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Antibiotic Residues in Foods of Animal Origin: Review

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Abstract
Antibiotic residue in food is a serious public health issue that demands much attention and has a harmful impact on consumer health. The presence of antibiotic residue in food of animal origin creates challenges in global trade in animals and animal products. Public health implications of antibiotic residue in food include the development and propagation of antimicrobial drug resistance, hypersensitivity reactions, carcinogenicity, mutagenicity, teratogenicity, bone marrow suppression, and disruption of normal intestinal flora. Improper use of antibiotics in animals results in the existence of residues beyond maximum limit levels and is associated with harmful health effects in humans. Supervision of antibiotics is required to ensure the safety of animal products. In this review, the use of antibiotics in food animals, antibiotic residues in foods of animal origin, and the effect of different cooking techniques on antibiotic residue levels are discussed.

Keywords: antibiotics, residues, processing, the effect of cooking techniques

1. Introduction

Veterinary medicines, particularly antibiotics, are among the most significant composites related to animal feed products (McEwen et al., 2002). Roughly 80 of the food-producing animals used in food products are–treated with veterinary remedies throughout their lives (Pavlov et al., 2008). Antibiotics are defined as substances that are suitable to kill or inhibit the growth of colorful microorganisms (McEwen et al., 2002). The World Health Organization (WHO) has developed norms for categorizing antibiotics as “critically important,” “highly important,” and “important” based on their significance in the management of human disease (Food and Drug Administration (2010); Darwish, 2013. Tetracyclines (TCs), -lactams (- LCs), aminoglycosides (AGs), macrolides (hosts), amphenicols (AMPs), sulfonamides (SAs), quinolones (Qs), fluoroquinolones (FQs), and lincosamides (LCs) are the most commonly used antibiotics in both human and veterinary medicine (Kümmerer, 2009). Antibiotics can also be classified based on their chemical structure or mode of action. These medicines can be administered by injection, orally, topically on the skin, or by intramammary and intrauterine infusions in veterinary drugs. The number of residue situations available from the injectable area is greater than the number of situations available from feeding (Katz and Brady, 2000).

Antibiotics are generally used in animals for the treatment and forestallment of different conditions, such as gastrointestinal infections, bacterial infections, mastitis, respiratory conditions, and arthritis (Darwish et al., 2013). Although some of the antibiotics used in animals are not currently used to treat human disease, several, such as tetracyclines and penicillins are used in the management of infections in humans (Maron et al., 2013). In order to help humans from the dangerous goods of veterinary medicine remainder in the food sources, the United Nations Food and Agriculture Organization (FAO), (WHO), and the European Union (EU) have set norms for maximum residue limits in foods. The standard maximum residue limits for tetracycline composites, including chlortetracycline and oxytetracycline, are set at 200 µg/ kg, 600 µg/ kg, and 1200 µg/ kg for cattle-deduced muscle, and liver, independently (Appelgren, 1999; European Commission, 2009; Codex Alimentarius Commission, 2012). The recommended withdrawal period for approved animals' medicines ranges from many days to many weeks (Blanchflower, 1997). The period may vary depending on the medicine used, lozenge, route of administration, and animal species. Failure to observe the suggested period is the main cause of illegal situations of veterinary medicine remainders in animal source food (Hussein and Khalil, 2013). Several foodstuff processing styles are known to help reduce the position of antibiotic remainders in food of animal origin (Akerman et al., 2007; Javadi et al., 2011; Hussein and Khalil, 2013). Nonetheless, a comprehensive review is essential to determine the fate of antibiotics residue after their treatment (Katz, 2000; Phillips et al., 2004; Paturkar et al., 2005; Darwish, 2013). This review discusses the use of antibiotics in food, antibiotic remainders, and the effect of different cooking techniques on antibiotics.

2. Data Collection

Data for this review was attained from journal composition quests of electronic databases similar to Google Scholar, Science Direct, PubMed, and Scopus on antibiotic remainders in food.

