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ANTIMICROBIALS USE IN BROILER CHICKEN BREEDING: CASE OF THE AIN DEFLA PROVINCE (ALGERIA)

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ABSTRACT

The objective of this study is to assess the use of antimicrobials in the broiler production in Algeria, through a survey completed by private veterinarians of the Ain Defla province. In this context, 65 band breeding were studied for antimicrobial use between October 2019 and June 2020. The results showed that all of the studied bands received antimicrobial treatments for at least 5 days during the breeding period. Quinolones class was the most widely used class of antimicrobials (24.4%), followed by the tetracyclines class (22.5%), sulfonamides (20.1%) and polypeptides (12.1%). Macrolides and beta-lactams come last (4.02% and 3.22% respectively). 160 mg of active compound were administered per kg of chicken meat produced. The number of daily doses (nDDkg) was 10.5, while the treated live weight (nCDkg) was 2.66. Per molecule, chickens were more exposed to colistin, doxycycline, oxytetracycline and enrofloxacin. The withdrawal period of used bands was not respected, and meat from these treated broilers was found to contain antimicrobial residues at 33.9%. The reasons for this frequent use are various: poor conditions and bad practices of breeding, poor quality of day-old chicks, veterinary practices, and difficulties of control by veterinary authorities.

Keywords : Antimicrobial use; Broilers; Veterinary prescription; Antibiotic residues; Ain Defla.

INTRODUCTION

The intensive broiler production has increased significantly in the last decade. The Algerian broiler production is estimated to offer annually on average 340,000 tons of white meat and more than 4.8 billion eggs with 20,000 farmers employing about 500,000 people (Alloui and Bennoune, 2013). Because the broiler is more susceptible to avian pathogens (Guy and Garcia, 2008), the antibiotics use was a success in controlling infectious pathologies through feed (Rushton *et al.*, 2014). Otherwise, the use of antibiotics is considered to be a risk factor contributing to the: (1) emergence of antimicrobial resistance, particularly in veterinary medicine (Aarestrup, 1999; Gyssens, 2001; McEwen and Fedorka-Cray, 2002; WHO, 2014; Rahmatallah *et al.*, 2018), and (2) consumers exposer to drugs residues in meat at consumption time (Mehdi *et al*., 2018). Therefore, the broiler meat can be a transmission source of both resistant bacteria and/or drug residues to humans (Schwarz *et al*., 2001; Catry *et al.*, 2003). This transmission is probably aggravated by a high consumption of poultry meat estimated at 34.5% of the total meat consumed in Algeria (FAO, 2020). For this reason, controlling antimicrobial resistance in poultry must be a priority. A prerequisite for such control is the quantification of antimicrobials used in veterinary practices. Antimicrobial consumption data can be used to: (1) detect inappropriate use, (2) quantify the selection pressure, and (3) identify risk factors contributing to the antimicrobial resistance emergence from birth to the slaughter age (Catry *et al*., 2003; OIE, 2019). Despite, the efforts of Algerian authorities, the control of veterinary antimicrobials use and consumption monitoring is not sufficient compared to DANMAP (2016) (Danish Program for surveillance of antimicrobial consumption and resistance in bacteria from food animals, food and humans), to GERMAP (German report on antimicrobial consumption and antimicrobial resistance in human and veterinary medicine in Germany) and to ESVAC (2010) (European Surveillance f Veterinary Antimicrobial Consumption). As shown by Werner *et al.* (2018), these programs are responsible for collecting, analyzing and publishing data on the sales and consumption of antimicrobials in livestock and food animals. In addition, to our knowledge, no studies have been reported on the use and consumption of antimicrobials in the production of broilers in Algeria. Thus, the objective of this study is to assess the use of antimicrobials in the broiler production sector from the results of a survey carried out for this purpose and completed by private veterinarians involved in health monitoring of broiler. This study could serve as a model to consult in case of future programs establishment to monitor antimicrobials use in Algeria.

MATERIAL AND METHODS

Study population

Eighteen veterinarians monitoring a broiler breeding in Ain Defla province (Algeria) have been visited between October 2019 and June 2020.

Sampling

The sample size was calculated basing on the formula in Equation 1 as described by TOMA *et al*. (2010):

$$n = \frac{3.84\,p(1-p)}{pPr^2} \quad \text{Eq. (1)}$$

n: number of subjects in the sample,

p: antimicrobial use frequency in literature,

Pr: relative precision.

The number of breeding bands needed is calculated taking into account a precision of 10% and an antimicrobial use frequency of 85%, while the default risk of error α is fixed at 5%.

The random sampling was carried out on all broiler bands that were enumerated on Excel sheet from 1 to n broiler band. Then, a random sample already calculated by Equation 1 was selected using ALEA function as ALEA.ENTRE.BORNES (1;228).

Data collection

The veterinarians were investigated for the perscription of antibiotics use through breeding period or for the antimicrobial treatments as interventions in breeding. All data about antibiotic perscription use were retrospectivelly collected on all the steps of broiler production until slaughter.

The surveys data were collected basing on open questions undertaken into two visits. The questionnaire was built on literature (Chauvin *et al*., 2001; Jensen *et al.,* 2004; OIE, 2019). Firstly, a preliminary survey was tested with five volontary veterinarians to check incomprehensibility of questions and remove any related ambiguity. Voluntary comments were also taken into account to finalize the questionnaire.

The survey consists of two parts (Table 1). The first part was conducted on general informations on broiler breeding such as farmer name and or its breeding codes, address of livestock buildings, veterinarian, broiler race, animals' number, arrival date, ages and weights at slaughter, and the mortality rate.

The survey second part was performed to collect informations on prescriptions of antimicrobial use (prophylaxis or metaphylaxis) at all steps of broiler production with clinical indication, the active compound, the type of antibiotic used with commercial and generic name and its packaging, duration of antibiotic use, chicken age, administration route and dose, average of chicken's weight on the day of treatment. When chicken weight was unknown, estimation was made using a growth table as reported in literature (Hubbard Algerie, 2019; Aviagen Group, 2020; Cobb-Vantress, 2020).

Assessment of antibiotic use

1. Use frequency (UF)

The number of treatments carried out was assessed in frequency (%) with taking into account only the the used drug without the molecules and associations.

2. Indicator of antibiotic use

As shown in Table 2, the main indicators used are the amount of compound in mg/kg, the prescribed daily dose (PDD), the body weight treated-day or number of daily doses (nDDkg), and the treated live weight (nCDkg).

