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Antimicrobial usage in the chicken farming in Yaoundé, Cameroon: a cross-sectional study

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Abstract

Background: Antimicrobials are widely used in chicken production in Cameroon, but no quantitative data are available. A cross-sectional survey was conducted in 98 farms holding 220,262 chickens, from February to May 2015 in six areas of Yaoundé, the capital of Cameroon, to describe and quantify the use of antimicrobials.

Results: All the farms were using antimicrobials via drinking water administration. Twenty types of drugs containing antimicrobials belonging to 9 classes were recorded. 19.4 % of farms used antimicrobials for therapeutic purpose, 11.2 % for prophylactic purpose and 69.4 % for both therapeutic and prophylactic. No disease was recorded in 36. 7 % of farms during the last 3 months and 42.9 % of farms were not following withdrawal periods. Fluoroquinolones, sulfonamides, tetracyclines and nitrofurans were the antimicrobials commonly used by most farms (57.1, 53.1, 46.9 and 17.3 % respectively), whereas sulfonamides, tetracyclines, fluoroquinolones and nitrofurans were quantitatively the most used compounds (48.2, 26.5, 16.1 and 7.6 % of the total amount of antimicrobials used). The ratio of Used Daily Doses (UDD)/Defined Daily Doses (DDD) estimating correctness of dosing showed that enrofloxacin, sulfadimethoxine and trimethoprim were underdosed in most of the administrations whereas ciprofloxacin, doxycycline, erythromycin, flumequine, furaltadone, neomycin, sulfadiazine, sulfadimidin and sulfamerazine were usually overdosed.

Conclusion: High and uncontrolled usage of antimicrobials (sulfonamides, tetracyclines and fluoroquinolones) was noted in chicken farming in Yaoundé, Cameroon, as well as usage of banned substances such as nitrofurans. It is therefore necessary to implement actions that will prevent the misuse of antimicrobials.

Keywords: Antimicrobial, Antimicrobial usage, Chicken, Cameroon

Background

To increase animal production, many chemical compounds are used as veterinary drugs with the aim of treating and preventing animal diseases, as well as improving growth performance (Page and Gautier 2012). However, their misuse can lead to the presence of residues in animal products that may have harmful effects on consumers, raison why maximum residue limits for veterinary drugs were defined in edible tissues of animal origin (Crawford 1985). The use of almost all classes of antimicrobials available for humans has been reported in animal production (WHO 2000), and widespread usage of antimicrobials in animal farming was associated to the development of antimicrobial-resistance which potentially decrease treatment choices for infections (WHO 2000; Apata 2009). Antimicrobial usage in animal farming could select for antimicrobial-resistant bacteria that may spread to humans either through direct contact, consumption of meat or indirectly through environmental pathways (Marshall and Levy 2011). Antimicrobial-resistance is a serious threat to global health associated to a dramatic increase of multidrug-resistant bacteria (Roca et al. 2015). To limit the advent of antimicrobial resistance, the World Health Organization recommended in 2007

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the stop for intensive routine use of antimicrobials in food production animals (Collignon et al. 2009). In some developed countries such as Sweden, Denmark, United Kingdom and Netherlands, strict control of antimicrobial usage coupled with effective surveillance of microbial resistance in the population has successfully reduced the prevalence of antimicrobial resistance (Cogliani et al. 2011; Mackie 2011). In the developing countries as Cameroon, the situation is however different; antimicrobials are readily available in local drug stores without prescription and there is no program to control antimicrobial usage (Nakajima et al. 2010). Such situation is likely to lead to misuse of antimicrobial and therefore favor development of antimicrobial resistance and public health hazards. The aim of the present study was to elucidate the usage of antimicrobials in selected chicken production units in Yaoundé, Cameroon.

Methods

Study design and data collection

This was a cross-sectional survey conducted from February to May 2015 in six areas (Mendong, Mbankomo, Nkolbisson, Byem-assi, Etoug-Ebe and Nsimalen) of Yaoundé, the capital of Cameroon. A total of 98 chicken farms containing 220,262 chickens (broilers) were randomly surveyed. A structured questionnaire was used to get data on antimicrobial usage. Farm owners were asked to provide details information on various antimicrobial drugs used within the last three months, including (i) method of administration, (ii) source of prescription, (iii) reasons for use, (iv) withdrawal period. Quantitative data on each antimicrobial drug administered were collected, including (a) the commercial name of the product and (b) the amount administered; the total amount of active antimicrobial compound was calculated from these data. The Anatomical Therapeutic Chemical classification system for veterinary medicinal products (ATCvet) was used for antimicrobial drug identification (WHOCC 2002).

