Public health risks related to microbial contamination of foods: A literature review

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(Received: 15/06/2022; Accepted: 27/09/2022)

Abstract

Food safety has become an interesting public health issue for the general population globally. Countries might utilize risk analysis frameworks to evaluate the impact as well as manage the risk of foodborne diseases from consuming contaminated foods in the food market. It is essential to obtain general information regarding hazard identification in the risk assessment process. Therefore, this literature review was conducted to identify common public health risks related to microbial contamination of food. Published studies with quantitative, qualitative, or mixed research methods were searched from peer-review journals. The chosen full-text articles were analyzed using an emergent thematic analysis approach to find key concepts and main results and then synthesized each item. The results of the literature review imply that food safety still has a significant impact on the health of consumers. Therefore, strict national risk-based food control systems should be considered to protect the health of the public. Some recommendations need to assure the quality of food through the promulgation of national official requirements, enhance of laboratory testing system, and strengthening inspection of the food market.

Keywords: *public health risks, microbial contamination, food safety, risk identify.*

1. INTRODUCTION

Food safety problems remain a challenge to public health with their impact on people of every age, race, gender, and income for the general population around the world. Foodborne diseases more than 200 diseases ranging from diarrhea to cancer caused by unsafe food containing harmful microbial or chemical substances have a significant impact on human health burden and costs to society [1]. It was estimated that the global burden of foodborne diseases caused by 31 foodborne agents resulted in more than 600 million cases becoming ill after consuming contaminated food, 420,000 deaths, and 33 million disability-adjusted life - years annually in the world [1]. Among these foodborne agents, 28/31 of foodborne hazards were reported as microbiological hazards including diarrhoeal disease agents, invasive infectious disease agents, and helminths [2]. The majority of foodborne disease cases occur in low-income regions of the world [3]. There are various reasons such as the utility of unsafe water for cleaning and processing food, unhygienic food production

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preparation and processes, improper food handling, lack of adequate food storage infrastructure, and inadequate enforced regulatory standards [3].

Beyond improving safe food culture, and the use of prevention or controls of food safety management, the set up risk-based systems were considered in food safety management capacities in low and middle-income countries. Countries might utilize a risk analysis framework to evaluate the impact as well as manage the risk of foodborne diseases from consuming contaminated foods in the food market. It is essential to obtain general information regarding hazard identification which includes biological, chemical, and physical pathogens in food with the potential to cause an adverse health effect in the risk assessment process. Risk assessment includes a review of scientific data and research to assess the risks associated with certain hazards [4], which should be based on the available scientific evidence and undertaken in an independent, objective, and transparent manner [5]. Therefore, this literature review was conducted to identify common public health risks related to microbial contamination of food, specifically in developing countries.

The literature review provides scientific evidence for health authorities in advocating and implement food safety strategies based on risk. Public health providers, policymakers, food safety authorities, and researchers might use analyzed data in this literature review to protect the community from health effects by minimizing the consumption of unsafety food. Given that, the review question is what public health risks related to microbial contamination of food are commonly found.

2. MICROBIAL CONTAMINATION OF RAW FOODS AS A PUBLIC RISK

Table 1 summarize some main results of the microbial contamination of raw foods which have been published in recent years in many countries.

Table 1. *The microbial contamination of raw foods in different countries*

Authors	***Country***	***Sample***	***Main results***
Adeyanju G.T. and Ishola O., 2014 [6]	***Nigeria***	***Frozen poultry meat (152 samples)***	This study evaluated the prevalence of *Salmonella* spp and *Escherichia coli* from frozen poultry meat in retail stores and processing plants. 33 and 43.4% of samples obtained from retail stores indicated the positive prevalence of *Salmonella* spp and *Escherichia coli* respectively. Whist samples at the processing plant reported 22.6% of them positive for *Salmonella* and 5.7% for *Escherichia coli.* This study also indicated that poultry meat collected from the retail market being unfit for human consumption should cook properly otherwise it will raise health-risk of human.
Banerjee M. and Sarkar P.K., 2003 [7]	***India***	***Kinds of spices (154 samples)***	This study assessed the microbial condition of 27 kinds of retail spices in India. According to International Commission on Microbiological Specifications for Foods, the total aerobic mesophilic bacteria $>10^6$ colony-forming units (CFU) g^{-1} as the unacceptable level, reported a high level of contamination with