3. Non-respect of withdrawal period

For each antimicrobial used, the compliance with the withdrawal period was monitored. The withdrawal period corresponds to the time required for the elimination of antibiotics residues between the end of a treatment and the slaughter of the animal (Moretain and Boisseau, 1987). Thus, for each antimicrobial use, the duration between the age of the animal at the end of the withdrawal period and the slaughter age is calculated. If the difference is negative, the conclusion could be "a compliance with the withdrawal period". If the difference is positive, it can be assumed that the meat obtained from the slaughted chicken is suspected to contain antimicrobial residues.

Data analysis

Data were analyzed using Epi Info ™ (version 7. 2. 3. 1) for data entry, Microsoft Excel 2019 for figures, and SAS® University Edition (Version: university.cny.sas.com @sas: university-6p.2 / 6p.2.6198d90b6b19-1-1, SAS Institute Inc., Cary, NC, USA) for the statistical analysis. In this line, a one-way analysis of variance (ANOVA) was applied and a probability level of $P<0.05$ was used in testing the statistical significance of data. In fact, P-values less than 0.05 were considered as statistically significant. Tukey's Kramer test was used to determine significance of mean values for multiple comparison at $P<0.05$ and $P<0.001$.

RESULTS

Among the 18 investigated veterinarians, 8 rejected the project, whereas, the other 10 veterinarians provided 228 broiler breeding bands in which the monitoring of antimicrobial use is complete and regular. Otherwise, only one veterinarian did not practice regular health monitoring. The registration of prescriptions by the veterinarian was for purely economic needs. The samples size randomly chosen from the 228 broiler bands was 65 bands. The selected bands were localized as shown in Figure 1.

All investigated bands breed a 784750 broiler birds, in an average of 3510 (95% IC [2912 – 4110]) per band with 400 birds as a minimum, 3000 birds as a median, and 12000 birds as a maximum.

Antimicrobials use

A total of 304 antimicrobial treatments has been recorded for all broiler breeding. All antibiotics treatments were administered via drinking water. The administration frequency is depending to bird age per weeks and treatment categorie (prophylactic or metaphylactic) (Table 3). Most of prophylactic (preventives) treatments were administered during the first life week (56.6%), the third week (13.2%), and the fourth week (14.5%). Otherwise, no variation was reported for the metaphylactic (treatment against illness) treatment during a week.

All chickens received at least one antimicrobial treatment during a breeding as follows: 9.23%, 26.2%, 20%, 13.9%, 10.8%, 61.5% for 2, 3, 4, 5, 6, 7, and 8 times, respectively. On the other hand, only 4 breedings (6.15 %) received antimicrobial treatments more than 9 times (and max 12) (Table 4). Thus, the results showed that each bird received in average 4.68 antibiotic treatment (95% IC [4.12 – 5.23], median = 4 and 99th =12).

Regarding the purposes of antimicrobials use, it has been noted that 25% of cases were found to be for prevention purpose, 55.3% were used against digestive concerns, and 17.1% were used to prevent respiratory diseases (especially those assigned to *Mycoplasma*). Furthermore, 75% of treatment cases were noticed to be used for therapeutic aims with 49.1% and 45.6% to treat respectively respiratory and digestive diseases. In the whole, the reasons for antimicrobials administration are mainly digestive (48.0%) and respiratory (41.1%) problems.

The causative microbial agents suspected were coccidia (23.4%), *E. coli* (21.7%), *Mycoplasma* assigned or not with virus (17.7%) and *Salmonella* (14.8%). As reported in Table 5, the coccidia and *Salmonella* were involved in the digestive and mortality concerns. Unfortunately, no confirmation of causal agent was realized.

The antimicrobial association has been prescribed in 42.8% of cases, in which 60.7% were factory associations, while 39.3% were prescribed by veterinarians.

By ANOVA, there were significant differences in the seasonal distribution of antimicrobial treatments (Fig 2), given that the majority of broiler flocks were reared in poultry houses without climate control systems. Spring is the season when the farms received more treatments (P<0.05).

Antimicrobial consumption per class and molecule

Table 6 summarized the different antimicrobial molecules used in broiler breeding in the studied region of Ain Defla. Regarding the frequency of antimicrobial use by class, the study found that quinolones class was the most widely used class of antimicrobials (24.4%), followed by the class of tetracyclines (22.5%), sulfonamides (20.1%) and polypeptides (12.1%). Macrolides and beta-lactams come last (4.02% and 3.22% respectively).

The investigation revealed that enrofloxacin was the most commonly used molecule with a frequency of 19.6% (237236 birds) with an average exposure of 4.05 days (95% CI [3.81 - 4.30]). It was followed by oxytetracycline with a frequency of 14.5% (166509 birds) with an average exposure of 3.24 days (95% CI [2.89 - 3.59]).

The total amount of antimicrobials per kg of chicken meat produced in this investigation was 92.8 kg of all active ingredients for 580415 kg equivalent of broilers at slaughter age. On average, 160 mg of active component was administered per kg of chicken meat produced.

The prescribed daily dose (PDD) was calculated for the various antimicrobial molecules identified (Table 6). For enrofloxacin, oxytetracycline, the sulfonylurea + trimethoprim combination, colistin, doxycycline, flumequine, tylosin and amoxicillin, the PDD (95% CI) were as follows: enrofloxacin, 27.6 mg/kg/d (21.7-33.5); oxytetracycline, 39.5 mg/ kg/d (28.7-50.4); the combination sulfonamides + trimethoprim, 48.3 mg/ kg/day (33.7-62.7); colistin, 416×10^3 IU/ kg/d (204×10^3 IU- 627×10^3 IU); doxycycline, 48.3 mg/ kg/d (34.5-62); flumequine, 29.8 mg/kg/d (18.7-40.8); tylosin, 59.5 mg/kg/d (39.9-79.2), and amoxicillin, 36.7 mg/kg/d (19.6-53.9). No significance (P>0.05) was found by a linear regression performed between PDD and duration of treatment.

Concerning the calculation of nDDkg and nCDkg, they were related to the total mass of the slaughtered chickens. The nDDkg was 10.5, while the nCDkg was 2.66. The nDDkg and nCDkg for each molecule is shown in Figure 3. It was noted that chickens are more exposed to colistin, doxycycline, oxytetracycline and enrofloxacin.

Non-respect of withdrawal period

The calculation of the duration between the age of the animal at the end of the withdrawal period and the slaughter age makes it possible to identify the broiler bands from which the meat of the resulting chicken may contain antimicrobial residues. These latter were 22 (33.9%) farms among the surveyed farms. Their meats may contain residues of only one antimicrobial (12/22), two antimicrobials (9/22), and even three antimicrobials (1/22). Sulfonamides come first with 31.3% of antimicrobials, tetracyclines with 28.1%, quinolones with 25.0 %, polypeptides and macrolides with 3.13% each, and other antimicrobials with 9.38%. In terms of meat production, these withdrawal violations affect around 22.2% of slaughtered chickens and 20.1% of meats made available to the consumer.

