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Food safety in Latin American informal food establishments

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Background and aim: Informal food establishments are an important source of food due to their increased affordability of products and convenience. Food security and safety are two key factors that must coexist for a proper functioning of the food system. In Latin America, the safety of food is less analyzed than food security, although it is central to people's health, as well as to their personal sustainability. Since informal food establishments are popular food sources in Latin America, this research aims to examine the presence of foodborne pathogens in food products from such establishments.

Methods: This research will be conducted as narrative literature review, collecting data from all publications in Spanish-speaking countries in Latin America between January 1, 2018, and May 31, 2023. The databases searched were PubMed and Web of Science. The search included pathogens such as bacteria, parasites and viruses. The languages of the articles assessed were English and Spanish.

Results: The analysis was based on 32 articles focusing on seven of all Spanish-speaking countries in Latin America. The pathogens found belonged either to a bacteria type, or to a parasite. No viruses were investigated within the selection of articles. The widest variety of pathogens was among bacteria. The most frequently identified bacteria belonged to the family *Enterobacteriaceae*. The food products examined ranged from animal products to fruit and vegetables, fish, seafood and already-prepared dishes or juices. The informal food establishments where the studies conducted their analyses were markets, backyard selling points, street establishments or convenience food stores.

Conclusion: Identifying pathogens in food products commercialized at different informal retail points has impacts for the safety of the food from personal sustainability viewpoint. Therefore, efforts need to be directed toward better support of the informal food sector in their provision of safe food. Further investigation could trace the exact sources of infection, while public health officials can implement safety programs in cooperation with food vendors.

KEYWORDS

Latin America, informal food establishment, pathogens, foodborne disease, market

1 Introduction

Food systems are vast networks that cover all individuals, actions and entities that engage with food production, supply, and consumption (Ericksen, 2008). Being found at the intersection of multiple domains, such as agriculture, economy and health, they form part of broader societal and institutional dynamics (Nguyen, 2018). The role of a food system is securing people's relations to food, while making sure it is not detrimental to these domains (Nguyen, 2018). Research has shown that in the context of a high income country, the global food supply chain, an essential element of food systems, goes hand in hand with local market structures for maintaining stable and health regulated supply channels that offer a broad portfolio of fresh food commodities (Ihle et al., 2020). However, in most of low- and middle-income countries, micro, small, and medium-sized enterprises (MSMEs) play an essential role in food supply chains and thus in ensuring food and nutrition security (Demmler, 2020; Nordhagen et al., 2021).

The small-scale place-based informal and formal markets provide mainly fresh or minimally processed foods, predominantly sourced from proximate rural areas, for example informal street markets, farmers markets, small and medium scale retail markets, and wholesale markets. These markets are all affected by public policies, but to varying degrees and importantly for crisis response, these markets are vital to local food security and nutrition (Carrara et al., 2022). Stressors like climate change (Mirzabaev et al., 2023), pandemics such as Covid-19 (Béné, 2020) and demographic challenges such as population growth and urbanization (Alarcon et al., 2021) strain the food system by hindering food supply and production, in the detriment of food security (Tendall et al., 2015).

It is important to understand the weaknesses of food markets as an essential part of the food system and highly relevant for the most vulnerable parts of the population (Skinner and Haysom, 2016). Being able to get food is not enough to be food secure, as this food should also not pose a health threat (FAO, 2023). Safe food entails the lack of contaminants that endanger the individuals consuming it (Smith et al., 2017; FAO, 2023). As highlighted by the World Health Organization (WHO), there is a synergistic effect between unsafe food and malnutrition, thus exacerbating the detrimental consequences of unsafe food upon one's health (WHO, 2020). The lack of safe food can lead to the occurrence of more than half a billion instances per year of foodborne illnesses, understood as an individual's health effects stemming from eating an infected food product (Adley and Ryan, 2016, p. 9).

Latin America faces a double burden of malnutrition, meaning that hunger and obesity coexist in the same space (Barquera et al., 2019). Yet, 77 million people are infected with 9,000 deaths each year due to food contamination or food poisoning (Guerrero et al., 2022). Most common foodborne diseases in Latin America were reported to be with Norovirus, Campylobacter, *E. coli* and non-typhoidal Salmonella causing 95% of cases (WHO, 2015). Low-income households often turn to informal food sources for food provision in these regions (Popkin and Reardon, 2018). Studies show that foodborne diseases contribute to the overall burden of diseases, economic loss for consumers as well as governments and food producers (Todd, 2020). However, Latin America lacks funding for food safety research in both formal and informal market settings (Jaffee et al., 2018). Therefore, assessments in Latin America are critical to ascertain food safety levels in the region.