Data analysis

Data were entered in Excel spreadsheet and descriptive statistic was used to estimate qualitative usage of antimicrobials in poultry farms. The quantity of antimicrobial administered was converted to mg of active substance per kg of live weight. The frequency of use of the different active substances was calculated. As described by Jensen et al. (2004), the defined daily dose (DDD) defined as the determined average maintenance dose per day and per kg chicken of a specific drug was calculated based on the drug's instruction leaflet. For all drugs including combination preparations, the DDD values were estimated for all active substances (antimicrobial). The used daily dose (UDD), describing the amount of active substance as administered by farmers to the animals in mg/kg, was calculated by dividing the amount of antimicrobial compound administered (mg) by the number of chicken times the average weight at treatment to define a standard treated chicken (Timmerman et al. 2006). The UDD/DDD ratios were calculated as a way to assess the correctness of dosage and based on the work reported by Timmerman et al. (2006); ratios between 0.8 and 1.2 were considered as correct dosing while values less than 0.8 and greater than 1.2 were considered to be underdosing and overdosing, respectively.

Results

Qualitative estimate of antimicrobial usage

From the 98 chicken farms visited, the majority (82.6 %) were small-scale units with population size in the range of 100–2000 chickens. Antimicrobial drugs were used in all the farms; 19 (19.4 %) of the chicken farms used antimicrobials for therapeutic purpose, 11 (11.2 %) for prophylactic purpose and 68 (69.4 %) for both therapeutic and prophylactic. No disease was recorded in 36 (36.7 %) of the chicken farms during the last 3 months. Seventy-four (75.5 %) of chicken farms signalled that antimicrobials were prescribed by a veterinary doctor or a zootechnician, while 24 (24.5 %) practiced self-medication. All treatments in visited farms were applied via drinking water administration and 42 (42.9 %) of chicken farms declared not knowing or not applying withdrawal periods. A total of 20 different drugs containing antimicrobial were used among the 98 chicken farms (Table 1), 38 (38.3 %) of the chicken farms used one drug, 28 (28.4 %) used 2 drugs, 25 (25.9 %) used 3 drugs and 7 (7.4 %) 4 drugs. The active ingredients (antimicrobial) of drugs could be accurately described by direct observation of the container (Table 1); 13 drugs contained one antimicrobial, 6 drugs contained two antimicrobials and one drug contained 4 antimicrobials. A total of 17 antimicrobials belonging to 9 classes were indentified (Table 2). The antimicrobials commonly used in most farms were fluoroquinolones, sulfonamides and tetracyclines.

A total of 3 (15.0 %) of the drugs used in the farms contained a combination of an antimicrobial consider to be bacteriostatic with another consider to be bactericidal, 7 (35.0 %) of the drugs contained one or two antimicrobials consider as bactericidal while 10 (50.0 %) included one or two antimicrobials consider as bacteriostatic (Table 3). In the farms visited, 46.4 % of applications were with drugs containing only antimicrobials considered as bactericidal, while 59.6 % applications were with drugs containing antimicrobials consider as bacteriostatic.

Quantitative estimates of antimicrobial usage

Table 4 displays the average dosage applied in the farms, described as DDD and UDD. From the UDD/

Table 1 Antimicrobial drugs used among the 98 chicken farms surveyed in Yaoundé, Cameroon