Regarding the effect of the number of treatments administered and the exposure to different doses on failure to comply with the withdrawal period, an ANOVA test was performed using SAS® University Edition. There was a very significant (P <0.001) effect of the number of antimicrobial treatments. More the number of treatments is higher more there is a tendency for non-compliance with withdrawal periods: such situation suggested the presence of antimicrobial residues in meat intended for human consumption (Figure 4). The effect of exposure to different doses of antimicrobials has been demonstrated (P<0.05): more the chickens are exposed to high doses of antimicrobials, more the withdrawal period will be violated.

DISCUSSION

Several information sources have been suggested by the Terrestrial Animal Health Code Manual (2019) regarding the antimicrobials use in poultry farming (OIE, 2019). To better understand the relationship between antibiotics use and the development of antimicrobial resistance, some information must be available such as reasons for their use, number of prescriptions, as well as dose and duration of each treatment (Gyssens, 2001). Actually, in Algeria, there is no system for monitoring the antibiotics use in chicken broiler breeding. Thus, this work was realized.

The data were collected through a face-to-face type survey. In the first visit, veterinarians were sensitized on the study subject. They have selected only the bands with full antibiotics use information, because several bands driving have not a complete monitoring. Then, a second visit was organized for a well investigation. Data validation was not possible because it requires independent verification with other prescription records, which it is impossible at present. In fact, Algerian veterinarians are not obliged to record their prescriptions with the veterinary authorities. Thus, veterinarians are considered to be the most trustworthy way of obtaining accurate information on the type of prescriptions, dosage, duration of treatment (days), age of chickens at treatment, and the amount of active compound administered as shown by Chauvin *et al.* (2002) and OIE (2019).

The results of this survey showed that antimicrobials are administered to broilers. In fact, 100% of the studied bands received antibiotic treatments for at least 5 days during the rearing period. The reasons for this regular consumption were various: poor breeding conditions, bad breeding practices, poor quality of day-old chicks, poor quality of animal feed, veterinary practices and lack of control by the authorities responsible for the safety of animal production.

The structure of the poultry industry in Algeria makes difficulties to the small breeders to acquire controlled poultry building. Breeders invest little in their production tool due to the high cost of such investments high. In addition, public development programs for the poultry sector concern only the buildings improvement (Mahmoudi *et al*., 2015; Kaci and Kheffache, 2016). Consequently, broiler farms are continually under influence of seasonal variations associated with insufficient or completely absent biosecurity measures. This situation frequently leads to the use of antimicrobial agents to treat flocks. Another important factor in Algeria is the spread of certain viral pathogens such as Newcastle, Gumboro and infectious bronchitis viruses (Berghiche *et al*., 2018). Viral pathogens result to more secondary infections with *Escherichia coli*, which further will increase the use of antimicrobial treatments (Nolan *et al.,* 2017). The bad quality of day-old chicks can be considered the primary factor in the use of antimicrobials in broilers during the first week of age. The high prevalence of infections due to *Salmonella*, *Mycoplasma* and *Escherichia coli* (Table 3) during the first week of life, leads to systematic use of antimicrobials. This could explain why 23.7% (72/304) of the treatments were given during the first week of age. These results are in agreement with a similar study carried out in Morocco (Rahmatallah *et al*., 2018), where 41.0% of treatments were administered during the first week of life. In France, a third of the treatments recorded in broiler production were administered during the 5 first days of breeding (Chauvin, 2009). Veterinarians can also be recognized as potential contributors to this consumption of antimicrobials. Several overdoses were observed (Table 6). Indeed, colistin is recommended at a dosage of 75×10^3 IU/ kg/day (3.66 mg/kg/day), doxycycline at a dosage of 20 mg/kg/day, enrofloxacin at a dose of 10 mg/kg /day, flumequine at a dose of 9-12 mg/kg/day, amoxicillin at a dose of 20 mg/kg/day, and tylosin at a dose of 75-100 mg/kg /day (Bensemmane *et al.,* 1995; Fontaine and Cadore, 1995; MADR/DSV, 2004; ANSES, 2020b). This could suggest that prescribers are contributing to the overuse of antimicrobials. Veterinarians should apply good antimicrobial prescription practices insisting on the need for an accurate diagnosis, an appropriate choice of antimicrobials, the best prescribed dose, and an appropriate laboratory tests indicating that bacterial disease has been confirmed or can reasonably be suspected to be the cause of the clinical signs (Passantino, 2007). In addition, breeders should be informed that antimicrobials are used when absolutely necessary and must abstain to resort to excessive prophylactic treatments. Providing training to veterinarians and breeders on the use of antimicrobials was among the key actions developed by the WHO Advisory Group (WHO-AGISAR), EMA and EFSA (Aidara-Kane, 2012; Murphy *et al.*, 2017).

The survey revealed that the prescription of the treatments was much more metaphylactic (3/4) than prophylactic (1/4), with concentration of prophylactic treatments during the first week of life and during the third and fourth weeks. This means that broiler breeding in Algeria is subjected to many challenges related to pathologies. The veterinarians explained the use of prophylactic treatments by the early mortality of chicks caused by infection with *Salmonella* and *Escherichia coli*, high prevalence of respiratory diseases (Rahmatallah *et al.*, 2018), and the exposition of coccidia in the third and the fourth week of life. For metaphylactic treatments, the main reasons were the control of CRD (45 treatments) often complicated by colibacillosis (58 cases), *Salmonella* infections (20 treatments), coccidiosis (60 treatments) and other unspecified diseases such as arthritis (45 cases) and mortality (9 cases).

Regarding the frequencies of antibiotic treatments, our results showed that the most commonly used antimicrobials were enrofloxacin (19.6% of treatments), oxytetracycline (14.5%), colistin (12.1%), the combination sulfonamides + trimethoprim (8.80%), and doxycycline (8%). Our results are similar to those found in Morocco except that colistin is the most widely used followed by enrofloxacin (Rahmatallah *et al*., 2018). In France, polypeptide, tetracycline and penicillin antibiotic families occupied the first ranks (ANSES, 2020a). On the other hand, it is important to denote that exposure to fluoroquinolones is in marked decrease: since 2017 there has been a decrease in exposure of - 30% (ANSES, 2020a). In China, amoxicillin is the most widely used antibiotic (76.5%) followed by norfloxacin, ofloxacin, ceftriaxone and oxytetracycline (Xu *et al*., 2020). In Vietnam, sulfonamides, beta-lactams, tetracyclines, aminoglycosides, ionophores, as well as colistin are commonly used in poultry (Kim *et al*., 2013). Of lower frequency, penicillin was the most used antimicrobial via drinking water in Canada with 4% of farms monitoring, followed by penicillin-streptomycin and sulfaquinoxaline (Agunos *et al*., 2017). The main reasons for these differences are: i) veterinarians in some countries recommended the administration of antimicrobials via food (Agunos *et al*., 2017), and other countries banned this practice (Murphy *et al*., 2017), ii) the data collection method is different from one study to another (farms, prescribers, distribution companies), iii) the regulatory and political aspect of certain countries which have developed strategies to reduce the consumption of antimicrobials such as France for the Ecoantibio plan (ANSES, 2020a).

