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# Investigation into the risk of exposure to antibiotic residues contaminating meat and egg in Ghana

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ABSTRACT

In Ghana and many developing countries, little is known about food safety in relation to antibiotic residues. The objectives of the study were to (i) determine the prevalence of antibiotic residues in animal source food and estimate the risk to consumers (ii) identify factors predisposing animal source food to contamination with antibiotic drug residues. A total of 634 samples of various animal source foods, including beef, chevon, mutton, pork and egg were screened for drug residues. Additionally, epidemiological data related to antibiotic usage on animals and consumption patterns of animal source food was collected from animal farmers and consumers of animal source food respectively. Overall, the prevalence of drug residues in animal source food was 21.1%, which translates to an average risk of exposure every fifth time animal source food is consumed. The prevalence rates of drug residues in the various animal source foods were; 30.8% (beef); 29.3% (chevon); 28.6% (pork); 24% (mutton); and 6.8% (egg). The trends of consumption of the animal source foods were similar, and majority of the consumers consumed the food every week. Considering the relatively high contamination rates of animal source food as well as their high rates of consumption, it is likely that consumers experience a high risk of exposure to drug residues, especially through beef. Specific causal factors associated with non-adherence of withdrawal requirements of drugs, and therefore contaminations of food were mainly knowledge related factors. This underscores the importance of health education of farmers in dealing with the problem of drug residues contaminating animal source food.



## 1. Introduction

Concerns about food safety especially, with animal source food are increasing in developing countries where urbanisation, increasing incomes and changing life-styles are associated with greater dependence on marketed foods by an increasing number of people (Delgado, Rosegrant, Steinfeld, Ehui, & Courbois, 1999).

The safety of human food is threatened by various agents including pathogenic microorganisms, aflatoxins, pesticides, and antimicrobial agents. Pathogenic microorganisms constitute the most important food related threat to public health. Relatively, little is known about food safety in relation to antimicrobial agents, in the developing world. While pasteurisation and other forms of heat treatment eliminate pathogenic microorganisms from animal source food, these procedures have limited or variable effects on drug residues in animal source food (Moat, 1988). Various antibiotics used in the treatment of animal diseases have been shown to occur in animal products used as human food (Wassenaar, 2005), and are usually attributed to non-observance of withdrawal periods before sale of animal source food (Roundant & Moreitain, 1990; Shitandi, 2004). Additionally, the drugs may be introduced through the use of antibiotics in animals for therapeutic and growth purposes (Wassenaar, 2005). Behavioral practices such as overuse of drugs and lack of understanding about drug usage also contribute to food contamination. The presence of antibiotics in human food is associated with several adverse public health effects including hypersensitivity, tissue damage, gastrointestinal disturbance, and neurological disorders (Lee, Lee, & Ryo, 2000; Wassenaar, 2005). Additionally, the use of antibiotics in animal husbandry and its occurrence in related food, may lead to selection of resistance in bacterial populations that do not respond to

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treatment commonly used for human illnesses (Lee et al., 2000). Reported occurrences of antibiotics in human food vary widely among various countries and are known to be low or non-existent in places where quality assurance programmes are effective (Aning et al., 2007; EC, 2005; Henzelin et al., 2007; Kang'ethe et al., 2005; Kurwijila, Omore, Staal, & Mdoe, 2006). Such programmes include mainly educational programmes, widespread testing of foods for antibiotic residues, and financial penalties. Implementation of quality assurance programmes to protect public health against adverse effects of antibiotics is a major challenge for developing countries where there is veterinary misuse of such drugs, and sales of animal source food are primarily informal.

In Ghana, very little is known about the usage of antibiotics in animal husbandry, and the public health effects on food safety. A study by Aning et al. (2007) on raw milk indicated that antibiotics may be translocated at high rates into raw milk, though the study did not elaborate the associated causal factors. Apart from raw milk, there is no data on the risk associated with drug residues through animal source food, though majority of Ghanaians consume animal source foods on a regular basis, and there are concerns that some of the drugs being used in animal husbandry may not be safe for humans (Wassenaar, 2005). Currently, there are no major quality assurance programmes in place in the country to protect public health against the adverse effects of antibiotics used in animal husbandry, which is partly due to the lack of research data to inform policy. This study was carried out to help address these needs and to provide fundamental data for future surveillance of these public health hazards.