Authors	*Country*	*Sample*	*Main results*
			51% of samples being over this maximum limit. *Bacillus cereus, Clostridium perfringens, Staphylococcus aureus,* and members of Enterobacteriaceae isolates were obtained at a prevalence of 85, 59, 11, and 85% respectively. Coliforms and faecal coliforms were found in 33 and 15% respectively of the kinds, while *Salmonella* and *Shigella* were found only in 2.6% of the samples. The non-packaged spices had a higher number of molds, *Bacillus cereus,* and Enterobacteriaceae than the packed ones.
Berthold-Pluta A. et al., 2019 [8]	***Poland***	***Marketed Food products (585 samples)***	This study assessed the prevalence of *Bacillus cereus* in various food products (herbs and spices, breakfast cereals, pasta, rice, infant formulas, pasteurized milk, fresh acid, and acid/rennet cheeses, mold cheeses, and ripening rennet cheeses) during 2007 - 2017. *Bacillus cereus* was found in 38.8% of the analyzed samples, reaching levels from 0.3 to 3.8 log CFU g^{-1} or mL^{-1}. Of the commercial selected samples, the high contamination of *Bacillus cereus* was reported in herbs and spices (63.3%), mold cheeses (52.5%), ripening rennet cheeses (43.4%), and pasta (37%), the lowest contamination prevalence in fresh acid cheeses (8.6%). It should be considered that the relatively high percentage (25%) of psychrotrophic among the isolated strains. By finding favorable conditions for growth in food products, these strains can make the possible risk of foodborne infections, resulting in posing risk for the health consumer.
Cárdenas C. et al., 2013 [9]	***Mexico***	***Tomatoes and peppers (160 samples)***	The study evaluated the microbiological contamination of tomatoes and peppers from markets and supermarkets in the metropolitan area. The results indicated that the levels of indicator organisms were relatively high in peppers (average 4.4 to 4.7 log CFU/g for total mesophilic, 3.25 to 3.73 log CFU/g for total coliforms, and 1.69 log CFU/g for fecal coliforms). The frequency of positive samples for *Salmonella* in tomatoes and peppers is low, only one tomato and one pepper reported positive for *Salmonella*.
Heredia N. et al., 2001 [10]	***Mexico***	***Meat (88 samples)***	Over 75% of the samples contained 10^5 total mesophilic microorganisms per g, and over 40% had 10^6 total coliforms per g. Fecal coliforms were present in most samples. *Staphylococcus aureus* was detected in 2.3% of the samples, *Salmonella* spp. in 11.4%, *Listeria* spp. in 62%, and *L. monocytogenes* in 16%. *Escherichia coli* was detected in 76% of samples, but none was serotype O157:H7. *Shigella* spp. was not found in any sample. *Fusarium* spp. and *Mucor* spp. were detected in 3.4% of the samples, and low levels of yeast in 93%.
Safaei H.G et al., 2011 [11]	Iran	Eggs (100 samples)	This study analyzed the prevalence of bacteria isolated from table eggs in retail markets. There was no contamination by *Salmonella* spp., *Listeria monocytogenes*, and *Campylobacter*

Authors	*Country*	*Sample*	*Main results*
			jejuni in all 100 eggs. However, 19% of samples were contaminated by *Escherichia coli*, 4% samples by *Proteus* spp. and 1% by *Klebsiella* spp. The prevalence of bacterial contamination of egg was 24% and average colony count of Coliform bacteria was 20 CFU/g and *E. coli* was 12/6 CFU/g.
Vindigni S.M. et al., 2007 [12]	***Thailand***	***Retail food (200 samples)***	This study examined foodborne microbial quality of retail food samples including four categories of raw chicken, beef, pork, and chicken eggs were purchased from fresh markets and supermarkets. Results showed that 61% of analyzed samples were positive for at least one *Salmonella* spp. Serogroup, several yielding multiple serotypes. Of these 61% samples isolates, the most common serotype was *Salmonella Anatum*, followed by *Salmonella Corvallis* and *Salmonella Derby*. *Campylobacter* spp. and *Arcobacter* spp. were prevalent primarily in chicken samples and *Enterococcus* spp. were isolated from all sample types. *Campylobacter* spp. were found in 31 (15.5%) of 200 samples. *Arcobacter* spp. were isolated from 42 (21%) samples; fresh market chicken had significantly higher *A. butzleri* contamination than supermarket chicken. The presence of *Enterococcus* spp., an indication of fecal contamination, was detected in 188 (94%) samples, including 100% of the beef and pork sources.
Vu T.H.A, et al., 2021 [13]	***Vietnam***	***228 raw meat samples and 301 raw seafood samples***	This study evaluated the Salmonella contamination of raw meat and seafood samples from traditional markets. The results showed that the prevalence of Salmonella spp. in meat was 70.61% (161/228). Among the contaminated meat samples, pork was infected with a ratio of 90.8 % (69/76) while the contamination ratios in beef and chicken were 43.4% (33/76) and 77.6% (59/76), respectively. *Salmonella* contamination was detected in fish (40.20%), shrimp (7.46%) and squid (17.14%).