In mg/kg, we found that the consumption of different antimicrobials in relation to the total weight was 160 mg/kg. This value is lower than that found in Pakistan (251 mg/kg) (Mohsin *et al*., 2019), but it is higher than that observed in Morocco with 63.4 mg/kg (Rahmatallah *et al*., 2018), and in France with 38.9 mg/kg (ANSES, 2020a). It should be noted that the comparison with these results is limited due to the differences in the data collection and the methodology adopted. In our study, the data were obtained from prescribers and related only to antimicrobials used in metaphylaxis or for prophylaxis in broilers and not to growth promoters and antimicrobials included in poultry feed. The current global average was around 50 mg/kg. This concentration has been proposed as a potential target for global regulations on the use of antimicrobials in livestock (O'neill *et al.*, 2016).

Concerning nDDkg and nCDkg, which are exposure indicators used in France since 1999 (Werner *et al.*, 2018) to quantify the mass of meat exposed to antimicrobials, we found that these values greatly ($P<0.05$) exceeded those reported in France by 0.57 and 0.11 respectively (ITAVI, 2019). This difference can be explained by the excessive dosage of antimicrobials as discussed for PDD and by repeated exposure several times during the chicken's life, in addition to the absence of control systems for the antimicrobials use and the lack of substitutes for antimicrobials such as probiotics.

Failure to comply with withdrawal times concerned 33.9% of the breeding bands surveyed, which corresponded to 22.2%. Therefore, these meats normally contained corresponding antimicrobial residues. We did not test meats for these antimicrobial residues to confirm this suspicion. However, the presence of antibiotic residues in poultry and chicken meat in Algeria has been reported in the literature. In fact, it varies from 3% to more than 85% (Titouche, 2014; Baazize-Ammi *et al.*, 2020; Djamai, 2020). This presence is mainly due to the non-compliance of withdrawal times and the lack of control on antimicrobial residues in meat by Algerian veterinary authorities after chicken slaughtering. This latter seems to be late considering that the laws regarding antimicrobial residues were not published until recently.

CONCLUSION

To our knowledge, this study is the first report on quantitative estimation of the antimicrobials use in broiler chickens in Algeria. It shows that antimicrobials are commonly used with higher administered amounts. Many actors are identified as plausible causes of this increasing use: day-old chick producers, feed producers, breeders, veterinarians, and veterinary authorities. Hence, a need to adopt an approach to improve the quality of broiler production as well as measures of controlling the use of antimicrobials is strongly recommended.

The administration of antimicrobials must be a case-by-case solution for the control of an infectious problem and in no case a systematic correction to zootechnical faults. The national authority responsible for the production and control of food of animal origin should put in place systems and regulations for monitoring antimicrobial use and levels of antibacterial resistance in animal's production.

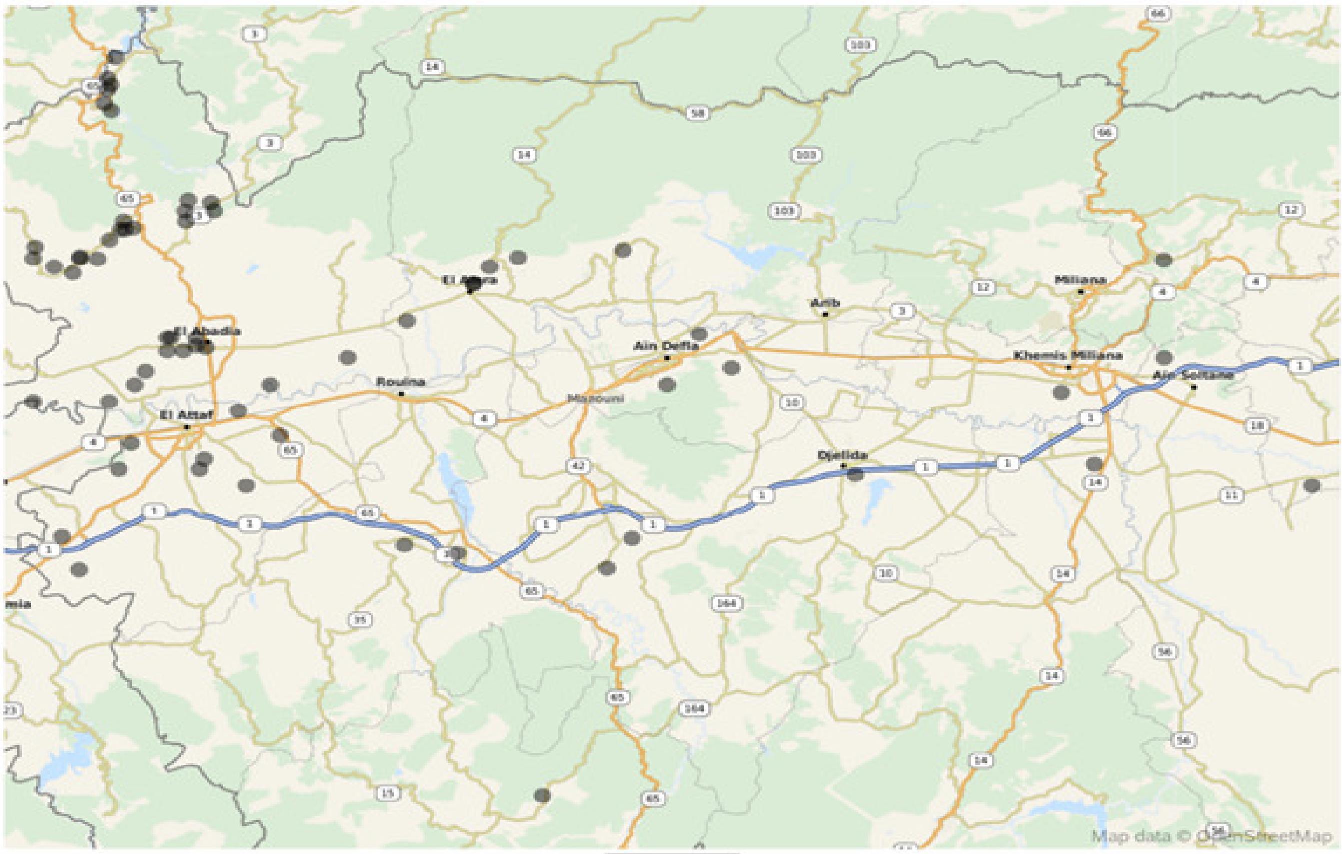

Fig. 1 : Distribution of the breeding bands retained on the territory of the XXX province.

