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First Survey on the Use of Antibiotics in Pig and Poultry Production in the Red River Delta Region of Vietnam

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Abstract In Vietnam where epidemics occur regularly in animal production, the farmers consider antibiotics as one of the solutions to fight against livestock diseases, thus the risk of abuse, even illegal use of antibiotics in livestock is very high. However, this is a recent issue and has not yet been thoroughly investigated. A cross-sectional study on the use of antibiotics in pig and poultry production as well as the farmer's knowledge on the danger of the antibiotic use in three different animal production systems (farm household, semi-industrial and industrial) was conducted from July 2009 to March 2010 on 270 entities, in 3 representative localities of the Red River Delta (RRD). The results showed that a large volume of antibiotics was used arbitrary in all animal production systems. Animals were not only treated for acute diseases, but also for disease prevention, and for growth promotion. At least 45 antibiotics of more than 10 classes were used. Fifteen antibiotics were used in pig and poultry feed. For diseases treatment and prevention, antibiotics were used abusively and even illegally (e.g. chloramphenicol) by both farmers and veterinarians. The findings of this survey will permit developing new strategies for prudent use of antibiotics in livestock in Vietnam. These results will help not only to strengthen issues such as veterinary networks; antibiotics use guidance, residues monitoring systems and food safety, but also to improve awareness and ethics of producers and veterinary drug sellers.

Keywords Antibiotics, Animal Production, Veterinary Drugs, Red River Delta, Vietnam

1. Introduction

In Vietnam, a country with more than 85 million inhabitants and a very high population density, especially in the Red River Delta (RRD), urbanization and industrialization increase rapidly. The demands of foodstuff from animal origin for domestic markets are more and more growing. The annual average consumption of animal products per Vietnamese capita in 2009 is 35 kg of carcass meat; 3 kg of milk and 80 eggs[1]. The development objective by 2020 is 56 kg of carcass meat, over 10 kg of milk and over 140 eggs[2]. As a consequence, the increase of intensive livestock husbandry models is an indispensable trend in the Vietnamese context. However, because of the low level of hygiene in livestock husbandry, the inadequacy of husbandry zone planning and the lack of state management and development strategies, it results in some new problems such as environmental pollution, as well as frequently occurring and uncontrolled epidemic diseases [2-4]. In 2003, during the avian influenza crisis, about 44 million poultry have either died because of the disease or have been slaughtered because of the crisis. The Porcine Reproductive and Respiratory Syndrome (PRRS), and the Foot-and-Mouth disease have also been a constant threat causing regular outbreaks in recent years[5]. In 2006, an epidemiological analysis about swine diseases in Northern Vietnam based on 4000 declarations highlighted a high incidence of porcine respiratory disease (50% of total reported cases). The proportion of digestive tract infections in piglets and reproductive disorders in newly raised exotic sows were 30% and 10% of total reported cases, respectively [6].

Facing this situation, producers consider antibiotics, used for disease prevention and therapeutic purposes, as one of the solutions to fight diseases in livestock. In fact, antibiotics are the most common registered drugs (70% of all veterinary drugs) used in animals in Vietnam[7]. However, the knowledge of famers is still very restricted while the state

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inspection and management haven't met practical demands yet[8]. The use of antibiotics in animal production by farmers in a casual, unmethodical manner, without any veterinary prescription and supervision, may lead to the presence of residues in animal products and to antimicrobial resistance[9-11]. These residues cause a danger for public health[12], and bad influences on environment and animal therapeutic sciences. A high proportion of the antibiotics used in animal production is excreted in urine or faeces and are found in manure[13]. When manure is applied on lands, these antibiotics can enter surface and/or groundwater and potentially alter the environment microbial ecosystem [14-16]. It could also contribute to the presence of antibiotic-resistant zoonotic agents and bacteria in the food chain [17-22]. The situation in Vietnam is amplified by the integrated agriculture-aquaculture (IAA) farming system encouraged by the government, which often involves an aquaculture system that is sustained through human and livestock waste. This creates an environment that greatly increases the ease through which antibiotic resistance genes can be spread[23]. These antibiotic resistance genes can be easily transferred to both human and animal pathogens, creating a severe health risk by greatly limiting the antibiotics that can be used to treat infectious diseases[24].