Studies on the microbiology of raw food products have demonstrated profiles of microorganisms including total aerobic mesophilic bacteria, *Escherichia coli*, *Salmonella* spp, *Bacillus cereus*, *Clostridium perfringens*, *Staphylococcus aureus*, *Campylobacter* spp., *Arcobacter* spp, *coliforms*, *fecal coliforms*. The prevalence of different bacterial species in raw food products depend on the product from 3 to 94%. The majority of samples also identified the presence of pathogens causes a risk of infection for consumers, for example *Salmonella* spp., *Bacillus cereus*, *Clostridium perfringens*, *Staphylococcus aureus*, *Campylobacter* spp. and *Arcobacter* spp.

Specifically, most of analyzed samples in this review found *Salmonella* spp. in various foods including poultry meat, seafood, tomatoes, peppers, spices and eggs from 2.6% to 70%. Of these samples, the high proportion of Salmonella spp isolation reported in meat products such as chicken [6, 12-13], turkey [6], beef [12-13], pork [12-13]. Chicken and

chicken products are widely known as poultry meat with high prevalence of *Salmonella* contamination among them from retail markets [14-16]. Nevertheless, two surveys in this review in Thailand and Vietnam found that pork meat had siginificantly higher *Salmonella* spp contamination than other meat kinds [12-13]. The difference prevalence of *Salmonella* spp contamination between pork meat and other ones was about 50% for beef and about 13% for chicken in Vietnam study, however this difference is lower in Thailand study with only 8% vs 17% difference respectively. The inconsistent findings could be partly due to different types of analyzed samples such as whole ones or steak ones, fresh or frozen. Limited information is available related to *Salmonella* spp contamination of meats such as duck, goose, pigeon. This review also found that *Salmonella* spp. were isolated significantly more often from chicken, beef, and pork samples purchased in fresh markets than from the same meats purchased from supermarkets. The most common serotype of *Salmonella* spp. was *Salmonella Anatum*, followed by *Salmonella Corvallis* and *Salmonella Derby*.

Bacillus cereus is often associated with food poisoning caused by consumption of cereal products, especially rice [17-18]. Nevertherless, in this review, the high contamination of *Bacillus cereus* bacteria reported in spices, herbs, mold cheeses, ripening rennet cheeses [7- 8]. Among spices, the presence of *Bacillus cereus* was high in most of kinds of spices contained aerobic mesophilic bacteria, and highest in the black cumin [7]. The non-packaged spices had a higher number of foodborne pathogen than that of packed ones [7]. *Bacillus cereus* food borne illnesses occur due to survival of the bacterial spores when food is improperly cooked, given that, though cooking these products can prevent *Bacillus cereus* food borne illnesses. The Poland study considered that the relatively high percentage (25%) of psychrotrophs among the isolated strains. As finding favorable conditions for growth in food products, these strains can make possible risk of foodborne infections, results in posing risk for health consumer.

Campylobacter is present in chicken samples [12] , no found in eggs [11]. Previous studies have similar figure wih a high C*ampylobacter* contamination in chicken products in developed countries, vary from 91% in Northern Ireland [19], 70% in Washington [16], 49% in the United States [20], 41% in Germany [21]. Apart from chicken, emerging C*ampylobacter* also isolated from other containmated-meat products such as beef [20], duck [19]. This review only examines occurrence of microorganisms of public health in developing countries, given that, one Thailand study found a presence of *Campylobacter* in retail food samples. It partly because of lacking specialized cultivation techniques to culture *Campylobacter* organism, advancement of molecular techniques to identify *Campylobacter* spp in developing countries [22].