To date, there is no recent overview of other pathogens than *Salmonella* present in food in the Latin American region (Guerrero et al., 2022) and no inspection of pathogens existing in the informal food sector. Consequently, this mini review aims to examine the literature on the presence of foodborne harmful microorganisms in foods from informal food establishments, in the Spanish-speaking countries of Latin America. This study is intended to update the existing literature and contribute to the development of initiatives to improve food safety and hygiene practices of personal sustainability.

2 Methods

The aim of the study is to examine the literature advancements on food safety and hygiene practices from informal food establishments, as a narrative review (Ferrari, 2015). Nonetheless, the article selection was conducted closely to the systematic review model. The key words selection in this research includes local food markets, street vendors, garden retailers and other points of sale that are unregulated. These markets can be specific to a food product (for instance, fish market or seafood market), location-specific (municipal, local), vendor-specific (farmer market, peasant market) and even size-specific (wholesale market). Other food establishments the studies focused on that fall under the informal classification are street or mobile sellers, backyard or farm establishments and convenience grocery stores.

The following databases will be searched: PubMed and Web of Science. The complete search query and strategy are presented in Supplementary material S1. The starting year of the selected articles was January 1, 2018, and the cut-off date of the search was May 31, 2023. Articles in both English and Spanish are analyzed. Articles will be included in the analysis based on the following criteria:

1. Data related to at least one of the Spanish-speaking countries of the Latin American region (Argentina, Bolivia, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Equatorial Guinea, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay, Venezuela).
2. Published between January 1, 2018, and May 31, 2023.
3. Sample is food products intended for human consumption (i.e., studies only analyzing water contamination or animal feed will be excluded).
4. Samples procured from a traditional market or an informal food establishment (i.e., studies with samples collected in supermarkets or retail stores will be excluded).
5. Study examines the existing contamination levels of the collected sample with a pathogen (i.e., if the food samples are first inoculated with infectious agents and then tested, the study is excluded).
   - 5.1 If the focus of the study is on the pathogen *Salmonella*, then the study will be excluded.
6. Data must be original. Review articles of any kind will be excluded.
7. Language: English or Spanish.

3 Results

The main findings of this research can be divided into three themes: the presence or absence of pathogens investigated and their distribution, the food establishments that have been found to host contaminated foods and finally, the food items in which pathogenic agents were examined.

3.1 Presence/absence of pathogens

This section aims to present a general overview of the findings of the articles, reflected as whether a pathogen was present or absent; one pathogen found present or absent in one paper will be quantified as "1" (Figures 1A,B). This method of results presentation was chosen as the articles investigate microbial presence or microbial load in different ways, for instance presence confirmation by PCR as in Lucero-Mejía et al. (2020), or counting colony-forming units per gram as in Tenea and Olmedo (2021).

Some of the agents analyzed are non-pathogenic, for example *Enterobacter amnigenus* (Westerfeld et al., 2009) or *Listeria innocua*, *L. welshimeri*, and *Listeria grayi* (Gilot and Content, 2002). The pathogenicity of other microorganisms is still debated upon, such as in the case of *Moellerella* (Athanasakopoulou et al., 2022) or *Entamoeba moshkovskii* (Heredia et al., 2012). The types of microorganisms as well as established pathogens, found either present

