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Current context of food safety in Vietnam: a glance at food of animal origin

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REVIEW ARTICLE

Abstract

Vietnam experiences a wet, tropical climate that encourages vector- and water-borne diseases. Official statistics of the Vietnam Food Administration point to microorganisms as the major cause of food poisoning outbreaks. This paper reviews the current situation of food safety in Vietnam focusing on microbial hazards of food from animal origin. Retail meat sample analyses (pork and chicken meat) showed high prevalence of *Salmonella* spp. in different regions including the main cities Hanoi and Ho Chi Minh. High levels of antimicrobial resistance are reported for pathogens in food-producing animals and raw foods sold on the market. Multidrug resistant *Salmonella* spp. to up to 12 different antibiotics has been found. *Escherichia coli* has also been reported as a significant reservoir of resistance and virulence genes in chicken and pork. Furthermore, resistance to chloramphenicol still occurs at high frequency in pig isolates and in aquaculture, although this drug has been banned from use in food-producing animals for a decade, suggesting a misuse of the antibiotic or a cross-resistance provided by the use of other antibiotics. From this point of view, strengthening the legal framework of the food safety and quality system in Vietnam is required to improve the surveillance of pathogens in food and to mitigate the antibiotic resistance. The integration of Vietnam into the World Trade Organisation in 2007 has fostered the development of food safety policy in the country. Based on the new food law issued in 2010, a national strategy for food safety was approved for the period 2011-2020.

Keywords: food safety, Vietnam, pathogens, antimicrobial resistance

1. Introduction

Foodborne diseases and antibiotic resistance of bacteria are a growing public health concern over the world. Occurrence of food poisoning outbreaks can adversely impact national economies and livelihoods leading to high cost of addressing the effects of the threat on public health and commerce. Furthermore, resistant strains of major foodborne pathogens (*Salmonella* spp., *Campylobacter* spp., *Escherichia coli*) are linked to the use of antibiotics in food-producing animals. In fact, the food chain promotes the dissemination of resistant bacteria or the genes they may carry on mobile genetic elements (plasmids, transposons and integrons) between animal, environment and human. In Vietnam, antibiotics are widely used in animal husbandry for several purposes including therapeutics, prophylaxis and growth promotion. The Directive 07/2002/TTg (Ministry of Justice, 2002) from the government of Vietnam provides a list of banned chemical, antibiotic and other veterinary drugs in livestock and aquaculture production. The contamination of the environment with bacterial pathogens resistant to antimicrobial agents is a real threat not only as a source of disease but also as a source from which resistance genes can easily spread to other pathogens of diverse origins which has severe implications on both animal and human health. The World Health Organisation has therefore targeted antibiotic resistance as one of the major emerging public health concerns that needs a global strategy for its containment.

For the period 2000-2010, in Vietnam, the annual average incidence of outbreaks were 195 cases (144-247) affecting 5,509 persons (7,828-3,584) and leading to 53 deaths/year (71-35) (Lâm *et al.*, 2011). The causative agents of food poisoning were identified as bacteria (30.7%), natural toxins (25.2%) or chemicals (10.4%). In 2010, the origins of outbreaks were mainly family meals (60.6%), collective meals (13.1%), parties (9.1%) and food vendors (5.7%).

The recent integration of Vietnam into the World Trade Organisation (WTO) in 2007 has fostered the food safety policy development in the country. Based on the new food law issued on the 17th June 2010 (law no. 55/2010/QH12; National Assembly of the Socialist Republic of Vietnam, 2010), a national strategy for food safety has been approved by the prime minister (20/QD-TTg; Ministry of Justice, 2012) for the period 2011-2020, with a vision toward 2030, with five objectives: (1) improve knowledge and practice on food safety for different groups; (2) strengthen the management system of food safety; (3) markedly improve safety conditions of food processing facilities; (4) markedly improve food safety in food trading establishments; and (5) effectively prevent acute food poisoning. By 2030, food safety is aimed to be controlled in a proactive, effective approach based on supply chain management: (1) achieving the training of major stakeholders involved in food processing, food business, and consumers towards food safety; (2) performing good practice in food safety; and (3) having the majority of food processing, business facilities and their operators meeting food safety requirements.

This paper reviews the current situation of food safety in Vietnam focusing on food of animal origin. Data were gathered from literature published over the previous five years and from national reports provided by national institutions involved in food quality management (Vietnam Food Administration, Ministry of Health; Ministry of Industry and Trade, Ministry of Agricultural and Rural Development).