Use of antibiotics in food animals

Antibiotics have been used numerous times in animals for different purposes. The ideal parcels that the antibiotic should have in order to be used in animals include the following: It must be safe and effective when used on a wide scale; The medicine must not be used in mortal or veterinary drugs indeed if exceptions might be justified to interpret seriously complications, be get resistant strains to do or be get cross-resistance to other medicines; It should not envenom the other medicines, used as a cover for good sanitation, be get inordinate goods on the body foliage (Paturkar et al, 2005). The main uses of antibiotics can be classified into three main groups: remedial (used for the treatment of conditions), precautionary (used for the prevention of conditions), and growth promoters (used for enhancement of growth rate) (Apata, 2009). Antibiotics that are used for remedial purposes are generally administered for many days, using boluses in amounts greatly more than the Minimum Inhibitory Concentration (MIC) of the affiliated microbe (Songster and Hofacre 2006). The growth promoter class of antibiotics is analogous to those used for remedial purposes, except that the amounts administered to the animals are generally lower. Antibiotic use at low doses for a longer period is, nonetheless, considered to be critical, as it results in the development of resistant bacterial strains.

Antibiotics are also used as feed complements for growth promoters without any monitoring to increase yields (Wegener, 2003). Antibiotics use in developing countries is common. The most generally used antibiotics are tetracyclines, (Zakeri and Wright, (2008), whereby oxytetracycline, ciprofloxacin, and sulfa medicines are applied to treat coccidiosis. Gentamicin (Filazi et al., 2013) neomycin, erythromycin, (Alhendi et al., 2000) fluoroquinolones and their derivations composites are used for treating soft towel infection, gastroenteritis, and skin infections (Sarkozy, 2001) and sulfonamide are used as preventative and chemotherapeutic agents against coccidiosis and fowl typhoid complaint (Kolaczek et al., 2014). Some of the antibiotics used in animals have been shown to have some serious effects on humans.

Idiosyncratic responses like skin rashes and phototoxic dermatitis have been reported in connection with the use of tetracyclines (Yates, 2003): Landers et al., 2012). Streptomycin has significant adverse effects on vestibular mechanisms in the inner observance. This side effect causes a loss of balance. Besides this side effect, invigorated animals exhibit neurotoxicity. Acuity, skin rashes, and convinced fever are the other poisonous causes of this medicine (Dewdney et al., 1991). Certain macrolides may be responsible for liver injury caused by a specific antigenic response to macrolide metabolite-modified hepatic cells (Davies, 2010).

3. Antibiotic Remainders

In Tanzania, numerous studies have been conducted based on the use of antibiotic remains in animals. Antimicrobial remains were detected in 36 retailed milk samples from milk force chains in and around Mwanza and Dar es Salaam between 1999 and 2002 (Kurwijila et al., 2006). Katakweba et al., (2012) stated also that several medicines, similar to oxytetracycline, are used aggressively to treat and cover cattle against colorful conditions. Likewise, Karimuribo et al., (2013) reported that merchandisers are constantly dealing with oxytetracycline and other tetracycline-based medicines at requests and along the road, without any tradition being needed or restrictions being assessed. In addition, Zuhura et al., (2015) showed that out of 60 beef samples anatomized for antimicrobial remains using HPLC, oxytetracycline remainders were set up in 71.1 of the samples, of which 68.3 were above respectable residue situations. It was also stated that the mean attention of oxytetracycline across meat was 3401.1 µg/ kg ±879.3 µg/ kg; attention in muscle, liver, and order was 2604.1 µg/ kg ±703.7 µg/ kg,3434.4 µg/ kg ±606.4 µg/ kg and 3533.1 µg/ kg ±803.6 µg/ kg, independently. Mgonja et al., (2017) indicated that twenty-one out of 60 samples (35) had OTC remainders and no samples had OTC situations above the outside allowed remainders limits (200 µg/ kg). The study went further to state that the highest OTC attention was 4.95 ng/ g, while the mean attention was 0.69 ±0.09 ng/ g. A study by Caudell et al., (2017) showed that tetracyclines especially oxytetracycline are accessible medicines and there are affordable, and the commonest antimicrobial available in farms or pastoral cattle-keepers in Tanzania.