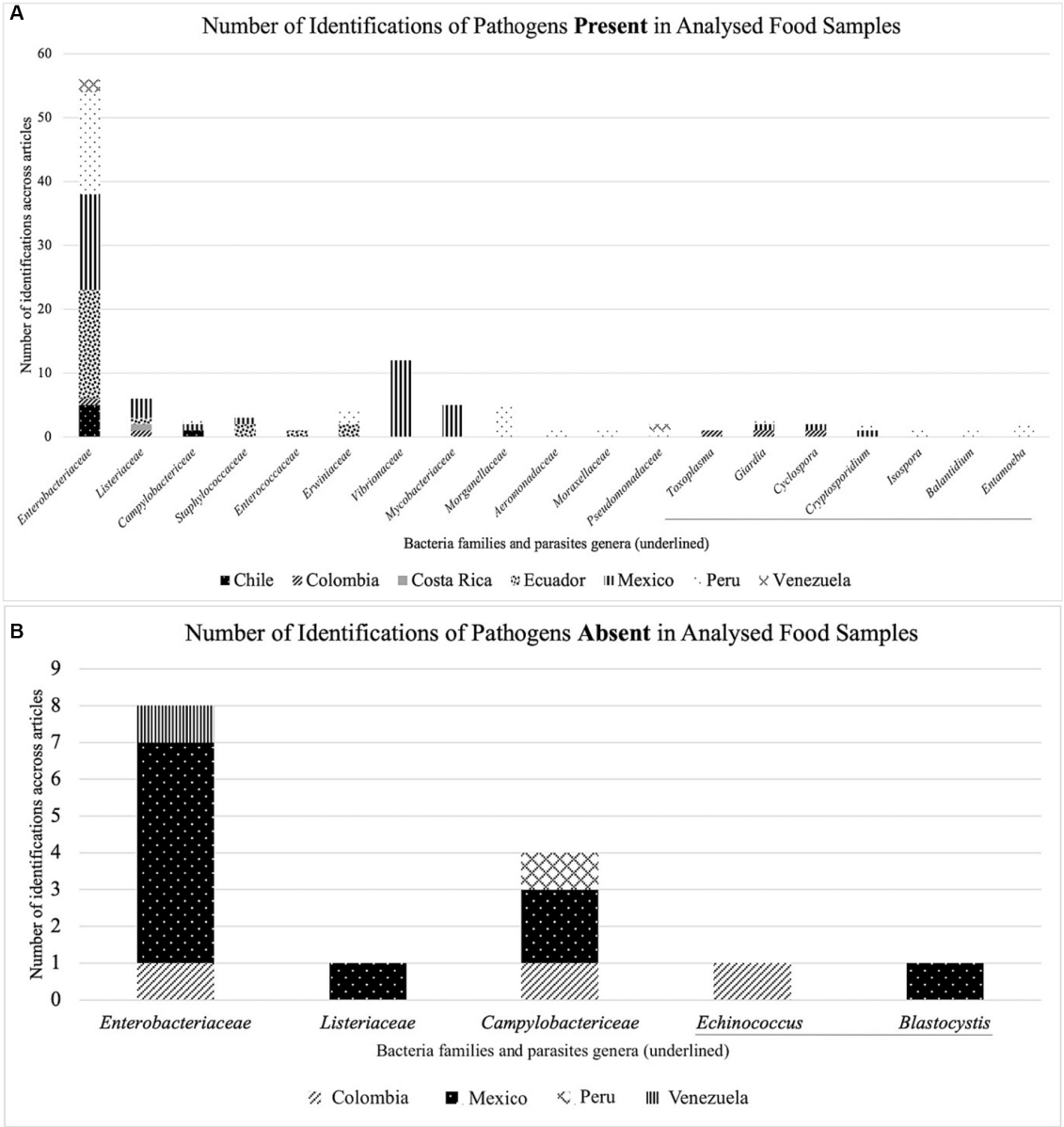

FIGURE 1
Presence or absence of microorganisms according to how many times it was investigated across articles per country. Bacteria were grouped into families and parasites into genera. **(A)** Number of identifications of pathogens *present* in analyzed food samples. **(B)** Number of identifications of pathogens *absent* in analyzed food samples.

or absent in the samples from the selected articles, are further summarized in Supplementary material S2.

There were more pathogens found present in foods than those investigated and found absent (Figure 1). Studies locating the absence of certain pathogens from foods were conducted in Mexico, Colombia, Peru and Venezuela, all being upper-middle-income settings (Figure 1). It is worth noting that most of the organisms reported as absent from foods were bacteria, belonging to the *Escherichia*, *Campylobacter* or *Listeria* genera (Figure 1). The other organism was a parasite of the genus *Blastocystis* (Figure 1).

Regarding the pathogens identified as present in the foods from the local food markets, once again, bacteria has been found much more often than parasites, while no study included the investigation of the presence of a virus. The bacterial range extended over multiple genera: *Escherichia*, *Citrobacter*, *Enterobacter*, *Klebsiella*, *Arcobacter*, *Listeria*, *Staphylococcus*, *Enterococcus*, *Shigella*, *Vibrio*, *Campylobacter*, *Mycolicibacterium*, *Morganella*, *Pantoea*, *Proteus*, *Providencia*, *Raoultella*, *Serratia*, *Aeromonas*, *Acinetobacter* and *Pseudomonas*. The parasites identified belong to the *Giardia*, *Toxoplasma*, *Cyclospora*, *Cryptosporidium*, *Isospora*, *Balantidium* and *Entamoeba* genera. The parasites have only been found in food items from Colombia, Mexico and Peru. Surprisingly, although the sources focusing on Mexico were almost four times more numerous than the ones on Peru, the variation of the investigated pathogens for both countries was higher in comparison to the other locations.