Echerichia coli counts are used more generally as an indicator of hygienic quality rather than of faecal contamination and therefore say more about general microbiological quality than possible health risks posed by the product. However, the high prevalence of *Echerichia coli* detected in frozen meat samples, for example, 76% of meat samples in

Mexico [10], 43.4% of samples obtained from retail strores in Nigeria [6] is quite alarming. These products can get contaminated with *Echerichia coli* along processing line due to equipments, storage, transporting facilities.

Most of the studies in this review included samples from one or a few regions from the whole territory of a certain country. Given the various data, it is expected that the prevalence and contamination levels will be different among the various regions of a country. As such, there is a lack of comprehensive data on microbial contamination in the whole region. This review identified microbial contamination of raw food is commonly reported in many studies in various nations. Some retail meats were also contaminated with more than one food-borne pathogen. The presence of bacteria causing food poisoning in retail meats remains a significant public health concern. Raw retail meats may be vehicles for transmitting food-borne diseases. Less effective food safety strategies in every stage of the food supply chain might result in microbial contamination of raw foods.

Previous studies revealed that improper food handling practices, poor production processes, bad agricultural practices, poor transportation systems, poor sanitation, and less quality preserving practice are able to risk factors to lead to microbial contamination of foods [23-24]. This review study provided insights into the public health importance of sources of bacterial infection and reiterated that awareness of the risks associated with marketed food handling, preparation, and consumption is essential for informed control over risk exposure in individuals.

Food safety strategies in every stage of the food supply chain are essential to minimize this contamination. Some suggestions would be recommended at every level. On-farm practice and processing, retail level, good manufacturing practices, good agricultural practices, and hazard analysis critical control point systems for microbial control in poultry production. At home level, consumption of undercooked meat products and cross-contamination during food handling and preparation must be avoided to ensure food safety at home.

3. MICROBIAL CONTAMINANT OF READY-TO EAT FOODS AS A PUBLIC RISK

The results of the microbial contamination of ready-to-eat foods in recent years in different countries are summarized in Table 2.

Table 2. *The microbial contamination of ready-to-eat foods in different countries*

Authors	***Country/city***	***Sample***	***Main results***
Abakari G, et al., 2018 [25]	***Tamale, Ghana***	***Ready-to eat salads (30 samples)***	The study assessed the microbial quality of pre-cut ready to eat vegetable salads sold by street food vendors. The prevalence of *Escherichia coli* group in vegetable salad samples was high (96.7%) with levels ranging from 0 to 7.56 log10 CFU/g, more than that of *Bacillus cereus* (93.3%) with counts ranging from

Authors	*Country/city*	*Sample*	*Main results*
			0 to 7.44 log10 CFU/g, *Salmonella* spp. (ranged from 0 to 4.54 log10 CFU/g) and *Shigella* spp. (0 to 5.54 log10 CFU/g) were present in 73.3% and 76.7% of salads, respectively. The mean bacteria count of various bacteria from the salad samples: *Escherichia coli* with a mean of 7.12 ± 6.96 log10 CFU/g, *Bacillus cereus* with a mean of 7.22 ± 7.11 log10 CFU /g, *Shigella* spp. with a mean of 5.04 ± 6.30 log10 CFU /g and *Salmonella* spp. with a mean of 3.90 ± 4.05 log10 CFU /g.
Cho J, et al., 2011 [26]	***Korea***	***Ready-to eat foods (634 samples)***	This study examined the contamination levels of ready - to - eat store foods including marine products, meat products, bread products, rice products. Results of study indicated that 12.3% and 12.6% of the samples had *Staphylococcus aureus* and *Bacillus cereus* at levels up to 1 log CFU/g. 12% of the ready - to - eat samples exceeded 10^6/g of the aerobic plate counts, and levels occurred in a relatively wide range, of 1.0-7.9 log CFU/g. Only 2 samples were positive for *E. coli* and *Listeria monocytogenes*.
Chon JW, et al., 2015 [27]	***South Korea***	***Ready-to-eat vegetables (145 samples)***	Assessed the quantitative prevalence and toxin gene profiles of *Bacillus cereus* strains isolated from ready-to-eat vegetables. A high contamination of *Bacillus cereus* was found in 48% of tail vegetable salad and sprout. The contamination level of *Bacillus cereus* reported ranged from 10^2 to 10^5 CFU/g; and this contamination found to be higher in sprout than in vegetable salad. However, according to the South Korean food standard, only 10.3% of samples exceeded the level of *Bacillus cereus* with unacceptable level for ready-to-eat vegetables being 10^3 CFU/g. The *Bacillus cereus* isolates harbored at least one enterotoxin gene. The detection rates of nheABC, hblCDA, cytK, and entFM enterotoxin genes among all isolates were 97.1, 100, 81.4%, and 98.6%, respectively.
Oliveira M.A, et al., 2011 [28]	***Brazil***	***ready-to-eat minimally processed vegetables (162 samples)***	This study examined indicator microorganisms of minimally processed leafy vegetables in the original package from supermarket chains. Results showed psychrotrophic aerobic bacterial populations > 5 log CFU/g were found in 96.7% of the samples, while total coliforms and thermotolerant coliforms were detected respectively in 132 (81.5%) and 107 (66%) of vegetables analyzed. *Escherichia coli* was detected in 53.1%, *Listeria spp.* detected in 3.7% and *Salmonella spp*. presented in 1.2% of the analyzed samples.