In recent years, Vietnam had many alerts about veterinary drug residues in general and antibiotics in particular. These alerts have caused warnings to authorities and alarmed consumers. Therefore, this problem has been discussed on several occasions in meetings of the Vietnam National Assembly[25-27]. However, until now, there is no systematic monitoring neither is there any regulation and control strategy on antibiotic use in food animals, and little information is available on antibiotic use.

For the reasons above, as well as to contribute to a long-term strategy of the Vietnamese Government on food safety, the collection of detailed information about antibiotics used in animal production is necessary. The aim of this study was to provide information on the use of antibiotics in different pig and poultry production systems in the RRD of Vietnam. This information can assist new strategies in the control of antibiotic use in pig and poultry production in Vietnam.

2. Experimental

A cross-sectional study of antibiotic use in pig and poultry production as well as farmer's knowledge about food safety related to the use of veterinary drugs in the region of the RRD was designed and conducted from July 2009 to March 2010, on 270 entities representing 3 different systems of livestock husbandry: farm household, semi-industrial and industrial, in 3 representative localities of the RRD (Hai Duong, Thai Binh and Ha Noi) (Fig. 1)(Table 1).

Table 1. Estimation of the total number of pig and poultry production systems in the RRD

System of animal production	Animal species	Provinces			Total (by production system)
		Ha Noi	Hai Duong	Thai Binh	
Industrial	Pig	10	10	10	30
	Chicken	10	10	10	30
Semi-industrial	Pig	10	10	10	30
	Chicken	10	10	10	30
Farm household (*)	Pig, chicken	50	50	50	150
Total (by localities)		90	90	90	270

(*): only households who have both the pig and chicken

Figure 1. Map of Red River Delta region indicating the three representative localities where the samples were collected (Hai Duong, Thai Binh and Ha Noi)

2.1. Sampling Area

The Red River Delta region is a flat plain formed by the Red River and its distributaries joining in the Thai Binh River in Northern Vietnam. It is an agriculturally rich area and densely populated (1225 persons/km^2, 4.8 times higher than the average population density of Vietnam). It includes the capital, Hanoi, and 10 others surrounding provinces (Fig. 1). The pig and poultry production of this region are the most developed of Vietnam (about 50% of the whole country production) with 7.0 million pigs, 66.5 million poultry in 2008[28].

Three representative provinces were selected not only for their production capacity but also representative of their geographic location and population density: Hanoi (3344 km^2), Hai Duong (1661 km^2) and Thai Binh (1542 km^2). The population density of Hanoi, Hai Duong and Thai Binh are 1943; 1030 and 1155 persons/km^2, respectively. The population of pig and poultry is the largest in Hanoi (1.2 10^6 pigs and 15.7 10^6 poultry), followed by Hai Duong (0.6 10^6 pigs and 6.9 10^6 poultry) and Thai Binh (1.0 10^6 pig and 7.9 10^6 poultry)[28].

2.2. Sampling Method

In each province, on the basis of the list provided by the local agricultural office (for industrial and semi-industrial systems), as well as from the lists provided by local veterinarians, 50 farm households who have both pig and poultry, 20 semi-industrial farms (10 for pig and 10 for poultry) and 20 industrial farms (10 for pig and 10 for poultry) were selected by random sampling for the survey. Official local agricultural criteria were used to classify the different farming systems. Farm household system displays a small number of animals, primarily for home consumption or local markets or ceremonial use. Livestock is raised in the garden, near the house of the farmer, and are fed with available vegetables, product and by-products of agriculture, or leftovers of the family kitchen (there is no supplementary feeding). Semi-industrial systems are farms with at least 50 pigs or 10 sows for the pig and 200 animals for the poultry.

2.3. Information Collection

Questionnaires, contents of which were compiled after test survey and adjustment, were used for direct interviews of owners, technical collaborators or veterinary doctors of the farm. The information of veterinary drugs, antibiotic components and active elements which weren't noted in the farm were tracked down and collected through labels on remedy packs or jars left around animal housing or at local veterinary medicine pharmacy. In order to ensure the objectivity of full remedy use information exploitation, all householders' names and addresses were kept in security through encoding addresses just at the survey time.