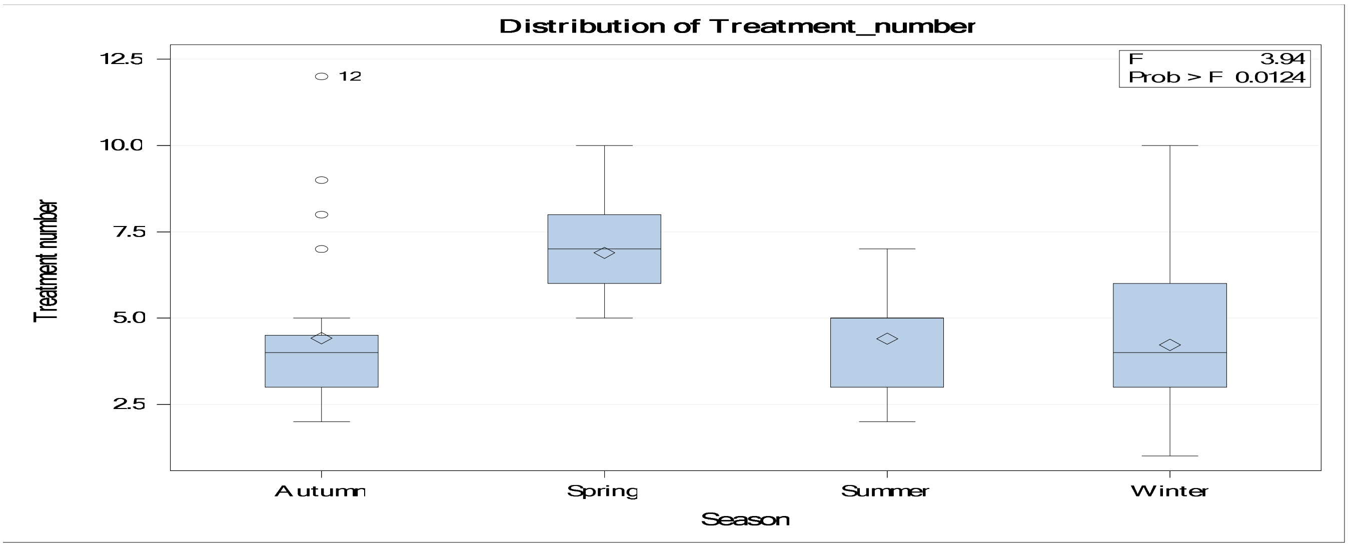

Fig 2 : Distribution of the treatments number according to the seasons

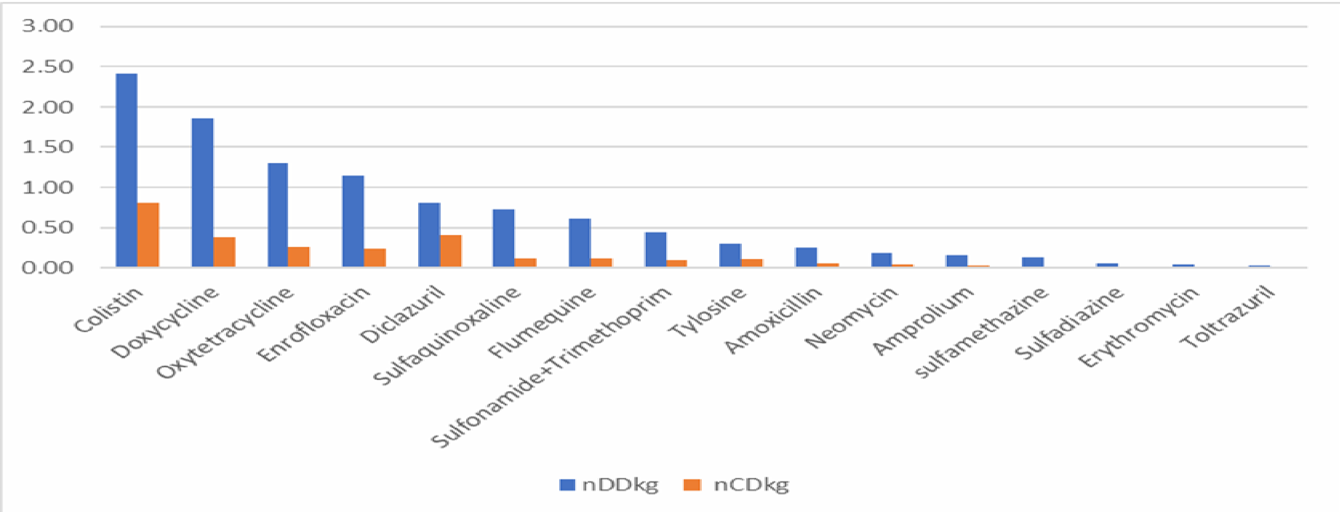

Fig. 3 : nCDkg and nDDkg of each molecule.

