables contaminants. Larva of *Strongyloides stercoralis* (7.76%) was the most commonly detected helminths followed by *Ascaris lumbricoides* (2.46%) and Hookworms (1.13%). Yeast cells of genus *Candida* spp. was the only one observed with the highest frequency of contamination (14.01%) among all the contaminants. *Entamoeba histolytica/dispar* (2.84%) was the only protozoan parasite identified. Contamination rates of *Strongyloides stercoralis* ($p = 0{,}001$) and *Candida* spp. ($p = 0.01$) were statistically high compared to other pathogen species (Table 2).

3.2. Relative abundance of resistant form of pathogens

Globally, abundance of pathogens resistant forms was high in vegetables compared to fruits with maximal value observed in green beans (519) followed by carrots (422), celery (412) and cabbage (322) while the least value was observed for okra (106). Yeast cells followed by larva of *Strongyloides stercoralis* had high abundance and Hookworms the lowest abundance in both vegetables and fruits (Fig. 1).

3.3. Contamination rate of washed and unwashed vegetables and fruits based on display method

According to whether the vegetables and fruits were washed or not before sale and the nature of display on either the ground or table, similar contamination rates were observed when all pathogens are considered (27.65% versus 28.78%). The frequency of contamination varied from 36% to 40% for vegetables and from19% to 21% for fruits in terms of washed and unwashed products respectively. Vegetables shown significantly high contamination rates compared to fruits ($p = 0.001$) (Table 3).

3.4. Contamination rate by months and season

Candida spp. and larva of *Strongyloides stercoralis* were the most frequent in all the months. Hookworm eggs were detected only during the month of January (8.3%). Significance was in favour of *Candida* spp. (p = 0.001), *Strongyloides stercoralis* ($p = 0.01$) and *E. histolytica/dispar* ($p = 0.017$) by month. The global frequency was high during the rainy season 112 (42.6%) compared to the dry season 40 (15.1%) with values ranging between 32.0% and 48.0% (Rainy season) and 23.0% and 33.0% (Dry season) (Fig. 2).

3.5. Contamination rate of sale environment

Among the 72 soil/water samples collected around the sale environment, 34 (47.8%) were contaminated by at least a pathogen species including parasitic helminths (36.1%), Protozoa (4.2%) and *Candida* spp. (13.9%). Larva of *Strongyloides stercoralis* (33.3%) were the most frequent followed by *Candida* spp. (13.9%) and *E. histolytica/dispar* (4.2%). The least values were observed for *Ascaris lumbricoides* (1.4%) and Hookworms (1.4%) (Fig. 3). All the pathogens detected were present in all the four markets sampled apart for *Ascaris lumbricoides* and hookworms, which were found only in Mokolo Market. Though no significant difference was observed between markets, Mokolo markets (83.3%) remained the most contaminated, followed by the Mfoundi (66.6%), Acacia (55.5%) and Huitième (33.3%) markets (Fig. 4).

Table 2
Contamination rate of fruits and vegetables by different infective agents sold in Yaoundé city markets from November 2020 to March 2021.

Variables ($n = 48$)	Infective agents					Total
	Ascaris lumbricoïdes	Hookworms	*Strongyloides stercoralis*	*Entamoeba histolytica/dispar*	*Candida* spp.	
Carrots	1 (2.08)	1 (2.08)	3 (6.25)	3 (6.25)	12 (25.00)	20 (41.66)
Celery	3 (6.25)	2 (4.16)	2 (4.16)	1 (2.08)	8 (16.66)	16 (33.33)
Cabages	0	0	2 (4.16)	3 (6.25)	12 (25.00)	17 (35.41)
Cucumber	0	0	3 (6.25)	0	7 (14.58)	10 (20.83)
Okra	0	0	0	0	3 (6.25)	3 (6.25)
Green Bean	4 (8.33)	0	2 (4.16)	3 (6.25)	8 (16.66)	17 (35.41)
Lettuce	2 (4.16)	2 (4.16)	13 (27.08)	3 (6.25)	5 (10.41)	25 (52.08)
Pepper	2 (4.16)	1 (2.08)	2 (4.16)	1 (2.08)	1 (2.08)	7 (14.58)
Leek	1 (2.08)	0	9 (18.75)	0	3 (6.25)	13 (27.08)
Green Pepper	0	0	3 (6.25)	0	8 (16.66)	11 (22.91)
Tomato	1 (2.08)	0	2 (4.16)	0	7 (14.58)	10 (20.83)
Total	**13 (2.46)**	**6 (1.13)**	**41 (7.76)**	**15 (2.84)**	**74 (14.01)**	**149 (28.21)**
X^2	15.30	12.47	24.66	13.99	21.46	/
p-value	0.12	0.25	**0.001**	0.17	**0.01**	/