In this survey, antibiotics are considered to be used abusively when they are used unscientifically and incorrectly (under/overdosing, no exact diagnosis or result of a susceptibility testing …).

2.4. Statistical Analysis

All data and information were registered and checked using Microsoft Excel 2003. The data were analysed statistically and compared, in 2x2 and 2x3 contingency tables, using the chi-square test and the Fisher's Exact Test, when the chi-square test was not relevant, using the SAS® Software 9.0. A Fisher exact test was performed using the data of number of production system using antibiotics for disease prevention, therapy or growth promotion (Table 2a), in order to assess if there is a significant difference with p<0.05) in the use of antibiotics between the three production systems (household farms, semi-industrial and industrial production systems), as well as to assess if there is a significant difference in the use of antibiotics (total of the three production systems) between the different production stages (piglets, fattening pigs and sows for the pig production) and production systems (breeding poultry, broilers and laying hens for the poultry production) (Table 2b).

Table 2a. Antibiotics use as growth promoter, for disease prevention and therapy purpose in three different pig or poultry production systems (in % of production systems using antibiotics)

Livestock	Percentage of production system using antibiotic								
	Growth promoter			Disease prevention			Therapy		
	Farm household (n=150)	Semi-industrial (n=30)	Industrial (n=30)	Farm household (n=150)	Semi-industrial (n=30)	Industrial (n=30)	Farm household (n=150)	Semi-industrial (n=30)	Industrial (n=30)
Piglets	38.7^{a}	43.3^{b}	63.3^{c}	13.3^{I}	$10.0^{I,II}$	30.0^{II}	54.7^{α}	43.3^{α}	66.7^{α}
Fattening pigs	31.3^{a}	40.0^{b}	66.7^{c}	4.7^{I}	$13.3^{I,II}$	26.7^{II}	54.7^{α}	43.3^{α}	66.7^{α}
Sows*	16.2^{a}	20.0^{b}	43.3^{c}	7.6^{I}	3.3^{I}	16.7^{I}	14.3^{α}	10.0^{α}	30.0^{α}
Breeding chicken	11.3^{a}	33.3^{b}	53.3^{b}	20.0^{I}	53.3^{II}	53.3^{II}	10.7^{α}	30.0^{β}	$23.3^{\alpha\beta}$
Broilers	8.7^{a}	26.7^{b}	43.3^{b}	11.3^{I}	6.7^{I}	30.0^{II}	4.0^{α}	23.3^{β}	23.3^{β}
Laying Hens	0.0^{a}	0.0^{a}	0.0^{a}	2.7^{I}	$6.7^{I,II}$	13.3^{II}	0.7^{α}	16.7^{β}	13.3^{β}

*: Only 105 household farms were having breeding sows from the 150 household farms investigated

a, b, c : the % of production systems using antibiotics for growth stimulation without the same letter in the same row differ significantly (P < 0·05)

I, II : the % of production systems using antibiotics for disease prevention without the same roman number in the same row differ significantly (P < 0·05)

α, β : the % of production systems using antibiotics for therapy without the same symbol in the same row differ significantly (P < 0·05)

Table 2b. Antibiotics use as growth promoter, for disease prevention and therapy purpose in three different types of pig and poultry products (in % of production systems using antibiotics)

Livestock	Percentage of production systems using antibiotics		
	Growth promoter (n=210)	Disease prevention (n=210)	Therapy (n=210)
Piglets	42.9^{a}	15.2^{a}	54.8^{a}
Fattening pigs	37.6^{a}	9.0^{a}	54.8^{a}
*Sows**	21.8^{c}	8.5^{a}	16.4^{b}
Breeding chicken	20.5^{α}	29.5^{α}	15.2^{α}
Broilers	16.2^{α}	13.3^{β}	$9.5^{\alpha\beta}$
Laying hens	0.0^{β}	4.8^{γ}	4.8^{β}

* Except for sows: n = 165

$^{a, b, c}$: the % of production systems using antibiotics for pig production without the same letter in the same column differ significantly ($P < 0{\cdot}05$)