Trade name	Composition
Amoxicol	Amoxicillin Trihydrate 100 g; Colistin sulfate 500,000,000 UI; Excipient, C.S.P 500 g
Anticox	Sulfadimidine sodique 80 g; Diaverindine 8 g; Excipient (with vitamin K3) 100 g
Anticoc super	Sulfadimerazine sodique 860 g/kg; Diaveridine 105 g/kg
Ciprosol- 200 oral	Ciprofloxacin 200 mg, Excipients ad 1 ml
Clortadona Ts	Erythromycin (estolate) 25 mg/g; Neomycin (sulphate) 35 mg/g; Sulfadimidine (sodium) 100 mg/g; Trimethoprim 18 mg/g; Bromhexine hydrochloride 1.5 mg/g.
Coccivit	sulfadimidine sodique 20 g; sulfadimethoxine sodique 2 g; Diaveridine 3 g; nicotinamide (vitamine PP) 3 g; menadione vitamine K3 2 g; excipient q.s.p. 100 g
Coli-4800 WS	Colistin sulfate 4,800,000 UI; Excipients ad 1 g
Coliflox	Colistin sulfate 1,200,000 IU; Enrofloxacin 100 mg
Diazipim - 48%S	Trimethoprim 80 mg/g; sulfadiazine 420 mg/g
Hipradoxi® P	Doxycycline (hyclate) 100 mg/g
Flumequine 100	Flumequine 100 mg/ml
Flumesol-200 WS	Flumequine 200 mg; Excipients ad 1 g
Furaltadone 300	furaltadone chlorhydrate 300 mg/g
Norfloxacin 20 % oral	Norfloxacine 200 mg; Excipients up to 1 ml
Limoxin-400 WS	Oxytetracycline hydrochloride 400 mg; Excipients ad 1 g
Oxyveto 50S	Oxytetracycline 500 mg/g
Tetracycline SP 324	Tetracycline 324 g/454 g
Trisulmix	Sulfadimethoxine 186.8 mg/g; trimethoprime 40.0 mg/g
Tromexin	Sulfadimidine 200 mg/g; Trimethoprim 60 mg/g; Bromhexine 1.3 mg/g; Tetracycline 110 mg/g
Vetacox	Natrium Sulfadimidin 80 g/100 g; Diaverindin 8 g/100 g

DDD ratio, it was noted that ciprofloxacin, doxycycline, erythromycin, flumequine, furaltadone, neomycin, sulfadiazine, sulfadimidin and sulfamerazine were usually overdosed, while enrofloxacin, sulfadimethoxine and trimethoprim were underdosed. The other compounds (amoxicilin, colistin, norfloxacine, oxytetracycline, pyrimethamine and tetracycline) were usually dosed within the range of correct dosing (UDD/DDD = 0.8–1.2). With 48 % of the total use, sulfadimidin was the most used antimicrobial followed by oxytetracycline (21 %), norfloxacine (12 %) and furaltadone (8 %) (Table 4). In reference to the total use, the classes of antimicrobial most used were sulfonamides (48.2 %), tetracyclines (26.5 %), fluoroquinolones (16.1 %) and nitrofurans (7.6 %).

Table 2 Type of antimicrobials used in the 98 chicken farms surveyed in Yaoundé, Cameroon

Class of antimicrobial	Name of antimicrobial	Number (%) of drugs administered containing the antimicrobial	Number (%) of farms using the antimicrobial
β-lactam	Amoxicilin	1 (5.0)	1 (1.0)
Aminoglycoside	Neomycin	1 (5.0)	1 (1.0)
Diaminopyrimidines	Trimethoprim	4 (20.0)	6 (6.1)
Fluoroquinolones	Ciprofloxacin, enrofloxacin, flumequine, norfloxacine	5 (25.0)	56 (57.1)
Macrolide	Erythromycin	1 (5.0)	1 (1.0)
Nitrofurans	Furaltadone	1 (5.0)	17 (17.3)
Polymyxins	Colistin	3 (15.0)	3 (3.1)
Sulfonamides	Sulfamerazine, sulfadimidine, sulfadimethoxine, sulfadiazine	8 (40.0)	53 (54.1)
Tetracyclines	Doxycycline, oxytetracycline, tetracycline	5 (25.0)	46 (46.9)

Discussion

The antimicrobial usage pattern observed in the present study showed that chicken farms administered antimicrobial medication to control diseases as all the farms investigated used one or more antimicrobial drugs for therapeutic and/or prophylactic purposes. This finding was comparable to previous studies in Africa (Turkson 2008; Nonga et al. 2009; Sirdar et al. 2012; Oluwasile et al. 2014; Bashahun and Odoch 2015) reporting high usage of antimicrobials in poultry production. As noted by Sirdar et al. (2012) in Ethiopia, the preferred method for administration of drugs in the farms visited was mass medication via drinking water. Feed was not used as route of administration; this could be because feed tend not to fully homogenize with drugs or because sick chickens will continue to drink, but will not eat (Sirdar et al. (2012).