2. Aquaculture products

Aquaculture is one of the fastest growing production sectors in the world. It accounts for nearly half (45%) of the world's food fish and is expected to reach 50% in 2015. Asia represents 90% of world aquaculture production. However, the intensive use of antibiotics in aquaculture has been associated with the increase of bacterial resistance in the exposed microbial environment (water, sediment, fish bacteria). In Vietnam, aquaculture production increased from 1,202,500 tonnes in 2004 to 2,671,800 tonnes in 2010. Shrimps (*Penaeus monodon*) and catfish (*Pangasianodon hypophthalmus* and *Pangasius bocourti*) are the main cultured species. In term of value, shrimps are the main seafood exported from Vietnam. As in many other countries in Asia, most farms in Vietnam are small-scale. However, some bigger farms are emerging and these are primarily associated with big processors who are striving to establish vertically integrated systems (Phan *et al.*, 2009). Antibiotics are used to large extent for health management in aquaculture. A report from Vietnam recorded 138 antibiotic products being used in aquaculture (Van, 2005). Many of these preparations contained similar agents, for example, 77 contained quinolones, and so the total range of agents is lower. The analysis of the susceptibility of bacteria isolated from the water and sediments of different fish farms (catfish, tilapia, common carp, snakeskin gourami and giant gourami) in five provinces on the Mekong river (Vietnam) showed that 90% of the isolates were resistant to tetracycline, 76% to ampicillin, 100% to chloramphenicol, 65% to nitrofurantoin and 89% to trimethoprim-sulfamethoxazol (Phuong *et al.*, 2005). Another study showed that the average rates of resistant bacteria isolated from catfish in the Mekong delta were 69.6% ampicillin, 60.9% for each of oxytetracycline and trimethoprim-sulphamethoxazole, 51.6% nalidixic acid, 37.5% nitrofurantoin and 32.6% chloramphenicol (Sarter *et al.*, 2007). Multiple antibiotic resistance was frequent in the selected farms ranging from 66 to 90% of isolates. Analysing the biodiversity of 557 mesophilic heterotrophic chloramphenicol-resistant isolates that were collected from pond water, sediment and farmed species in fish and shrimp farms in Malaysia, Thailand and Vietnam, Huys *et al.* (2007) suggested that *E. coli* could be a potential indicator of chloramphenicol (a banned antibiotic) resistance in Southeast Asian aquacultural environments. In that study, chloramphenicol-resistant *E. coli* were predominant in Vietnam with 58.3% of the isolates (Malaysia: 25%; Thailand: 31.8%) (Huys *et al.*, 2007).

In aquaculture, it is recognised that rearing water is the main source for entry of pathogens into the host. Vibrioses for instance are a major constraint for intensive production of shrimps as the *Vibrionaceae* family, which represents the major pathogenic bacteria for penaeid crustacean larvae, is autochthonous to marine environments. The culture pond serves then as a constant source of exposure for the shrimp and massive mortalities of shrimp larvae associated with luminescent strains of *Vibrio* spp. have been reported in hatcheries from several countries. On the other hand, it has been reported that 30% of farms of catfish in the Mekong Delta sell dead fish to other fish farmers which represents a significant pathway for disease and resistant bacteria transfer (Phan *et al.*, 2009). Therefore, to make the aquaculture industry more sustainable, new strategies to control infections, hygiene and water quality are urgently needed. In Vietnam, like in many other countries, the sector is able to improve husbandry practices through the adoption of better management practices. To reduce the occurrence of antibiotic resistance of pathogens, alternatives for health management have been successfully tested, such as vaccination of fish, plant extracts (Harikrishnan *et al.*, 2011; Randrianarivelo *et al.*, 2010; Sarter *et al.*, 2011), immunostimulants (Defoirdt *et al.*, 2007; Sakai, 1999) or probiotics (Kesarcodi-Watson *et al.*, 2008). Up to 45% of shrimp farms, shrimp hatcheries, marine fish hatcheries and fresh water cage farms in Vietnam are using probiotics (Van, 2005). Routine methods to detect antibiotic residues also need to be developed to provide an accurate control of fish and shrimps supplied to and received from farmers. In this regard, a two-plate microbiological method to

screen shrimp for residues of the main antibiotics used in Vietnam has been developed and validated according to criteria derived from the European Commission Decision 2002/657/CE (Dang *et al.*, 2010).

3. Meat products

Slaughterhouses are a key step in the food chain contamination of meat because slaughter operations, such as bleeding, dressing, and evisceration expose sterile muscle to microbiological contaminants that are present on skin, in the digestive tract, and in the environment. During processing, microbial contaminations are spread from carcass to carcass by equipment, tools and workers. In these conditions, overall hygiene and temperature control during transport and storage are important control measures in limiting microbial spread and growth through the supply chain.