$^{\alpha, \beta, \gamma}$: the % of production systems using antibiotics for chicken production without the same letter in the same column differ significantly ($P < 0{\cdot}05$)

Table 3. Antibiotic use in pig and poultry production in Red River Delta expressed in number of entities having used the antibiotic at least once

Group	Antibiotic	Use frequency (expressed in number of entities)					
		Growth promoter (n=210)		Disease prevention (n=210)		Therapy (n=210)	
		Chicken	Pig	Chicken	Pig	Chicken	Pig
	Bycomycin	-	-	5	-	5	1
	Gentamicin	-	-	5	3	12	78
Aminoglycosides	Kanamycin	-	-	-	-	1	13
	Neomycin	-	-	5	3	2	4
	Spectinomycin	-	-	2	5	-	33
	Streptomycin	-	-	3	3	3	17
	Amoxicillin$^{(i)}$	-	6	8	7	9	19
	Ampicillin	-	-	31	2	13	18
Beta-lactams	Cefotaxime	-	-	-	1	-	1
	Cefalexin	-	-	-	-	1	-
	Cepharadin	-	-	-	-	-	1
	Penicillin	-	-	2	1	1	14
	Danofloxacin	-	-	-	-	-	2
Fluoroquinolons	Enrofloxacin$^{(f)}$	-	-	14	10	5	62
	Flumequine	-	-	-	-	-	2
	Norfloxacin	-	-	6	17	5	16
	Maduramycin	3	-	-	-	-	-
Ionophores	Monensin$^{(r)(p)}$	6	5	-	-	-	-
	Salinomycin$^{(r)(p)}$	38	13	-	-	-	-
Macrolides	Erythromycin	-	-	1	-	-	-
	Josamycin	-	-	1	-	-	-
	Kitasamycin	-	-	-	1	-	-
	Spiramycin$^{(r)}$	-	-	5	1	2	5
	Tiamulin$^{(i)}$	-	1	2	-	1	12
	Tylosin	-	7	15	8	20	94
	Chloramphenicol$^{(f)}$	-	-	2	-	3	6
Fenicols	Florfenicol	-	-	-	5	-	17
	Thiamphenicol	-	-	1	1	3	21
	Sulfachlorpyrazin	-	-	23	2	12	1
	Sulfadimidin	-	-	2	-	1	1
Sulfonamides	Sulfamethoxazole	-	-	4	1	6	2
	Sulfaquinoxaline	-	-	2	-	5	-
	Sulfaguanidine	-	-	9	1	8	2
	Chlortetracycline	29	72	1	1	1	1
Tetracyclines	Doxycyline	-	-	11	1	5	12
	Oxytetracycline	-	1	13	11	8	31
	Tetracycline$^{(i)}$	5	1	11	5	7	4
	Bambermycin	4	-	-	-	-	-
	Lincomycin	-	3	2	9	1	24
	BMD$^{(*)}$	4	20	-	-	-	-
Others	Colistin$^{(i)}$	6	78	44	12	22	56
	Diclazuril$^{(i)}$	9	-	-	-	-	-
	Toltrazuril	-	-	6	-	-	2
	Diaverindine	-	-	9	-	4	-
	Trimethoprim	-	-	16	4	16	6
Number of different antibiotics used		9	11	31	25	29	33

$^{(*)}$: Bacitracin Methylene-Disalicylate -: not used (f): illegal use and $^{(r)}$: restricted use in veterinary medicine (MARD 2009[d]). $^{(p)}$: illegal use as growth promoter for pig and $^{(i)}$: illegal use as growth promoter for both chicken and pig (MARD 2006, 2009[b,c])

3. Results and Discussion

3.1. Identification of Antibiotics Used in Pig and Poultry Production in the RRD

At least 45 antibiotics representing more than 10 classes were used in pig and poultry production in the provinces studied, not only for treatment of diseases, but also for disease prevention and to promote growth.

For disease prevention purpose, 31 and 25 different antibiotics were found to be used in poultry and pig production, respectively, while the number of different antibiotics used for curative purpose in pig and poultry were 33 and 29 respectively (Table 3). These data show that in pig production, antibiotics from aminoglycosides, tetracyclines, fenicols, beta-lactams and fluoroquinolones groups are the most commonly used for mostly disease treatment, and to a lesser extent for disease prevention. In poultry, antibiotics from sulfonamides, beta-lactams, tetracyclines, aminoglycosides and ionophores, as well as colistin are commonly used mostly for disease prevention and to a lesser extent for therapy.