N = number examined; % = percentage in brackets.

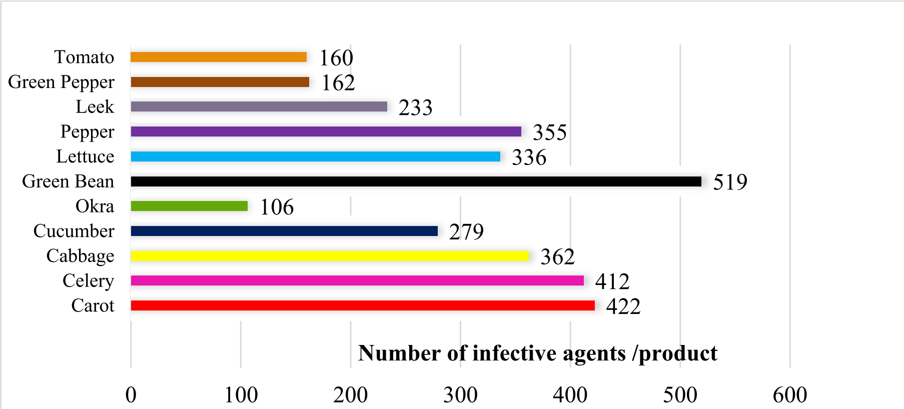

Fig. 1. Relative abundance of pathogens resistant forms in fruits and vegetables.

Table 3
Contamination rate of washed and unwashed vegetables and fruits.

Type of product	State of product	Number examined	Number positive (%)
Vegetables	Washed	120	44 (36.66)
	Unwashed	120	48 (40.0)
	Total	**240**	**97 (40.41)**
Fruits	Washed	144	29 (20.13)
	Unwashed	144	28 (19.44)
	Total	**288**	**57 (19.79)**
	Washed	**264**	**73 (27.65)**
Overall	**Unwashed**	**264**	**76 (28.78)**
	Washed and un washed	**528**	**149 (28.21)**

Washed: display on tables; **unwashed:** display on ground.