Authors	*Country/city*	*Sample*	*Main results*
Kwiri R, et al., 2014 [29]	***Zimbabwe***	***cooked vended foods (200 samples)***	This study investigated the microbiological safety of mostly vended ready to eat foodstuffs (comprising chicken and beef stew, egg rolls, doughnuts and boiled mealie cobs) in an urban informal market. The results showed that total aerobic plate count ranged from 11 - 172 × 10^3 CFU/g, while coliform count ranged from 8 - 85 × 10^2 CFU/g. From cooked vended foods, nearly 85.5 and 53% of the samples were highly detected *Staphylococcus aureus* and *Escherichia coli* respectively, while no *Salmonella* spp. was detected in any of the foodstuffs. The mean bacteria count of *Staphylococcus aureus* and *Escherichia coli* were expressed respectively as 3 - 62 × 10^2 and 6 - 49 × 10^1 CFU/g. Time of selecting samples may play a role in food contamination, with afternoon samples had higher microbial load than morning samples ($p < 0.05$).
Moloi M, et al., 2021 [30]	***South Africa***	***Cooked beef and preparation surfaces***	This study evaluated the microbial levels of street foods and preparation surfaces in vending sites close to taxi ranks where prepared meals to consumers. The bacteria count in the surface swabs obtained ranges from 1.1 × 10^4 - 1.1 × 10^6 CFU/m^2. The high presence of microbial counts observed on meat samples and different levels in various urban areas range from 48 × 10^4 - 50 × 10^5 CFU/g. These results were higher when compared to the regulations governing microbiological standards for foodstuffs and related matters in South Africa (the total colony count of organisms no exceed 10^4 per gram). After assessing, the microbial levels, *Staphylococcus aureus*, *Escherichia coli, Candida guilliermondii, Corynebacterium jeikeium, Psychrobacter phenylpyruvicus,* and *Peptostreptococcus tetradius* were identified. These identified foodborne pathogens could pose a public health problem because of the consumption of such contaminated foodstuff.
Talukder N.I.T, et al., 2021 [31]	***Bangladesh***	***street iftar food items (74 samples)***	This study assessed the common food pathogens in street iftar food items collected from a street along with the antibiogram profile of the bacterial isolates. The results indicated that an average 6 log10 CFU/g of total viable bacteria, exceeded the standard acceptable microbiological limit (< 5 log10 CFU/g or mL). Fungi, *Pseudomonas* spp. and *Staphylococcus* spp. were found in the majority of the samples irrespective of the categories. Few samples were contaminated with *Escherichia coli* and *Klebsiella* spp. Additionally, the study also revealed the alarming