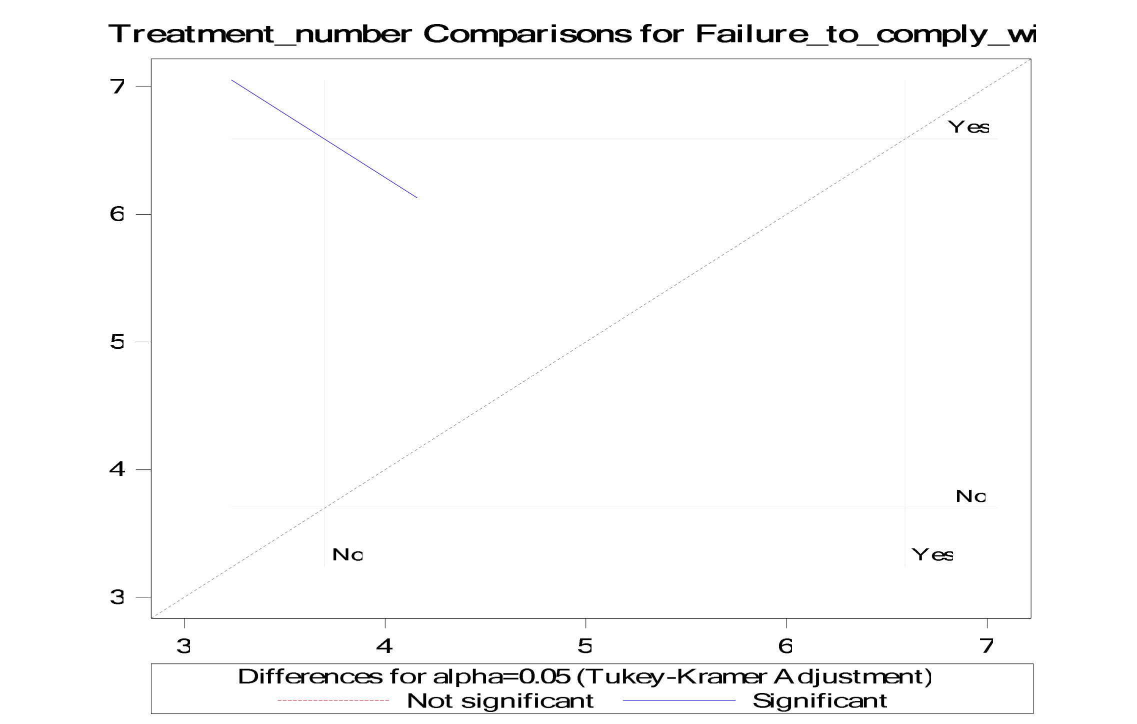

Fig. 4 : Comparison of the number of treatments according to the failure to respect the withdrawal periods by the Tukey Kramer test.

Table 1 : Questions included in the survey distributed to veterinarians practicing in the XXX province.

Question object	Response type
First page	
1. Farmer	Open
2. Address	Open
3. Veterinarian	Open
4. Address	Open
5. Date of implementation	Open
6. Race	Open
7. Number	Open (number of heads)
8. Slaughter weight	Open (in kg)
9. Slaughter age	Open (in days)
10. Mortality	Open (number, or percentage)
Second page	
1. Treatment order	Open (Number)
2. Medication date	Open (start date of treatment or age of animal)
3. Trade name	Open
4. Active compound	Open
5. Concentration	Open (determine the unit)
6. Quantity allocated and conditioning	Open (number of cans, sachet, vials, etc.)
7. Indication of use	Digestive Respiratory Locomotor Mortality Others (explain)
8. Type of use	Prophylaxis Metaphylaxis
9. Suspected pathogen	Open
10. Duration and dose of treatment	Open
11. Average weight at the beginning of treatment	Open

Table 2 : Indicators used in antimicrobials quantification.

Indicator	Definition	Formula	Source
AAc (Amount in mg per kg)	milligram of active ingredient per kilogram of carcass	$Amount\ in\ mg\ perkg = \frac{AAc}{Tw}$	ANSES (2020a)
PDD	the administered quantity of the active coumpound of each molecule per 1 kg of body weight of the animal and per day	$PDD_{\frac{mg}{kg}/j} = \frac{\left[\frac{AAc\ (kg) * 10^6}{ASw\ (Kg) * NVa}\right]}{TD\ (d).}$	Chauvin *et al.* (2002)
nDDkg	the weight amount of antibiotics administered by the daily dose used for this drug.	$nDD_{kg} = \frac{AAc\ (kg)}{DDr\ (\frac{\frac{mg}{kg}}{d})}$	ANSES (2020a) ITAVI (2019) Sanders *et al.* (2017)
nCDkg	Division of the amount of antibiotics administered by the dose needed to treat one kg of a typical animal over the total duration of treatment.	$nCD_{kg} = \frac{AAc}{DDr\ (\frac{\frac{mg}{kg}}{d}) * TD}$	

AAc = amount of active compound, NVa = number of viables animals, ASw = average slaughter weight, TD = treatment duration, DDr = daily dose recommended, Tw = treated weight.

Table 3 : Distribution of treatments (Frequency/Pourcentage) by week-age according to their type of use and the pathogen involved.

	Type of treatement		Pathogen involved				
.	**Prophylaxis**	**Metaphylaxis**	**Coccidia**	***E. coli***	***Mycoplasma***	***Salmonella***	**Others**
Week 1	43	29	4	14	17	28	9
	56.6	12.7	5.63	21.2	31.5	62.2	13.2
Week 2	2	23	6	8	5	2	4
	2.63	10.1	8.45	12.1	9.26	4.44	5.88
Week 3	10	25	11	5	4	2	13
	13.2	11.0	15.5	7.58	7.41	4.44	19.1
Week 4	11	36	12	9	10	5	11
	14.5	15.8	16.9	13.6	18.5	11.1	16.2

Week 5	6	49	15	18	12	1	9
	7.9	21.5	21.1	27.3	22.2	2.22	13.2
Week 6	2	29	12	3	4	2	10
	2.63	12.7	16.9	4.55	7.41	4.44	14.7
Week 7	1	20	6	2	1	3	9
	1.32	8.77	8.45	3.03	1.9	6.7	13.2
Week 8	1	12	5	3	1	2	2
	1.32	5.26	7.04	4.55	1.85	4.44	2.94
Week 9	0	5	0	4	0	0	1
	0	2.19	0.00	6.06	0.00	0.00	1.47
Total	76	228	71	66	54	45	68

Table 1 : Frequency of number of treatments per broiler breeding band.

Number of treatments	Frequency	Percentage
1	1	1.54
2	6	9.23
3	17	26.2
4	13	20.0
5	9	13.9
6	7	10.8
7	4	6.15
8	4	6.15
9	1	1.54
10	2	3.08
12	1	1.54

Table 2 : Distribution of suspected causative pathogens based on disease symptomatology.

Frequency	Digestive	Locomotor	Mortality	Respiratory	Others	Total
Coccidia	62	0	8	0	1	71
E. coli	36	0	1	27	2	66
Mycoplasma	0	0	0	53	1	54
Salmonella	45	0	0	0	0	45

Table 3 : Frequency, quantity, duration of treatment, number of chickens treated and PDD of some administered antimicrobials .