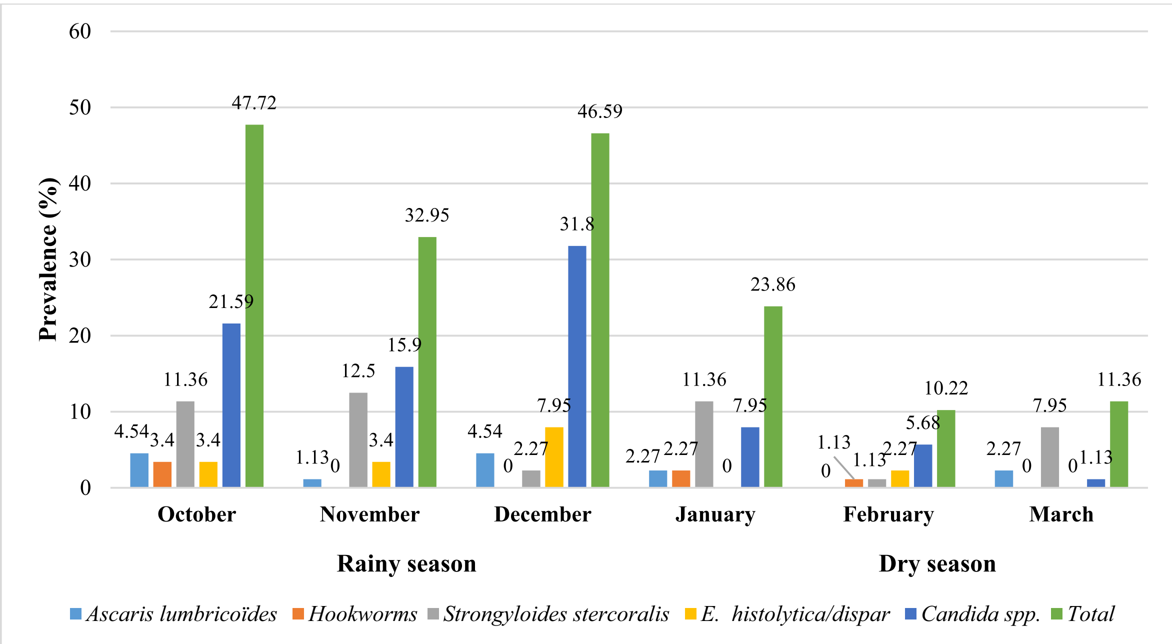

Fig. 2. Frequency of vegetables and fruits contamination variation by months and season.

Contamination rate was globally higher in the dry season (69.4%) than in the rainy season (50%), though with no significance. Larva of *Strongyloides stercoralis* larvae was predominant in all months except November and December. The contamination peak was observed in December (83.3%). *Ascaris lumbricoides* and Hookworms eggs were not detected in the rainy season.

Correlation between sale environment and vegetables and fruits revealed the presence of same pathogens in both cases without any significant difference. *Strongyloides stercoralis* (33.3%) ranks first in the environment while yeasts cells (14.0%) dominated in fruits and vegetable samples. However, Hookworms and *A. lumbricoides* rank last in both cases. (Table 4).

4. Discussion

The results of this study show that vegetables and fruits sold in the Yaoundé city markets are contaminated by multiple infective agents. Several studies have highlighted the public health hazard regarding the consumption of vegetables, and fruits (Nkengazong et al., 2016). The presence of parasites of human health significance on fruit and vegetables in this study can be attributed to contamination with parasite eggs, oocysts and larvae from the environment and water used for irrigation and washing of fruit and vegetables, poor hygiene practices by food handlers. Similarly, sources of water supply needed for growing vegetables among others include rivers and ponds, which are widely contaminated by human and animal excrements. Also, climate type has shown to be an exponential factor favouring the contamination of these food stuffs in a global scale, where highest incidence rate was found to be associated with tropical rain forest climate regions (Nkengazong et al., 2016). The contamination of these products by one or more pathogens is worth confirming polyparasitic infection of human in many previous studies (Aida et al., 2022; Brice et al., 2020; Bowo-Ngandji et al., 2021). Varied contamination rates by helminthes, protozoans and yeast cells infective stages have been obtained on studies related to vegetables and fruits contaminants: 61.6% in Fako Division (Akoachere et al., 2018), 13.21% in Buea (Judith et al., 2018), 39.1% in Ethiopia (Getaneh et al., 2020), 40% in Nigeria (Amaechi et al., 2016; Ola-Fadunsin et al., 2022) with global incidence rate of 30% in vegetables and 20% in fruits (Nkengazong et al., 2016). This shows that vegetables, which are highly recommended for human consumption (Fominyam et al., 2023), are important sources of multiple human infectious diseases. The difference observed could be related the number of samples collected, sensitivity of analysis technics used, the period and duration of the study as well as variations in geographical distribution of parasites, sanitary and socioeconomic status of the community.

In the present study, although three parasitological techniques were used, very few infectious forms were identified with a low overall contamination rate (28.21%). This result is comparable to that obtained in Tiko and Limbe (22.9%), but considerably lower than that reported in Nigeria (40.1%). This observation could be explained in one hand by a difference in sensitivity of techniques used in the various studies and on another hand by variations in geographical location, number, origin and type of the fruit and vegetable samples, and the seasons during which the samples were collected. (Getaneh et al., 2020; Ola-Fadunsin et al., 2022; Fominyam et al., 2023).