Authors	*Country/city*	*Sample*	*Main results*
			presence of multidrug-resistant bacteria in the street iftar items.
Phuc N.Đ and Oanh N.T.H, 2018 [32]	***Vietnam***	***ready-to-eat meat (200 samples)***	This study assessed the rate and level of *Staphylococcus aureus* contamination isolated from ready-to-eat meat including pate, pork roll, barbecue pork, roasted pork, and roasted duck. Results indicated that 38% of samples were positive for *Staphylococcus aureus.* Of these positive samples, 46% exceeded the allowable limit (10^2 CFU/g). The rate of *Staphylococcus aureus* contamination isolated in pork rolls (50%) was reported highest compared to other meat groups, and roasted duck was reported lowest (25%).
Than T.T.N, et al., 2021 [33]	***Vietnam***	***processed meat products (90 samples)***	A survey on microbiological contamination of processed meat products was conducted on samples collected from some markets. The results 90 samples of three groups of fermented meat, packaged and non-packaged meat indicated that 100% of the samples were contaminated with aerobic microorganisms, Coliforms and Escherichia coli, in which 100% of the samples of Coliforms and E. coli did not meet the quality norms set by the Ministry of Health. The total aerobic microorganisms, Coliforms and E. coli ranged from 2.7×10^3 to 2.8×10^9 CFU/g, 1.1×10^4 to 1.5×10^8 MPN/g and 1.1×10^2 to 9.2×10^5 MPN/g, respectively. No presence of *Clostridium perfringens* or *Staphylococcus aureus* was detected in the examined samples.
Simforian E, et al.,2015 [34]	***Tanzania***	***Fruit juice (90 samples)***	This study aimed to assess microbiological quality and establish the risk factors for contamination of raw fruit juices vended in Dar es Salaam city, Tanzania. The results showed that the total plate counts (TPC) ranged between 2.32 and 8.54 (Log CFU/mL). About 72.2% of juice samples had TPC above Codex recommended maximum levels (3.7 - 4.7 Log CFU/mL). The prevalence of Escherichia coli in the juices was 80% with a range between 0.0 and 5.0 (Log MPN/mL) suggesting of direct faecal contamination or contamination from the environment. All samples were negative for Salmonella species.

Almost indicator microorganisms of ready-to eat foods have found in this review. Different pathogenic microorganisms can possible to pose a food-poisoning risk identified such as *Bacillus cereus, Staphylococcus aureus, Listeria spp., Salmonella spp., Shigella spp., Escherichia coli, Klebsiella spp, Candida guilliermondii, Corynebacterium jeikeium, Psychrobacter phenylpyruvicus* and *Peptostreptococcus tetradius*. Microbial contamination of foods especially street-food causes millions of morbidity and thousands of mortality due

to foodborne diseases [1]. The street vended foods with bacteria exposed the potential hazard of street vended foods, imposed the need of implementing adequate measures to guarantee food safety.

This review shows that *Escherichia coli, Bacillus cereus, Shigella spp., Salmonella spp., Listeria spp.* were commonly detected in ready - to - eat foods from vegetables and fruit than ones from meat. The prevalence of ready-to-eat vegetables and fruits being positive for *Escherichia coli* reported higher than 50%. The highest prevalence of *Escherichia coli* group in vegetable salad samples found in Ghana (96.7%) [25], and lowest in Brazil (53%) [28]. A study in Ghana assessed the microbial quality of pre-cut ready to eat vegetable salads sold by street food vendors showed the prevalence of *Escherichia coli* group in vegetable salad samples being 96.7% with mean bacteria count of *Escherichia coli* of 7.12 ± 6.96 log10 CFU/g [25]. Reported risk factors for bacterial contamination in vegetables such as salad vegetables often overlap and include the production source of the raw vegetables; handling processes and preparations before they are served to consumers; improper hygienic practices by food vendors; food safety behavior of consumers before ingesting. Bacteria presence and levels in ready-to-eat vegetable salad mixtures may be attributed by less hygiene practices of food vendors as well as source of cultivation such as untreated waste water from storm drains used in irrigating the vegetables [25, 28, 34, 35]. For example, one study in Tanzania in 2015 conducted to determine the microbial status and associated practices of the vendors in fruit juice showed that 78.9% of preparation and vending premises were unhygienic and encouraged contamination of the juices [34].

The presence of *Staphylococcus aureus* detected in ready-to eat meat products higher than ready - to - eat foods from vegetables and fruit. The rate of *Staphylococcus aureus* contamination in ready-to eat meat products reported about 12.3% in Korean [26], 85% in Zimbabwe [29], 46% in Vietnam [32]. However, one study in Vietnam reported no presence of *Staphylococcus aureus* in the examined processed meat products samples [33]. The study in Zimbabwe investigated the microbiological safety of mostly vended ready to eat foodstuffs (comprising chicken and beef stew, egg rolls, doughnuts and boiled mealie cobs) in an urban informal market showed that nearly 85.5% of the samples detected *Staphylococcus aureus* with mean bacteria count of *Staphylococcus aureus* as 3 - 62 × 10^2 CFU/g [29]. The Zimbabwe study also pointed out that time of selecting samples may play a role in food contamination, with afternoon samples had higher microbial load than morning samples. Specific, in the morning microbial loads were up to 40 CFU/g *Staphylococcus aureus* (beef stew), while afternoon samples had up to 57 CFU/g *Staphylococcus aureus* (egg rolls) [29]. The high contamination of ready-to-eat foodstuff on the affternoon may link the high temperature values which were favourable for microbiology growth.