In the present study, fluoroquinolones, sulfonamides and tetracyclines were the antimicrobials commonly used by most farms. This result agreed with previous studies in other African countries. In this regards, Nonga et al. (2009), in Tanzania, reported the use of tetracycline and sulfonamides in 90 and 85 % of poultry farms respectively, Ogunleye et al. (2008), in Nigeria, reported high usage of fluoroquinolones (enrofloxacin and norfloxacin) in poultry farms. However, the above qualitative estimates of antimicrobial usage is different of the quantitative estimate of usage, where sulfonamides was by far the most used in quantitative terms, followed by tetracyclines and fluoroquinolones. A similar result was

Table 3 Detailed description of classes of antimicrobial contained in 20 antimicrobial drugs administered by 98 chicken farms

	Aminoglycoside	Sulfonamides	Fluoroquinolones	Nitrofurans	Polymyxins	Tetracyclines	No. applications with each class of antimicrobial
β-lactam					1[a]		1
Diaminopyrimidines		4[c]					4
Macrolide	1[c]						1
Fluoroquinolones			55[a]		1[a]		56
Nitrofurans				17[b]			17
Polymyxins					1[a]		1
Sulfonamides		1[b]					1
Tetracyclines						44[b]	44

[a]bactericidal
[b]bacteriostatic
[c]bactericidal + bacteriostatic
Shaded cells is to indicate that one formulation include macrolide/aminoglycoside/diaminopyrimidines/sulfonamides

obtained by a recent study in Vietnam, where it was suggested that differences between qualitative and quantitative usage could be explained by differences in the doses and concentration of active principles of the different drugs (Carrique-Mas et al. 2015).

Our results suggested that, the use of antimicrobials in chicken production in Cameroon could be problematic as a non-negligible proportion of farms investigated did not relied on veterinarians for prescription (24.5 %) and did not applied withdrawal periods (42.9 %). A similar result was reported by a recent study in the West region of Cameroon, where 49.6 % of farms were not respecting withdrawal (Guetiya et al. 2016). This could be the result of factors such as lack of suitable legislation to support the responsible and prudent use of antimicrobials, lack of knowledge and lack of veterinary services (Vuuren

Table 4 Daily dosages (mg/kg) and dosing ratio of antimicrobial compounds for all treatments registered in the 98 chicken farms at Yaoundé, Cameroon

ATCvet	Antibiotic	DDD	UDD	UDD/DDD	Total used[a] [g (%)]
QJ01CA04	Amoxicilin	9.0	10.0	1.1	11.5 (0.12)
QJ01MA02	Ciprofloxacin	11.4	50.0	4.4	25.0 (0.26)
QJ01XB01	Colistin	47.4	37.5	0.8	82.9 (0.85)
QJ01AA02	Doxycycline	20.0	38.7	1.9	478.1 (4.93)
QJ01MA90	Enrofloxacin	10.0	5.0	0.5	8.0 (0.08)
QJ01FA01	Erythromycin	5.0	6.3	1.3	13.8 (0.14)
QJ01MB07	Flumequine	20.9	31.9	1.5	358.9 (3.70)
QJ01XX93	Furaltadone	20.0	50.0	2.5	738.3 (7.61)
QJ01GB05	Neomycin	7.0	8.8	1.3	19.3 (0.20)
QJ01MA06	Norfloxacine	14.5	11.5	0.8	1170.7 (12.06)
QJ01AA06	Oxytetracycline	40.6	36.5	0.9	2007.0 (20.68)
QJ01EQ10	Sulfadiazine	6.3	21.0	3.3	3.2 (0.03)
QJ01EQ09	Sulfadimethoxine	21.3	12.5	0.6	16.3 (0.17)
QJ01EQ03	Sulfadimidin	33.0	51.0	1.5	4628.3 (47.69)
QJ01EQ17	Sulfamerazine	34.4	63.2	1.8	31.6 (0.33)
QJ01AA	Tetracycline	41.6	37.2	0.9	88.8 (0.91)
QJ01EA01	Trimethoprim	10.8	6.7	0.6	22.3 (0.23)

DDD defined daily dose, *UDD* used daily dose
[a]Percentage of the total amount of antimicrobials (in g) used