Seasonal variation was related to parasite transmission, as a high contamination rate was observed during the rainy season as opposed to the dry season. This result may be attributable to factors including lower temperatures, higher rainfall and soil moisture. These factors might have increased the survivability of eggs, oocysts and larvae of parasites in the environment resulting in the contamination of fruits and vegetables. Similar observations were made in a study conducted in the south West region of Cameroon (Fominyam et al., 2023) and in works conducted in other countries (Getaneh et al., 2020; WHO, 2016).

The high contamination rate observed in vegetables (22.34%) could reflect the nature of their surface. The uneven/rough surfaces and proximity to the soil of vegetables such as lettuce and cabbage facilitate the attachment of pathogen-resistant forms and allow them to overcome the effects of washing. Most edible parts of vegetables are in close contact with the soil, which exposes them more to contamination than fruit (Al Nahhas and Aboualchamat, 2020).

Strongyloides stercoralis larva was the most frequently identified helminth with the highest abundance. This observation is in line with that of (Nkengazong et al., 2016) which in a systematic review revealed *Strongyloides stercoralis* to be one of the most prevalent in vegetables. This could be related to the presence of a free stage in its development cycle and the presence of an animal reservoir defecation by animals infected with this parasite, which would increase the chances of environmental contamination. The cysts of Amoeba species such as *Entamoeba histolytica/E. dispar* are very resistant in the environment, which explains the frequency observed in this study. Our results corroborate with the results observed in other studies (Al Nahhas and Aboualchamat, 2020; Tefera et al., 2014). The high prevalence of yeast cells reflects their exponential multiplication rate (90 min for a complete cycle) in the environment (Dankwa et al., 2018).

Previous studies have shown that vegetables and fruits exposed without washing were significantly more contaminated than those washed before exposure (WHO, 2016; Dacombe et al., 2007; Endale et al., 2018; Mostafidi et al., 2020). Our results differed from the latter in that washed and unwashed produce showed almost the same contamination trend. The softness and fragility of these products would encourage vendors not to wash them thoroughly before displaying them (vegetables). In addition, the products displayed on the ground and on the tables had almost the same contamination rate. This shows that the water used for washing and the environment can serve as additional sources of contamination. Most vendors displayed fruits and vegetables on bare ground and in open shades for easy viewing by customers, what increases the risk of easily contamination by the infective stage of parasites found in the environment (Fominyam et al., 2023).

The high prevalence values obtained in Mokolo, Mfoundi and Huitième markets are believed to be the result of poor sanitation practices. In the Mokolo and Mfoundi markets, for example, the drainage system does not allow for the proper channelling of wastewater, resulting in a constant flow of wastewater into the areas where the majority of vegetables and fruit are sold. In addition, the presence of waste disposal points in markets could contribute to the contamination of the selling environment if not disposed of quickly. Studies have shown that dumpsites provide a favourable environment for pathogen growth (Lucia et al., 2021). Examination