Although the detection prevalence of *Listeria* monocytogenes, *Klebsiella spp* were very low in thí review, establishment new microbiological standard and specification on the

ready-to eat products is crucial because these pathogens can cause serious food-borne disease.

Presence of certain microbial pathogen such as *Bacillus cereus, Shigella spp., Salmonella spp., Listeria spp., Klebsiella spp* indicate that the food is hazardous and should not be used for human consumption. On the other hand, presence of non pathogenic microbes in food does not necessitate unfitness for consumption, but may indicate the hygiene status of the preparation and processing. More accurate understanding of the drivers behind continued apparent sporadic foodborne diseases caused by microbial has implications for public health intervention, control, and targeted treatment.

4. CONCLUSION

Microbial contamination of food products has been mentioned as a major public health risk associated with food safety in eighteen full-text articles in this review. Evaluation of the microbiological quality of various food products categorized two groups: foodstuff related to microbial contamination of raw foods and ready-to-eat foods. This review indicated that bacterial contamination in foodstuff is commonly found in various kinds of food in many studies, and the high prevalence of bacteria isolated in ready-to-eat foods.

In the field of food safety, the literature review is an approachable effective tool to solve a broad range of prevalence of microorganisms interest. Results from the literature review can provide data for risk assessment. The literature review identified public health risks related to common food safety with specifications on microbial contamination of foods in the food market. The results imply that food safety still has a significant impact on the health of consumers. Therefore, strict national risk-based food control systems should be considered to protect the health of the public. It is considered for the promulgation of national official requirements, enhancement of laboratory testing system, and strengthening inspection of the food market. Moreover, food producers and food retail sectors have significant responsibility for complying with the national food safety guideline. An effective and synchronized national food control system would play importance of protecting health community.

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Nguy cơ sức khỏe cộng đồng liên quan ô nhiễm vi sinh vật trong thực phẩm: Tổng quan tài liệu

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Tóm tắt

An toàn thực phẩm đã trở thành một vấn đề sức khỏe cộng đồng đáng quan tâm đối với người dân nói chung trên toàn thế giới. Các quốc gia có thể sử dụng khung phân tích rủi ro để đánh giá tác động cũng như quản lý nguy cơ mắc các bệnh truyền qua thực phẩm do tiêu thụ thực phẩm bị ô nhiễm trên thị trường thực phẩm. Điều cần thiết là phải có được thông tin chung liên quan đến việc xác định mối nguy trong quá trình đánh giá rủi ro. Do đó, tổng quan tài liệu này được thực hiện để xác định các nguy cơ sức khỏe cộng đồng phổ biến liên quan đến ô nhiễm vi sinh vật trong thực phẩm. Các nghiên cứu đã công bố với phương pháp nghiên cứu định lượng, định tính hoặc hỗn hợp được tìm kiếm từ các tạp chí bình duyệt. Các bài báo toàn văn được phân tích bằng cách sử dụng phương pháp phân tích theo chủ đề nổi bật để tìm ra các khái niệm chính và kết quả chính; sau đó được thảo luận tổng hợp từng mục. Kết quả từ bài tổng quan tài liệu này cho thấy an toàn thực phẩm vẫn còn ảnh hưởng đáng kể đến sức khỏe của người tiêu dùng. Do đó, các hệ thống kiểm soát thực phẩm quốc gia nghiêm ngặt dựa trên rủi ro cần được xem xét để bảo vệ sức khỏe của cộng đồng. Một số khuyến nghị, cần đảm bảo chất lượng thực phẩm thông qua việc ban hành các văn bản quy phạm pháp luật quốc gia, tăng cường hệ thống phòng kiểm nghiệm, tăng cường kiểm tra thị trường thực phẩm.

Từ khóa: *sức khỏe cộng đồng, ô nhiễm vi sinh vật, an toàn thực phẩm, xác định rủi ro.*