Regarding the foodborne pathogens, a particular emphasis is given to *Salmonella* spp. and *Campylobacter* spp. as they are the main zoonotic bacteria causing foodborne toxi-infections. The prevalence of *Salmonella* spp. in retail meat analyses in North Vietnam was 40% in pork and 43-49% in chicken samples (Truong *et al.*, 2012). These isolates (n=241) were resistant to multiple antibiotics, showing for instance that 15% of isolates (n=36) were resistant to 7-9 antibiotics, and 8% of isolates (n=20) to 10-13 antibiotics. Most frequent resistances were to tetracycline (58.5%), sulphonamides (58.1%), streptomycin (47.3%), ampicillin (39.8%), chloramphenicol (37.3%), trimethoprim (34.0%) and nalidixic acid (27.8%). No isolate was resistant to ceftazidime (Cephalosporin 3G). In Ho Chi Minh City, high prevalence was found as well for *Salmonella* spp. in the retail raw meat from markets and supermarkets with 64, 62 and 53%, respectively, for pork, beef and chicken samples (Van *et al.*, 2007). Another study in the Mekong Delta showed that 21% of *Salmonella* (n=230) isolated from food (pork, beef, chicken meat, duck meat, and shrimp), domestic animals (pig, chicken, and duck), and human (children with diarrhoea) showed antimicrobial resistance, mainly to oxytetracycline (16.5%) chloramphenicol (11.3%), nalidixic acid (7.4%), streptomycin (7.0%), kanamycin (2.2%), and ampicillin (1.7%) (Ogasawara *et al.*, 2008). *Salmonella* resistance to nalidixic acid (quinolone) in food-producing animals or meat products, showed moderate to high level of resistance in the region: Vietnam 19-29% (n=332); Thailand 9% (n=131); Malaysia 36% (n=88); and Cambodia 23% (n=152) (Van *et al.*, 2012). This study showed that multiresistant *Salmonella* from food or food-producing animals are common in different countries in the region: Malaysia 49-75% (n=88); Thailand 44-66% (n=342); Vietnam 21-56% (n=180), which underlines the global concern posed by multidrug resistant *Salmonella* hazard entering the food chain (Van *et al.*, 2007, 2012). High prevalence of class 1 integrons (28%, n= 297) was found among *Salmonella* isolated from different food animals and humans in Vietnam, including genes cassettes encoding for resistance to several molecules (Vo *et al.*, 2010). Multidrug resistant *Salmonella* spp. were found in poultry isolates (76%), in pigs (30.6%), in cattle (19%) and in humans (50%) (Vo *et al.*, 2010).

The comparison of resistance of *Campylobacter* isolated from chicken neck-skin (n=546) in different cities in the world showed that Ho Chi Minh-Vietnam had the highest level of resistance (95%) to quinolone antibiotics: nalidixic acid and ciprofloxacin (Garin *et al.*, 2012). It is important to emphasise that ciprofloxacin (fluoroquinolone) is the second-choice drug (after erythromycin) for treatment of campylobacteriosis in humans which is mainly attributed to contamination from chicken.

Antibiotic use can also select antibiotic resistance in non-pathogenic bacteria. Indeed commensal bacteria can serve as a reservoir from which resistant genes can spread horizontally leading to the dissemination of the resistance to other bacteria through the food chain and the environment. The screening towards 15 antibiotics of *E. coli* (n=99) in samples from raw meat (chicken, pork, beef), shellfish and chicken faeces, showed that the rates of multiresistance reached 89.5% in chicken meat, 95% in chicken faeces and 75% in pork meat isolates. Resistance rates for all isolates were tetracycline (77.8%), sulfafurazole (60.6%), ampicillin (50.5%), amoxicillin (50.5%), trimethoprim (51.5%), chloramphenicol (43.4%), streptomycin (39.4%), nalidixic acid (34.3%) and gentamicin (24.2%). Isolates also exhibited resistance to fluoroquinolones (ciprofloxacin 16.2%, norfloxacin 17.2%, and enrofloxacin 21.2%). For this class, chicken isolates showed the highest rates of resistance (52.6–63.2%) (Van *et al.*, 2008). And multiresistance of *E. coli* isolates was 61.6% (Van *et al.*, 2007). On the other hand, large conjugative plasmids and integrons containing many antibiotic determinants have been found in both enterobacteria *Salmonella* (35 and 13%, respectively) and *E. coli* (76 and 57%, respectively) isolates, underlining the importance of the *E. coli* reservoir for resistance genes in raw chicken and pork meats from the market place in Vietnam (Van *et al.*, 2007).

Resistance to chloramphenicol still occurs at high frequency in Vietnam (42% of pig isolates) although this drug has been banned from use in food-producing animals for a decade, suggesting a misuse of the antibiotic or a cross-resistance provided by the use of other antibiotics (Ellerbroek *et al.*, 2010).