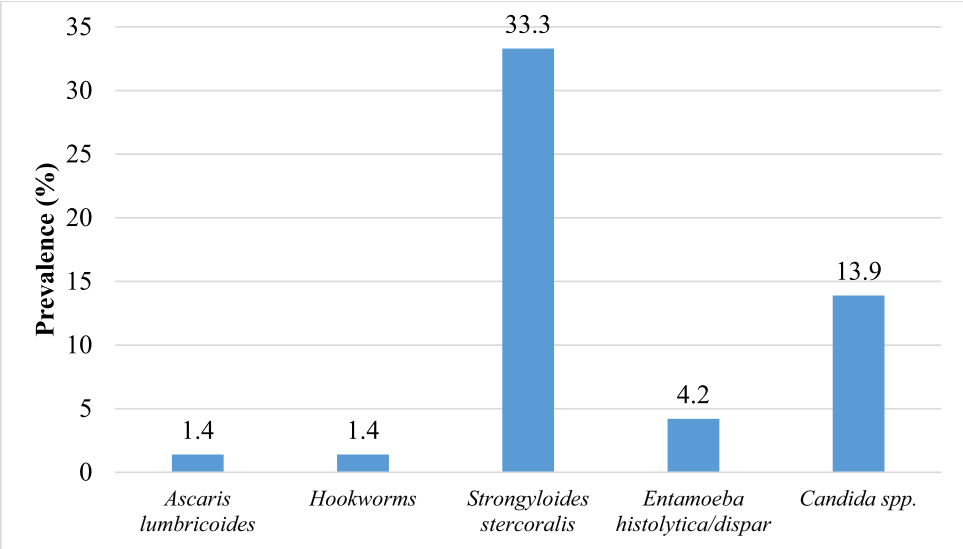

Fig. 3. Global frequency of contamination rate of sale environment.

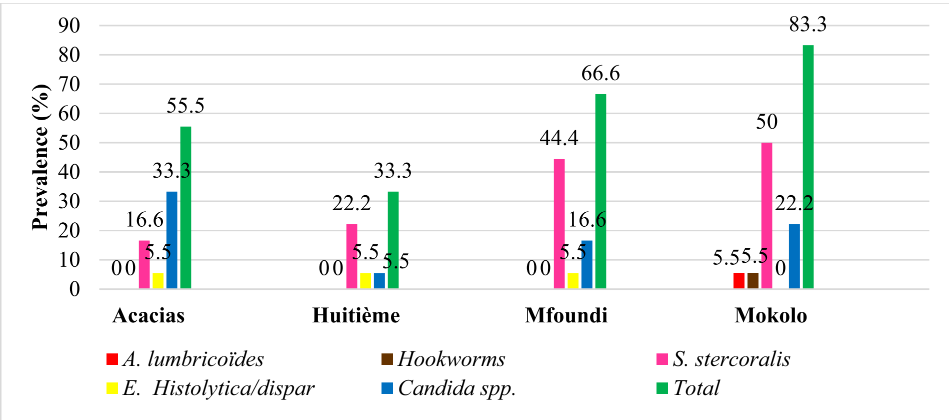

Fig. 4. Contamination rate according to collection site.

Table 4
Correlation between the sale environment and fruits/vegetables.

Variables	Infective agents					
	A. lumbricoïdes	Hookworms	*S. stercoralis*	*E. histolytica/dispar*	*Candida* spp.	Total
Fruits/Vegetables ($n = 528$)	13 (2.46)	6 (1.13)	41 (7.76)	15 (2.84)	74 (14.01)	149 (28.21)
Soil /Water ($n = 72$)	1 (1.4)	1 (1.4)	24 (33.3)	3 (4.16)	7 (13.9)	34 (47.72)
p-value	**0.545**	**0.593**	**0.21**	**0.555**	**0.238**	/

of water and soil samples taken around the sales environment revealed the same pathogens as those identified in fruit and vegetables, with a negative correlation. This shows that contamination of fruit and vegetables can have an exogenous or endogenous origin.

Similarly, the restriction of samples collected from markets and technics used may have resulted in many gaps in detecting other contaminants and other sources of contamination of fruit and vegetables through the assessment of factors associated with contamination in the pre- and post-marketing phases.

5. Conclusion

The present study provides additional information on food biosafety and more specifically on the health stress related to vegetables and fruits sold in some local markets in Cameroon, showing that the sales environment and the products sold are potential sources of microbial contamination. Consumers are therefore exposed to a high risk of various microbial infections. There is therefore an urgent need for the public sector to develop more appropriate policies on the sanitary surveillance of the sales environment and on the management of these products during the different phases of cultivation, harvesting, transport, handling and consumption. The implementation of good sanitary practices and periodic screening of products using techniques that are more sensitive during the pre-harvest and post-harvest phases should be encouraged.

Declaration of Competing Interest

The authors declared that the results submitted are original and no other person can claim authorship of the results, apart from the authors included in the article.

Acknowledgments

We acknowledged the Institute of Medical Research and Medicinal Plants Studies for the financial support, and all the technical staffs for their multiple input during the realization of the research work.

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