## 2. Methods

### 2.1. The study area

The study was carried out in the two major cities in Ghana, namely Accra and Kumasi. The climate in the study area is hot and humid, and there is a bimodal rainfall pattern with a mean of 1300 mm. The main rainy season starts from March and ends in mid-July followed by a short dry spell that runs until the end of August. The minor rainy season starts from early September and ends in mid-November. The dry season starts from November to the end of February. The mean daily temperature is 26 °C with a range of 18–35 °C. The relative humidity can be as high 97% in the mornings of the wet season and as low as 20% in the afternoon of the dry season.

### 2.2. Sampling and data collection

The study was carried out from January, 2007 to November, 2008. A stratified, purposive and random sampling methodology was used to select respondents at the farm and consumer levels of the food chain for interviews. Farmers and consumers were randomly selected to cover five types of animals including, cattle, goat, sheep, pig, and poultry. Sampling at the farm level is described as follows. Farmers were invited for a meeting at the various animal farming areas in the city, through the local chief of the area. Farmers who attended the meeting were interviewed. Additionally, farmers were located for interviews through other farmers who had already been sampled. At the consumer level, sampling was carried out in each metropolitan area of the city (only Accra). A metropolitan area consists of several suburbs, and a table of random numbers was used to select one suburb in each metropolitan area, where interviews were to be carried out. Overall, a total of 698 respondents comprising 395 farmers and 303 consumers were enrolled in the study. Data collected from farmers focused on general farm management practices, handling of antibiotics, and withdrawal requirements of drugs. Data collected from consumers focused on consumption patterns of animal source food and consumer risks; this involved frequency of food consumption, knowledge of consumers about possible contamination of food with drug residues and the experience of allergies by consumers. Farm and consumer level interviews were done using structured questionnaires (with a Leikert scale) and precautions were taken to limit bias.

Animal source foods of the various animals were sampled for laboratory analysis. In most cases, it was not possible to obtain meat samples from farmers, so sampling was carried out at slaughterhouses, where meat samples of about 150 g of different animals were collected and frozen until they were ready to be analysed. Egg samples were obtained directly from poultry farmers and retail outlets. A total of 634 animal source food samples were collected from separate animals. This comprised 414 meat (muscle tissue) samples and 220 egg samples; no organ meats were sampled and background information of the animals was not available.

### 2.3. Laboratory analyses

Animal source food samples were screened for antibiotic residues using the microbial inhibition plate test described by Koenen-Dierick et al. (1995) but with some modifications in terms of the antibiotics used as controls. The test detects antibiotic levels above recommended maximum residue for various families of antibiotics including β-lactams, tetracyclines, chloramphenicol, macrolides, aminoglycosides, sulphonamides, and quinolones. Briefly, the test procedure is described as follows: using *Bacillus subtilis* BGA strain as the test organism, a 0.5% McFarland's standard suspension of the organism was prepared. This was used to inoculate the surface of Mueller-Hinton agar plates prepared at pH = 7.0 and containing 0.2 μg/ml of trimethoprim. A sterile 8 mm diameter cork borer was used to create disc shaped meat samples of 2 mm thickness, which were applied to the surface of the agar medium. The cork borer was also used to make wells in the agar medium for introduction of egg samples. The egg samples were homogenized with 10 ml of phosphate buffer (pH 7.0) after which ~1 ml was introduced into wells made in the Mueller-Hinton agar medium. Positive controls were set up with 1 mg/ml of ciprofloxacin, chloramphenicol and tetracycline, while negative controls were set up with distilled water. The agar plates were incubated at 37 °C for 18–24 h. After incubation a zone of inhibition of 1 cm or more was considered a positive case of the meat or egg sample containing drug residues. Positive controls were expected to have zones of inhibition while the negative control was not expected to have any zone of inhibition.

### 2.4. Data analyses

The field and laboratory data collected were entered into MS EXCEL and MS-ACCESS, and analysed in STATA 7.0 (Strata Corp., College Station. Tex.) to address the objectives of the study. The strategies taken to analyse the data involved descriptive statistics, including geometric means, frequencies, ranges and prevalence rates of the study variables. Significant differences, associations, and interrelationships of the variables were assessed at $p < 0.05$. Fischer's exact chi-square was used to compare prevalence rates and means. Specific analyses were carried out to: (i) evaluate the prevalence of drug residues in beef, pork, chevon, mutton, and eggs (ii) evaluate the consumption trends of the various animal source foods, and the associated risk due to drug residues (iii) identify the causal factors of non-adherence to withdrawal requirements of drugs by farmers (iv) ascertain related consumer knowledge of food safety.