			Amount of active compound					Treatment duration				Prescribed daily dose (PDD)		
Active compound	N obs	%	Mean	Sum	Lower bound of the CI at 95%	Upper bound of the CI at 95%	Number of treated birds	Mean	Sum	Lower bound of the CI at 95%	Upper bound of the CI at 95%	Mean	Borne inférieure de l'IC à 95%	Upper bound of the CI at 95%
Amoxicillin	12	32%	023	280	010	037	49418	450	54	399	501	367	196	539
Amprolium	8	21%	039	308	006	071	33287	338	27	261	414	281	128	435
Colistin	45	121%	011	514	005	017	154009	322	145	296	349	203	997	306
Diclazuril	18	48%	001	024	001	002	90745	200	36	//	//	243	079	407
Doxycycline	30	80%	072	216	045	098	103857	410	123	364	456	483	345	62.0
Enrofloxacin	73	196%	009	667	006	012	237236	405	296	381	430	276	217	335
Erythromycin	3	08%	015	045	-039	069	10245	233	7	090	377	212	-3394	764
Flumequine	18	48%	024	427	017	030	39691	378	68	331	425	298	187	408
Neomycin	21	56%	010	207	007	013	106013	281	59	219	343	976	441	151
Oxytetracycline	54	145%	028	151	021	035	166509	324	175	289	359	395	287	504
Sulfadiazine	13	35%	012	156	008	016	37103	369	48	298	441	809	659	959
Sulfonamide +Trimethoprim	33	88%	035	117	028	043	83873	309	102	274	344	482	338	627
Sulfaquinoxaline	16	43%	022	357	014	031	47132	350	56	288	412	171	144	197
Toltrazuril	4	11%	002	0,09	-001	006	17272	200	8	//	/	224	-146	594
Tylosine	12	32%	108	13	055	161	49014	333	40	284	383	595	399	792
Sulfamethazine	13	35%	012	156	008	016	37103	369	48	298	441	809	659	959

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Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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REFERENCES

Aarestrup, F.M (1999) Association between the consumption of antimicrobial agents in animal husbandry and the occurrence of resistant bacteria among food animals. *Int. J. Antimicrob. Agents.,* 12(4): 279-285.

Agunos, A.; Léger, D.F.; Carson, C.A.; Gow, S.P.; Bosman, A.; Irwin, R.J. and Reid-Smith, R.J. (2017) Antimicrobial use surveillance in broiler chicken flocks in Canada, 2013-2015. PLOS ONE 12: e0179384.

Aidara-Kane, A. (2012). Containment of antimicrobial resistance due to use of antimicrobial agents in animals intended for food: WHO perspective. *Rev. Sci. Tech.,* 31: 277-287.

Alloui, N. and Bennoune, O. (2013) Poultry production in Algeria: Current situation and future prospects. *World's Poultry Science Journal*, 69: 613-620.

Aviagen Group (2020) Arbor Acres Guide d'élevage du Poulet de Chair.https://eu.aviagen.com/assets/ Tech_ Center/BB_Foreign_Language_Docs/French_TechDocs /AA-BroilerHandbook2018-FR.pdf. (Download 2020 - 09-11).

Baazize-Ammi, D.; Dechicha, A.S.; Tassist, A.; Gharbi, I.; Hezil, N.; Kebbal, S.; Morsli, W.; Beldjoudi, S.; Saadaoui, M.R. and Guetarni, D. (2020). Recherche et quantification des résidus d'antibiotiques dans le muscle du poulet de chair et dans le lait dans la région centre d'Algérie. *Rev. Sci. Tech.,* 38 :863-877.

Bensemmane, A.; Tber, A. and Zarrouk, K. (1995). Dictionnaire des médicaments vétérinaires au Maghreb, Editions du Point vétérinaire, France, 262p.

Berghiche, A.; Khenenou, T.; Kouzi, A. and Labiad, I. (2018). An investigation on the predominant diseases, its diagnosis, and commonly used drugs in the poultry farms in the North-Eastern regions of Algeria. *Vet. World*, 11: 986-989.

Catry, B.; Laevens, H.; Devriese, LA.; Opsomer, G. and De Kruif, A. (2003). Antimicrobial resistance in livestock. *J. Vet. Pharmacol. Ther.,* 26: 81-93.

Chauvin, C. (2009). Usage des antibiotiques et résistance bactérienne en élevage de volailles [These de doctorat]. *Univ de Rennes* 1, 310 p.

Chauvin, C.; Madec, F.; Guillemot, D. and Sanders, P. (2001). The crucial question of standardisation when measuring drug consumption. *Vet. Res.,* 32: 533-543.

Chauvin, C.; Beloeil, P.A.; Orand, J.P.; Sanders, P. and Madec, F.A. (2002). Survey of group-level antibiotic prescriptions in pig production in France. *Prev. Vet. Med*., 55: 109-120.

Cobb Vantress Inc (2020). Performances et Recommendations Nutritionnelles. 2020.

Djamai, A. (2020) Les résidus d'antibiotiques dans la viande de poulet de chair: Prévalence des résidus d'antibiotiques dans la chair du poulet destiné à la consommation humaine, Bejaia, Algérie. *Éditions universitaires européennes*, 116p

Fontaine, M. and Cadore, J.L. (1995). Vade-mecum du vétérinaire, *Edition Vigot, France*, 1672p.

Food and Agriculture Organization (FAO) (2020) FAO Statistical Yearbook 2020. Italy: FAO; Doi.10.4060/ cb1329en.

Guy, J.S. and Garcia, M. (2008) Laryngotracheitis. In: Diseases of Poultry, Y.M. Saif, A.M. Fadly, J.R. Glissen, L.R. McDougald, L.K. Nolan amd D.E. Swayne (eds) 12th Ed, Wiley-Blackwell, 137-152p

Gyssens, I.C. (2001). Quality measures of antimicrobial drug use. Int. J. Antimicrob. Agents 17: 9-19.

Hubburd, A. (2019) BROILER Performance objectives. https://www.hubbardalgerie.com/wpcontent/uploads/2019/11/Broiler_Performance-Objectives_Efficiency-Plus_20190715.pdf. (Download 2020-09-09).

Institut technique de l'aviculture (ITAVI) (2019). Réseau professionnel de Références sur les usages d'Antibiotiques en élevage Avicole. https://www.itavi.asso.fr/content/reseau-professionnel-de-references-sur-les-usages-dantibiotiques-en-elevage-avicole. (Accessed on nobember 6, 2020).

Jensen, V.F.; Jacobsen, E. et Bager, F. (2004). Veterinary antimicrobial usage statistics based on standardized measures of dosage. *Prev. Vet. Med.,* 64: 201-215.

Kaci, A. and Kheffache, H. (2016) La production et la mise en marché du poulet de chair dans la wilaya de Médéa (Algérie): Nécessité d'une coordination entre acteurs. *Les Cahiers du Cread*, 118 : 113-132.

Kim, D.P.; Saegerman, C.; Douny, C.; Ton, V.; Bo, H. and Dang Vu, B. (2013). First survey on the use of antibiotics in pig and poultry production in the Red River Delta region of Vietnam. *Food Public Health* 3: 247-256.