Examining the severity of the pathogens revealed that *Toxoplasma gondii*, *Listeria monocytogenes*, Norovirus and *Campylobacter* (*Salmonella* excluded) were in the top five for their lethality (Gourama, 2020). There were six identifications of *Listeria monocytogenes* in the studies, three of *Campylobacter*, only one of *Toxoplasma gondii* and none of Norovirus. Taken together, they represent less than 10% of the total number of identifications. However, attention needs to be given to them due to their capacity to harm the individual who has ingested them (Bintsis, 2017).

3.2 Food establishments

There were multiple types of informal food retail points where the selected articles sampled their chosen products from (Table 1).

Table 1 shows the type of food establishments that have been analyzed in the studies including types of markets, street vendors, backyard, and convivence groceries. The reason why the convenience store has been included in the final selection and considered an informal establishment is because the article specifically mentions the unregulated means of production of some foodstuffs usually sold in these establishments (Chávez-Martínez et al., 2019).

In this research, the identified food establishments from Table 1 have been looked at as individual, non-communicating entities. This means that the implications of production or provisioning sites were not included in the analysis. While this approach was taken to keep the focus narrow and manageable, it is relevant to mention the associations existing within a broader frame. For instance, the food markets could be supplied by producers that work in improper conditions, therefore contamination could already occur there. Further, the analysis purposefully includes backyard food establishments. These could, potentially, supply either sellers in the market or local stores, thereby creating a communication channel between the products sold. Once again, the exact cause of infection becomes more difficult to establish. Finally, as street and convenience sellers often sell products that are already prepared, the same situation occurs, in which the provenience of the ingredients and their possible pre-infection remain unknown. It might even be the case that these and the food markets have the same supplier of food. While these observations have a conjectural nature, their acknowledgement is useful for the exploration of further research avenues.

3.3 Food items

The foods investigated in the selected studies can be divided into eight distinct categories: fruit, vegetables, dairy products, meat products, fish, seafood, juice and prepared foods (see Supplementary material S2 – Division of Food Items table). The fruit section has the widest array of distinct food elements from all the categories, followed by the vegetables. Fish is most unspecific, as the studies do not identify fish types. There is a surprising specificity regarding the cheese types that have been investigated for pathogenicity. Moreover, cheese is the only type of diary product analyzed by the selected articles. There is also a concentration of studies investigating lettuce and its specific types. Poultry and natural orange juice are other products that have been frequently looked at as well. It is important to observe that this table only highlights the variety of the food products analyzed, since the quantity of each product is highly variable (see Supplementary material S2). For instance, the highest food sample has been 3,300 food products, while the smallest has been 125 g of parts of a mango.

4 Discussion

This research has assembled studies identifying both the presence and the absence of some pathogenic agents in food products from informal food establishments of Latin America. A wide array of bacteria was detected by the studies, followed by a few parasites and no observation of viruses present in the food items. Most of the informal food establishments belong to a type of local food market, the rest being street vendors, backyard farmers or informal stores. These establishments differ in location but are similar in the degree of informality. A varied range of food items have been studied for contamination, with vegetables being the most diverse type, followed by fruit, meat products, already-prepared foods, seafood, dairy products, juice and lastly, fish. The articles were found for each of the years of the range 2018–2023.

Results show that food is sold through a range of food retailers including street mobile vendors, roadside stalls, open/covered markets, shops, kiosks, supermarkets (including mini-marts and hypermarkets). Consumers are mainly supplied by small-scale market vendors, street vendors and neighborhood shops, even

TABLE 1 Categories of food establishments included in the analysis and their specific names within the articles.

Food establishment categories	Specific type
Markets	Fish market, street market, farmer market, retail market, fish store in market, peasant market, local retail market, local market, public market, outdoor market, central municipal market, low-cost open market, food courts within the market, dairy retailers within public markets, retail seafood markets, traditional markets, wholesale markets, poultry market, open-air market
Street vendors	Street vendors, food courts within the streets, mobile vendors, street stalls
Backyard	Backyard, local farm grower, backyard farms
Convenience grocery store	Convenience grocery store

though supermarkets and convenience stores are increasing their market share. The studies that have explored the domestic food supply chain in Latin American context (Guarín, 2013; Moustier et al., 2023) reported on the similarities of these establishments by the type of access to food (market/non-market) and the nature of retailing points (market/street vendors, shops, supermarkets, or e-commerce). The differences of these establishments vary due to their organization in terms of the origin of food, nature of intermediaries, interactions between stakeholders in the supply chain (Guarín, 2013; Moustier et al., 2023).