2001). Self-medication could be associated with improper and/or illegal usage of antimicrobials while the non-application of withdrawal periods could lead to a high concentration of antimicrobial residues (above MRLs) in animal products as noted by Guetiya et al. (2016) in the West region of Cameroon. According to regulations and guidelines, antimicrobials should only be used to treat infections, respecting the dose, the length of treatment and the withdrawal (Commission Notice 2015/C 299/04). Sixty-nine percent of the farms were using antimicrobials for both therapeutic and prophylactic purposes and about 37 % of the farms did not report any disease during the last 3 months; besides, several antimicrobial were underdosed. This suggested that some antimicrobials were used in the absence of clinical disease, probably to prevent infections or for growth promotion. Such usages have been linked to the development of antimicrobial resistance (Levy and Marshall 2004) as observed in chicken meat from Kenya (Odwar et al. 2014) and Cameroon (Tatsadjieu et al. 2009; Guetiya et al. 2016). In this regards, it has been reported that, the administration of antimicrobials via medicated feed or drinking water (case in the present study) lead to imprecise dosing, as animals can choose what quantity of feed or water to consume, and potentially increase selection for antimicrobial resistance (Love et al. 2011). To limit the development of antimicrobial resistance, multiple jurisdictions such European Union have banned antimicrobial use for growth promotion (European Commission 2005), but others such as the United States are still approving large number of antimicrobials for use in low doses as growth factor, arguing that restriction policies have been harmful to food animal production where they have been adopted (US Government Accountability Office 2011; Maron et al. 2013).

Most of antimicrobials recorded in the present study are considered as critically important (amoxicilin, neomycin, fluoroquinolones, erythromycin, colistin) or highly important (sulfamerazine, sulfadimidin, sulfadimethoxine, sulfadiazine, doxycycline, oxytetracycline, tetracycline) for humans by the World Health Organization (WHO 2012). In the present study, fluoroquinolones were the third most commonly used antimicrobials representing 15 % of all usage in quantitative terms. This is a concern since fluoroquinolones are commonly used as a treatment for multidrug-resistant *Salmonella spp*. in humans (Reina et al. 1993). Besides, the use of fluoroquinolones in chicken causes the development of fluoroquinolone-resistant *Campylobacter*, an etiologic agent of gastroenteritis in humans (Endtz et al. 1991; Randall et al. 2003; Nelson et al. 2007). The use of banned substances such as nitrofurans, which represented 7 % of all usage in quantitative terms, is also a great concern. Nitrofurans have been banned from use in food-producing animals since 1991 in the United States and 1995 in the EU because of concerns over the carcinogenicity of these compounds (FDA Vet 1991; Council Regulation 1442/95).

Results of the present study indicated that usage of antimicrobials in chicken farming is a serious threat to public health in Cameroon, and that it is necessary to take preventive actions. The safety of foods is achieved by the implementation of appropriate rules applied from primary production to retail and requires the participation of all parties involved (Codex Alimentarius 2014). Our results suggested that improper administration of antimicrobials by farmers and the lack of suitable legislation that support responsible use of antimicrobial are the key factors favoring inappropriate and uncontrolled usage of antimicrobials. This indicates that training of farmers on correct administration of antimicrobials as well as improvement of existing veterinary law would be effective strategies to restrict misuse of antimicrobials. On the other hand, it can be questioned whether the use of antimicrobials is always necessary and if alternative methods to manage infectious diseases in animal husbandry such as optimal use of existing vaccines (Potter et al. 2008) and improvement of hygiene (Boklund et al. 2004) cannot be promoted.

Conclusion

The present study revealed that, the use of antimicrobial in chicken farming in Yaoundé, Cameroon is worrisome as all the parameters for the occurrence of antimicrobial resistance and consumers hazards were met: (i) withdrawal periods before selling chickens to the public for human consumption were not followed by 43 % of farmers, (ii) critically important antimicrobial such as fluoroquinolones were among the most commonly used antimicrobials, (iii) several antimicrobials were used in the absence of clinical disease to prevent infections or for growth promotion, (iv) banned substances such as nitrofurans represented 8 % of all usage in quantitative terms, (v) dosage of antimicrobial in many cases was not according to the indications for the product. It is therefore necessary not only to improve existing veterinary legislations, set up a monitoring system, but also to educate farmers on alternative methods for disease management such as vaccination, environmental sanitation and disease containment, which could decrease the use of antibiotics; educate veterinary drug sellers and improve public awareness.

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Authors' contributions
GNM drafted the research protocol, analysed the data and drafted the manuscript; MKG, FTK and HMY helped with data collection under the guidance of GK. All authors edited the manuscript and approved its final contents.

Competing interests
The authors declare that they have no competing interests.

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