L'Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (ANSES) (2020a) Suivi des ventes d'antibiotiques vétérinaires Anses-Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail.

L'Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (ANSES) (2020b) Index of veterinary medicinal products authorized in France.

Mahmoudi, N.; Yakhlef, H. and Thewis, A. (2015). Caractérisation technico-socio-professionnelle des exploitations avicoles en zone steppique (wilaya de M'sila, Algérie). *Cah. Agric.,* 24: 161-169.

McEwen, S.A. and Fedorka-Cray, P.J. (2002). Antimicrobial Use and Resistance in Animals. Clin. Infect. Dis 34(Supplement_3); S93-S106.

Mehdi, Y.; Létourneau-Montminy, M.P.; Gaucher, M.L.; Chorfi, Y.; Suresh, G.; Rouissi, T.; Brar, S.K.; Côté, C.; Ramirez, A.A. and Godbout, S. (2018). Use of antibiotics in broiler production: Global impacts and alternatives. *Animal Nutrition* 4:170–178.

Ministère de l'Agriculture et du Développement Rural/Direction des service veterinaire (MADR/DSV) (2004). Dictionnaire des medicaments a usage veterinaire. Algerie : Editions du Ministere de l'agriculture et du developpement agricole, 322 p.

Mohsin, M.; Boeckel, T.P.V.; Saleemi, M.K.; Umair, M.; Naseem, M.N.; He, C.; Khan, A. and Laxminarayan, R. (2019). Excessive use of medically important antimicrobials in food animals in Pakistan: A five-year surveillance survey. *Global Health Action* 12(sup1): 1697541.

Moretain, J.P and Boisseau, J. (1987). Elimination of polypeptide antibiotics (colistin and bacitracin) in the milk after intramuscular or intramammary administration. *Ann. Rech. Vet.,* 18: 405-413.

Murphy, D.; Ricci, A.; Auce, Z.; Beechinor, J.G.; Bergendahl, H.; Breathnach, R.; Bureš, J.; Pedro, J.; Da Silva, D.; Hederová, J.; Hekman, P.; Ibrahim, C.; Kozhuharov, E.; Kulcsár, G.; Persson, E.L.; Lenhardsson, J.M.; Mačiulskis, P.; Malemis, I.; Markus-Cizelj, L.; Michaelidou-Patsia, A.; Nevalainen, M.; Pasquali, P.; Rouby, J.C.; Schefferlie, J.; Schlumbohm, W.; Schmit, M.; Spiteri, S.; Srčič, S.; Taban, L.; Tiirats, T.; Urbain, B.; Vestergaard, E.M.; Wachnik-Święcicka, A.; Weeks, J.; Zemann, B.; Allende, A.; Bolton, D.; Chemaly, M.; Salvador, P.; Escamez, F.; Girones, R.; Herman, L.; Koutsoumanis, K.; Lindqvist, R.; Nørrung, B.; Robertson, L.; Ru, G.; Sanaa, M.; Simmons, M.; Skandamis, P.; Snary, E.; Speybroeck, N.; Ter Kuile, B.; Wahlström, H.; Baptiste, K.; Catry, B.; Cocconcelli, P.S.; Davies, R.; Ducrot, C.; Friis, C.; Jungersen, G.; More, S.; Madero, C.M.; Sanders, P.; Bos, M.; Kunsagi, Z.; Edo, J.T.; Brozzi, R.; Candiani, D.; Guerra, B.; Liebana, E.; Stella, P.; Threlfall, J. and Jukes, H. (2017). EMA and EFSA Joint Scientific Opinion on measures to reduce the need to use antimicrobial agents in animal husbandry in the European Union, and the resulting impacts on food safety (RONAFA). *EFSA Journal* 15: e04666.

Nolan, L.K.; John, B.H.; Vaillancourt, J.P.; Abdul-Aziz, T. and Logue, C.M. (2017). Colibacillosis, in: Diseases of Poultry, D.E. Swayne (eds), Jo*hn Wiley & Sons Ltd*, 751-805p.

O'neill, J. (2016). Tackling Drug-resistant Infections Globally: Final Report and Recommendations. Review on Antimicrobial Resistance. HM Government and Welcome Trust, UK.

Passantino, A. (2007). Ethical aspects for veterinarians regarding antimicrobial drug use in Italy. *Int. J. Antimicrob. Agents*, 29: 240-244.

Rahmatallah, N., Rhaffouli, H.E.; Amine, I.L.; Sekhsokh, Y.; Fihri, O.F. and Houadfi, M.E. (2018). Consumption of antibacterial molecules in broiler production in Morocco. *Vet. Med. Sci*., 4: 80-90.

Rushton, J.; Pinto Ferreira, J. and Stärk, K.D.C. (2017). Antimicrobial Resistance: The Use of Antimicrobials in the Livestock Sector. OECD Food, *Agriculture and Fisheries Paper*s 68; 43p.

Sanders, P.; Perrin-Guyomard, A. and Moulin, G. (2017). Évolution de l'utilisation des antibiotiques en production animale. *Cah. Nutr. Diet.,* 52 : 301-311.

Schwarz, S.; Kehrenberg, C. and Walsh, T.R. (2001). Use of antimicrobial agents in veterinary medicine and food animal production. *Int. J. Antimicrob. Agents,* 17: 431-437.

Titouche, Y. (2014). Recherche des résidus d'antibiotiques dans la viande de poulet de chair par la méthode microbiologique.

Toma, B.; Dufour, B.; Jean-Jacques, B.; Moez, S.; Shaw, A. and Moutou, F. (2010) Épidémiologie appliquée à la lutte collective contre les maladies animales transmissibles majeures. *Association pour l'Étude de l'Épidémiologie des Maladies Animales, France*, 600p.

Werner, N.; McEwen, S. and Kreienbrock, L. (2018). Monitoring Antimicrobial Drug Usage in Animals: Methods and Applications. In: Antimicrobial Resistance in Bacteria from Livestock and Companion Animals, F.M. Aarestrup, S. Schwarz,J. Shen and L. Cavaco (eds), *American Society for Microbiology, Washington*, 569-594p.

World Health Organization (WHO) (2014). Antimicrobial resistance: Global report on surveillance.

World Organisation for Animal Health (OIE) (2019) Code sanitaire pour les animaux terrestres.

Xu. J.; Sangthong, R.; Mcneil, E.; Tang, R. and Chongsuvivatwong, V. (2020). Antibiotic use in chicken farms in northwestern China. *Antimicrob. Resist. Infect. Control*, 9: 1-10.