For both prophylactic and therapeutic purposes, most producers use antibiotics to prevent infection diseases not according to the prophylactic or therapeutic dosage, length of treatment and withdrawal time indicated on the product label, but most of them use a higher dosage and don't respect the recommendations of the drug producer.

In the 45 antibiotics identified in this survey, colistin, chlortetracycline and oxytetracycline are the most commonly used. Chlortetracycline was overall used for growth promoter purpose, oxytetracycline for disease prevention and therapy, while colistin was used for all three purposes. In particular, colistin was indicated for prevention and therapy of gastrointestinal disorders in piglets and poultry caused by gram negative bacteria (in particular *E. coli* and *Salmonella spp*).

3.2. Antibiotic Use in Different Systems of Livestock

It appeared that the use of antibiotics as growth promoters in pig production was significantly different ($p<0.05$) in the three production systems, displaying the following order: industrial production system > semi-industrial production system > farm household. In breeding poultrys and broilers production, growth promoters are significantly less used in farm households (11.3% and 8.7% respectively) than in semi-industrial and industrial production systems (up to 53.3% of the farm for breeding poultrys), for which there is no significant difference (Table 2a).

The use of antibiotics for disease prevention is significantly different with $p<0.01$ for piglets and with $p<0.05$ in farm households than in semi-industrial or industrial production systems for fattening pigs, breeding poultry, broilers and laying hens, but not in sows (Table 2a). In piglets, fattening pigs, breeding poultry and laying hens, the use of antibiotics for disease prevention is lower in farm households than in industrial systems (Table 2a).

When the antibiotics are used for therapy, a significant difference ($p<0.05$) between farm household and industrial production systems is observed only for poultry production (breeding poultry, broilers or laying hens), but not for pig production (Table 2a).

In a general manner, antibiotics are less used in farm households, and equally used in both semi-industrial and industrial production systems, except for growth promotion purpose in pig production, where the industrial systems are the largest antibiotic users (up to 66.7 % for fattening pigs), and for disease prevention purpose in broilers, where farm households and semi-industrial production systems use less antibiotics than industrial systems (11.3% and 6.7% against 30.0% respectively) (Table 2a).

In pig production, the use of antibiotics is not significantly different between the three kinds of age groups (piglets, fattening pigs and sows), when the antibiotics are used for disease prevention. On the contrary, the use is significantly different ($p<0.05$), when the antibiotics are used for therapy or for growth promotion (Table 2b).

For growth promotion and therapy, antibiotics are less used in sows than in piglets, and are equally used for piglets and fattening pigs (Table 2b).

In poultry production, the use of antibiotics is significantly different ($p<0.05$) between the three production systems (breeding poultry, broilers and laying hens), for all considered purposes (disease prevention, therapy or growth promotion) (Table 2b).

Growth promoters are equally used in breeding poultry and broilers and not used in laying hens. Antibiotics are more used in breeding poultry for disease prevention, equally used for therapy of breeding poultry and broilers, and less used for therapy of laying hens (Table 2b).

If we consider the overall use of antibiotics for the 3 purposes, in the 3 production systems, the number of farms which do not use antibiotics are the following: 2 out of 150 farm households, 13 out 30 semi-industrial pig farms, 2 out of 30 semi-industrial poultry farms, 1 out of 30 industrial pig farms and 6 out of 30 semi-industrial poultry farms.

Besides the non-compliance with dosage, length of treatment and withdrawal time, the number of different antibiotics used in each production system appeared to be high. The data in the Table 4 show that up to six categories of different antibiotics can be used in a production system for therapy of pig and poultry. The rate of breeders who used from 1 to 2 antibiotics is high for all kinds of livestock and production systems. Except for breeding poultry raised in semi-industrial systems, the rate of farmers using from 3 to 6 antibiotics is higher than those using 1 or 2 antibiotics (16.7% compared with 13.3%). For fattening pigs, the rate of farmers using from 3 to 6 antibiotics in the three production systems (farm household, semi-industrial and industrial) is rather high (20%; 6.7% and 26.7% respectively).