4. Current food safety improvement measures and perspectives

The government of Vietnam has paid much attention to food hygiene and safety, and has issued a system of legal documents on food hygiene and safety. Vietnam has built

its hazard analysis and critical control points (HACCP) food safety control programmes on that promoted by the Codex Alimentarius Commission (TCVN 5603:2008; STAMEQ, 2008a; TCVN is the Vietnamese abbreviation for National Vietnamese Standard).

Vietnam has also adopted the main ISO 22000 series into the TCVN/ISO2200 series, related to food safety management system, as follows:

- TCVN ISO 22000:2007 (ISO 22000:2005) (STAMEQ, 2007).
- TCVN ISO/TS 22003:2008 (ISO/TS 22003:2007) (STAMEQ, 2008b).
- TCVN ISO/TS 22004:2008 (ISO/TS 22004:2005) (STAMEQ, 2008c).
- TCVN ISO 22005:2008 (ISO/TS 22005:2007) (Vietnam STAMEQ, 2008d).

Since the integration of Vietnam into the WTO, food safety became a priority for international funding and development agencies strengthening the application of the SPS agreements requirements. The Food and Agriculture Products Quality Development and Control Project (2008-2013) funded by the Canadian International Development Agency and implemented by National Agro-Forestry-Fisheries Quality Assurance Department/ Ministry of Agricultural and Rural Development (MARD) in collaboration with Ministry of Health, aims to develop the tools for assuring safety and quality of agricultural foods through the whole value chain. This project addresses the improvement of laboratory facilities using international standards (ISO 17025; ISO, 2005). With the support of the Food and Agriculture Organisation, the project 'Strengthening veterinary public health to support the new food safety law and improve surveillance and reduce the risk of food-borne and zoonotic pathogens in Viet Nam' (2011-2012) has been conducted for capacity building with 'One Health' component, addressing food value chain and safety issues in connection with zoonotic diseases control. A number of research programmes to monitor the prevalence of pathogens (mainly *Salmonella* spp. and *Campylobacter* spp.) in slaughterhouses (pig, poultry) and local markets have also been intensively carried out by the National Institute of Veterinary Health (part of MARD) for the past five years.

The STAMEQ (Dr Ngo Thi Ngoc Ha, personal communication) highlighted the need for increasing standards and technical regulations towards food safety with the participation of the private sector; and enhancing technical assistance to professionals. As the responsibility for food safety is shared among government, industry, academia and consumers, the control of food hazards occurring along the entire food chain requires effective relationships and cooperation among all stakeholders including government agencies, institutions involved in food control, food industry and consumer groups. Collaboration is indeed essential to assure communication among stakeholders on food safety issues to be taken into consideration in the decision-making process.

However, food safety standards and quality systems pose a great technical challenge and cost to smallholders and small and medium size enterprises and may also represent non-tariff barriers to trade. According to Food and Agriculture Organization Regional Conference for Asia and Pacific (FAO, 2012), harmonisation, equivalence and simplification of standards and regulations could greatly reduce the costs of certification to enhance trade and facilitate market access for small-scale producers and processors. In Vietnam, strengthening the legal framework of the food safety and quality system is required to improve the monitoring and surveillance of pathogens and their resistance to antibiotics. Multi-resistance is commonly found in isolates from foods of animal origin in Vietnam and the percentages are comparable to those of others countries of the region, which illustrate a more global problem. Given the public health risks posed by certain critical antibiotics (e.g. quinolone, cephalosporin, macrolide resistance), the collection of data on multi-resistance and the detection of emergent resistance patterns among pathogens and indicator bacteria through the food chain is of great importance to investigate the relationship between antimicrobial use and resistance of bacteria. To mitigate antibiotic resistance emergence and dissemination through the food chain and the environment, proper use of antibiotics should be enhanced: restricting antibiotics to therapeutic use only, assuring an accurate diagnosis of diseases, using appropriate molecules, respecting the dose and duration of treatments, forbidding growth promoter use, requiring a veterinarian prescription. Vaccines should be promoted to limit diseases whenever possible. Priority should also be given to good hygiene practices with proper handling and appropriate preventive measures to prevent food contaminations from farm to fork. Evidence from the literature suggests that beyond traditional approaches based on training, food analysis and official inspections, there is a need to ensure a 'food safety culture' to improve food safety performance (Powell *et al.*, 2011; Sarter and Sarter, 2012). It means that operators: (1) know the risk associated with the food they produce; (2) know how it should be managed and effectively manage it; and (3) promote a value system that focuses on preventing diseases. From this point of view, research, education and training activities are required to address these global challenges to cope with safer and sustainable food-producing animal systems.

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