Vegetables and fruits can serve as a reservoir of certain infectious disease agents such as *Salmonella* spp., pathogenic *E. coli* and *Listeria monocytogenes* which can cause outbreaks of infectious diseases. STEC, *Salmonella* spp., *S. aureus* and *L. monocytogenes* are regarded as high risk although low in infectious dose (Gizaw, 2019; Crotta et al., 2022). Moreover, since the exact source of contamination is not known, the mere detection of pathogens could indicate a contamination of the surroundings as well (Patiño et al., 2020). Therefore, studies that do not provide descriptions of microbial loads, but just indicate the presence of pathogens could be important indicators of food safety as well. An explanation of the presence of pathogens in the food can be the improper hygiene measures taken by the vendors, as has been already found, for instance, by fish stalls, vegetable stores at local markets (Morales-Figueroa et al., 2019; Oliveros et al., 2019; Dominguez-Gonzalez et al., 2022). Nevertheless, there could also be broader explanations such as infection at a previous stage of manufacturing, as shown by García-Frutos et al. (2020). They found, for instance, foodborne pathogens present in the soil and the water used for irrigation (García-Frutos et al., 2020).

The findings relate to personal sustainability when viewed through the experiences of the vendors. Having microbial contaminants found in their produce translates into a detriment for their immediate circumstances- the natural environment on which their products depend on, as well as their personal welfare. Further implications are linked to food safety from a social point of view. Unsafe food increases the risk of dire health consequences for susceptible groups or immuno-suppressed individuals (Uyttendaele et al., 2016). Even more broadly, the topic falls under the concept of One Health, which enforces the interconnectedness between humans, animals, and ecosystems. One justification for this is presented in Kniel et al. (2018), who highlighted how bacteria pertaining to the *Staphylococcus*, *Listeria*, *Pseudomonas* and *Escherichia* genera can be contaminate natural products as well (Kniel et al., 2018). Subsequently, the survival of these bacteria is not only dependent on humans, but it extends to the broader natural environment. Therefore, the recent discoveries of harmful microorganisms in food urges the prioritization of preserving food safety across decision-makers.

This study has limitations as well, a first one being that conceptualizing a broad term such as informal food establishments introduces a certain degree of subjectivity, as the specific parameters of what counts as an informal source cannot always be extracted from the literature straightforwardly. Another limitation concerns the studies included in the analysis. As their reporting style varies, there could be information omitted from the articles. For instance, there could be a lack of specificity regarding the food product investigated (de la Rosa-Hernández et al., 2018; Oliveros et al., 2019). The mini review design of the study inhibits the development of deeper, more focused observations, such as comparisons using the prevalence of a pathogen or outbreaks over time instead of the presence in different, particular times. By only drawing from the existing literature, it is difficult to contour a trend of the whole Latin American region. This is particularly because of the geographical distribution of findings, which shows a bias toward Mexico, as most research comes from there. The causes of the disproportionate literature available can only be speculated.

Positioning the findings of this research within broader literature, several comparisons can be made. First, this study was aimed to be a relevant extension of the existing literature on the topic, such as the systematic review on water and foodborne pathogens in South America (Adell et al., 2018). Further, this study has identified a more extensive set of pathogens compared to previous studies on food safety in food markets (Gizaw, 2019). Nonetheless, it has acknowledged the severity of foodborne pathogens present in foods, thus strengthening the importance of such studies being conducted (Gizaw, 2019). Moreover, finding fruit as the most varied group of pathogen investigations is interesting in parallel to the research conducted by Pires et al. (2012). The study highlights how animal products have been the main sources of contamination by food at the end of the 20th century and beginning of the 21st (Pires et al., 2012). These findings highlight the need for improvement of public policies on the food supply chain of the informal sector and food safety (FAO, 2020).

Additional investigations within informal food establishments could also be conducted in lower-middle-income settings for a better understanding not only of the differences between different income groups, but also to get an improved regional overview. Moreover, proving that a wide variety of pathogens exists in the

food invites advancements in the research on practices or treatments that could reduce the infectious load. These observations would solidify the evidence that further action is needed to defend the small-scale food systems against existing and arising stressors. Understanding what makes the food markets fragile is crucial for building the resilience of food systems and for increasing personal and environmental sustainability.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frsus.2023.1325060/full#supplementary-material

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