Table 4. Number of antibiotics used in each production system (in % of production systems)

Livestock	Number of antibiotic used	**Percentage of production systems using antibiotics**		
		Farm household (n=150)	Semi-industrial (n=30)	Industrial (n=30)
Piglets	No use	45.3	56.7	33.3
	1 to 2	46.0	36.7	43.3
	3 to 6	8.7	6.7	23.4
Fattening pigs	No use	45.3	56.7	33.3
	1 to 2	34.7	36.7	40.0
	3 to 6	20.0	6.7	26.7
Sows	No use	85.7	90.0	70.0
	1 to 2	12.4	10.0	23.3
	3 to 6	1.9	0	6.7
Breeding chicken	No use	89.3	70.0	76.7
	1 to 2	7.3	13.3	16.7
	3 to 6	3.3	16.7	6.7
Broilers	No use	96.0	76.7	76.7
	1 to 2	2.7	16.7	13.3
	3 to 6	1.3	6.7	10.0
Laying hens	No use	99.3	83.3	86.7
	1 to 2	0.7	3.3	10.0
	3 to 6	0	13.4	3.3

3.3. Veterinary Activities and Issues Linked to Food Safety in the Use of Antibiotics

Table 5. Veterinary activities and issues linked to food safety concerning the antibiotics use, in three different pig and poultry production systems in the Red River Delta

Criteria of assessment			**Percentage of production system (%)**			
			Farm household (n=150)	Semi-industrial (n=60)	Industrial (n=60)	Total (∑n=270)
Veterinary activities	Veterinary activities	Owner	59.3^{a}	95.0^{b}	100.0^{b}	76.3
		Local veterinarian	39.3^{a}	5.0^{b}	0^{b}	23.0
		Both of them	1.3^{a}	0^{a}	0^{a}	0.7
	Basis of choosing drugs	Experience	7.3^{a}	13.3^{a}	40.0^{a}	15.9
		Drug seller	33.3^{a}	38.3^{a}	36.7^{a}	35.2
		After sending samples	0^{a}	6.7^{b}	13.3^{b}	4.4
		Veterinarian	39.3^{a}	5.0^{b}	0^{b}	23.0
		Others (friends, marketing, books and newspapers...)	20^{a}	36.7^{b}	10.0^{a}	21.5
Use of veterinary drugs in compliance with sanitary legislation	Percentage of production systems respecting the withdrawal time, in which:		**41.3^{a}**	**58.3^{b}**	**73.3^{b}**	**52.2**
	Motivation of respect is:	Required by purchasers	8.1^{a}	8.6^{a}	4.5^{a}	7.1
		Protecting consumers	37.1^{a}	37.1^{a}	56.8^{a}	43.3
		Others (economic, weight gain)	54.8^{a}	54.3^{a}	38.6^{a}	49.6
	Percentage of production systems in which :		**72.7^{a}**	**86.7^{a}**	**81.7^{a}**	**77.8**
	safety information sources are :	Technical staff	2.8^{a}	1.9^{a}	0^{a}	1.9
		Medias (TV, Radio ...)	85.3^{a}	61.5^{ab}	73.5^{b}	76.7
		Friends and colleagues	0.9^{a}	1.9^{a}	2.0^{a}	1.4
		Drug sellers	5.5^{a}	0^{a}	2.0^{a}	3.3
		Others (indication on product labels)	5.5^{a}	35^{b}	22.4^{b}	16.7
	What is done with ill livestock with bad prognosis	Changing remedies	21.3^{a}	31.7^{a}	20.0^{a}	23.3
		Selling quickly	44.7^{a}	18.3^{b}	40.0^{a}	37.8
		Slaughtering & consuming in family	8.0^{a}	10.0^{a}	6.7^{a}	8.1
		Destroying	16.0^{a}	26.7^{a}	18.3^{a}	18.9
		Feeding other animals	4.0^{a}	6.7^{a}	11.7^{a}	6.3
		Others	6.0^{a}	6.7^{a}	3.3^{a}	5.6

a, b, c : Percentage of production system without the same letter in the same row differ significantly ($P < 0{\cdot}05$)

Few animal raising householders are trained on veterinary practices; however, they are themselves in charge of most veterinary activities such as vaccination, animal prophylactic and treatment. Especially for the industrial and semi-industrial production systems, veterinary activities and therapy are mainly assumed by the owners (95% of them for semi-industrial farms and 100% for industrial farms), while, for farm households, about 60% of them undertake themselves the therapy of their animals and nearly 40% need the assistance of animal health workers, veterinary technicians or para-veterinarians (Table 5).

The antibiotics were mainly chosen on the basis of the experience of the farmer, or advice from representatives of pharmaceutical companies or local drug sellers[according to symptoms told by farmers) (15.9% and 35.2% respectively). Very few samples of ill animals are sent to laboratories for diagnosis or susceptibility testing before therapy. This shows that the use of antibiotic by farmers without any veterinary prescription and supervision is very frequent in this region. This can be explained by the fact that in practice, the leading role and the actions of local veterinarians are limited. In each commune, there is a livestock committee of 1 to 2 responsible animal health workers (usually para-vets). Most of veterinarians are only concerned by commercial activities (distributor of feed, or veterinary drugs) or in the marketing network of feed or drug companies.

The results of this survey reveal that overuse and illegal use of antibiotics in pig and poultry production in the region of the RRD is worrisome. At least 45 antibiotics of more than 10 different classes were shown to be used: - fourteen antimicrobial growth promoters used as pig or poultry feed additives, - thirty four antibiotics used for disease prevention (31 antibiotics in poultry production and 25 antibiotics in pig production), - thirty six used for disease treatment (in which 29 antibiotics in poultry production and 33 antibiotics in pig production).

Antimicrobial feed additives have been used worldwide in animal production for many decades because of their favourable economic effects in livestock. However, there has been an increasing public concern about the possible links between their use and the transfer of antibiotic resistant organisms and resistance genes to humans[29]. Through studying bacterial strains isolated from eggs in Greece, Papadopoulou et al[30] concluded that antibiotic-resistant strains might be transmitted to human by the consumption of eggs containing multiresistant bacteria. In addition, the results of an other study on antibiotic resistance of common foodborne pathogens isolated from major meat products[31] indicated that meat can be a source of resistant strains, which could potentially be spread to the community through the food chain. Many scientists agree on the fact that the use of antibiotics in animal production for growth promotion, prophylaxis and treatment can lead either to the selection of resistant bacteria, which can be transmitted through the food chain[32, 33], or to the horizontal transfer of resistance genes to human pathogenic or commensal microflora[34]. So, the use of antibiotics, both in human and animals should be avoided, as far as possible[35]. Due to the emergence of cross-resistance to antibiotics that are used in human medicine and also in animal infections, the European Commission decided to totally ban antimicrobial growth promoters since the 1st January 2006[36]. In contrast, antimicrobial growth promoters continue to be authorized in the USA under the FDA regulation and controlled on a case-by-case basis[37]. Meanwhile, in Vietnam, this is still permitted[38-41]. Nine and 11 different antibiotics are used for growth promotion in poultry and pig production, respectively (Table 2), from which 3 (colistin, diclazuril and tetracycline) and 6 (amoxycillin, tiamulin, monensin, salinomycin, colistin and tetracycline) antimicrobials, respectively, are not allowed by the Vietnamese legislation [38-41]. This result confirm that, in spite of their absence on the list of permitted antibiotics for growth promotion, some antibiotics are popularly used yet, especially colistin and chlortetracycline in pig feed, found in 78 and 72 pig farms respectively. This use may be related to diarrhea and oedema in piglets, one of the most common diseases in Vietnam[42, 43]. One study in Hai Duong[44] shows that diarrhea in pig is very high (48%) and that this occurs in any season of the year.

The state of antibiotic use in animal production is worrisome in developing countries, where the antibiotic use is not tightly controlled and where few detailed information is available on these problems[9]. The results of this study are completely consistent with the above statement of the WHO. Antibiotics from the groups of aminoglycosides, tetracyclines, fenicols, beta-lactams and fluoroquinolones are the most commonly used for disease prevention and treatment, mainly for therapy in pig production, while antibiotics from the groups of sulfonamides, beta-lactams, tetracyclines, aminoglycosides, ionophores, as well as colistin, are commonly used for poultry disease prevention and therapy, but mainly for disease prevention. The results of this study confirm that antibiotics listed here, and considered as critically important for humans by WHO, are still commonly used in animal production. Allowed antibiotics were used but also banned substances, such as chloramphenicol and enrofloxacin, by both famers and veterinarians. In other countries, such as for example Australia, the pig industry is based on drugs of low importance to human health (e.g. tetracyclines, penicillins (including amoxicillin and ampicillin) and sulfonamides). Only two drugs of high importance for humans (ceftiofur and virginiamycin) can be used legally in pig production[45]. Moreover, tetracyclines, sulfonamides and tylosin were shown to be commonly used these last years in pig production not only in China, Russia and Southeast Asia, but also in the European Union[46] and in the United States[47]. A recent study carried out by Kools et al.[48] showed that tetracyclines, beta-lactams, and sulfonamides are the most used groups in animal production in EU. In 2005, tetracyclines were the most prescribed antibiotics among the 1,320 tons used for animal production in France[49]. In comparison, about 12,650 tons of antimicrobials were used in 2007 in the USA in veterinary medicine[50], 40% of which were tetracyclines and about 13% of the total amount of antimicrobials was used as growth promoters.

Livestock breeders have very low awareness of the reasonableness and safety of antibiotic use as well as of food safety. According to regulations and guidelines of the use of veterinary drugs, antibiotics should only be employed to treat bacterial infections, respecting the dose, the length of treatment and the withdrawal time provided by the manufacturer or indicated by the veterinarian. However, referring to the Vietnamese veterinary ordinance promulgated in 2004[51], the violations on the veterinary activities of livestock breeders are very widespread. Their use of antibiotics is very unmethodical and unscientific, mainly based on their experiences or on advices from veterinary drug sellers.

The results of this study show that, although the appropriate withdrawal period is mentioned on the label of the antibiotic used, in practice, only about 52% of the farmers surveyed were respecting the withdrawal time, from which 60%, 40% and 27% were from farm household, semi-industrial and industrial system, respectively (Table 5).

Furthermore, animals in disease and therapy can be sold quickly in order to save funds (this is the case in 40% of the farms investigated) or slaughtered and used for food, or feed for other animals. This creates both difficulties for prophylaxis of epidemic diseases and unsafety for consumers. In particular, these practices lead to a high risk of undesirable residues in animal products[10]. This is one of the reasons why traces of residues of veterinary drugs in general, and antibiotics in particular, have been found in animal products and also in the environment[52]. One study about the emergence of fluoroquinolone resistance in the native *Campylobater coli* population of pigs[53] indicates that a single course of enrofloxacin treatment contributes directly to the emergence and persistence of quinolone resistant *C. coli*.

To collect information on the consumption of veterinary drugs in general, and of antibiotics in particular, is not easy in developing countries. In this context, the background of animal production in Vietnam is low, scale is small and scattered, the organization system and management qualification of the animal production and veterinary sector display a lot of inadequacies which do not meet the real development requirements. The quality of food, safety and hygiene is an urgent requirement for consumers. Differences in animal production systems between developed and developing countries lead to the need for different approaches to control antibiotics.

4. Conclusions

The antibiotic overuse and illegal use in pig and poultry production in the region of the RRD is highly worrisome. Livestock breeders have very low awareness of the reasonableness and safety of antibiotic use as well as the food safety. Their use of antibiotics is very unmethodical and unscientific, mainly based on their experiences of on advices from veterinary drugs sellers after describing symptoms.

These preliminary results will be the basis for developing new strategies for a prudent use of antibiotics in food animals in the context of Vietnam. It is necessary not only to strengthen the monitoring system, veterinary network, antibiotic use guidance issues, but also to improve awareness and ethics of producers and veterinary drug sellers as well as training of para-veterinarians and farmers, public awareness and strength of surveillance systems in slaughterhouses.

In conclusion, antibiotics have been used largely and even illegally (e.g. chloramphenicol) in both poultry and pig production for disease prevention and treatment.

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