Worldwide several studies have been conducted based on antibiotics remains. Wageh et al., (2013) stated that tetracyclines are the most used antibiotics in African countries, accounting for 41 percent of all antibiotic pollutants, followed by β -lactams. The study further showed that antibiotic remains in animal-derived foods are regularly available in several African countries, and their remainders exceeded the WHO limits. The study went further and recommended that great care must be taken to observe the withdrawal period before the products of animal-origin foods can be recommended for human consumption. Another study by Boeckel et al., (2015) showed that the periodic use of antimicrobials encyclopedically for funk and cattle products is 148 and 172 mg/ kg of the animal. This study also projected a 67 increase in the global ingestion of antimicrobials in animal products from 2010 to 2030. Van Boeckel et al., (2015) have revealed the antibiotic operation bracket in food animals grounded in the country. China is the first country in using antibiotics in food animals with 23, the United States (13), Brazil (9), India (3), and Germany (3). This study also indicated that in 2030 the consumption will increase to 596 tonnes compared to the 2010 consumption of 151 tonnes. The study went more and stated that around one-third of the rise in consumption of antimicrobials in animals is related to changes in animal parenting practices in middle-income countries. The increase in BRICS countries may be over 99 along with an increase in animal protein demand (Maron et al., 2013). The number of people dying due to antibiotic-resistant bacterial infections is rising. By the year 2050, it's anticipated that antibiotic-resistant microorganisms will kill more people than cancer. The major transmission may take place through the food chain and/or animal instructors (Levy & Marshall, 2004).

Some of the antibiotics such as oxytetracycline, chlortetracycline, tylosin, neomycin, avoparcin, and bacitracin, are useful for illness as well as growth promoters because, at lower concentrations, they work better than those used for remedial purposes (Apata, 2009). Nonetheless, their operation exceeds the acceptable limits in the absence of observance as pullout ages, its remnants may deposit in the muscles of the animals under scrutiny, posing a threat to mortal health (Nisha, 2008; Beyene et al., 2015). Antibiotics used as feedstuff complements are a public health concern since their use in animal husbandry worldwide for supporting the growth of animals is regular (Angulo, 2005). The use of antibiotics in inappropriate quantities for animal treatment has been shown to be the cause of the emergence of resistance in microbial strains within animals (Bager et al., 1997, Wegener, 2003) and, accordingly, in foodstuff products of animal sources (WHO, 2011).

The presence of antibiotics in human food has been linked to several negative public health outcomes, including acuity, gastrointestinal disturbance, kidney damage, and neurological diseases (Apata, 2009). It's also known that antibiotic remainders may change the physicochemical characteristics of cow milk, like a strange smell in the case of penicillins. Another problem is when veterinary medicines are administered by an unskilled person; challenges of the wrong route of administration and incorrect dosing are possible to arise (Shitandi, 2004). The administration of antibiotics to animals for growth promoter which causes deposit is not quite good. The discussion concerning the benefits and dangerous goods of growth promoters (AGPs) has been in focus for a long period. The advantages of using AGPs in animals as food can be overshadowed by some of their negative effects. When antibiotics are used as hormones in animals for growth-promoting and remedial purposes are supposed to be applied grounded on regulations to help their trace amounts as remainders in meat (Moreno- Bondi, 2009, Nisha, 2009). The trace amounts of some of these antibiotics can eventually be got mortal health hazards and can be one of the possible causes of the circumstance of pathogenic strains resistant to different antibiotics (Niewold, 2007). A study conducted in Egypt by Abd El- Aty et al. (2001), observed ceftazidime remainders in the meat of rabbits, with the loftiest attention seen in the order of liver, heart, and muscle meat.

Through processing, storage, and transportation, direct impurities in animals can come from air and water. Antibiotics in the feed specified for animals are exemplifications of circular contamination (Elizabeta et al., 2011). Contamination of feed with fecal recycling is also another problem that needs to be handled properly. When the medicine is present in the feces of treated animals, these feces may also pollute the feed of other untreated animals (Darwish et al., 2013). Vegetables might also be defiled by feces, particularly in countries where animal feces are typically used as ordure (Phillips et al., 2004). Because of increasing practices on food safety and public health concerns, antibiotic residues in food have received a lot of attention recently. Their presence in foodstuffs of animal origin creates socioeconomic challenges worldwide. Inappropriate use of antibiotics in foodstuff performed in the circumstance of remainders in animal products and accompanying dangerous health goods in humans needs direct measures to ensure consumer full protection (Olatoye and Ehinwomo, 2010). In malignancy of the prohibition of antibiotics use in animals, until they're administered with overdoses or inappropriate boluses for remedial, precautionary, as well as nontherapeutic purposes (Kabir et al., 2004; Mubito et al., 2014) they would be harmless to products if these medicines aren't absorbed. Unfortunately, that isn't what always happens. Hence, unsafe medicine remains in the body of treated animals creating big challenges for proper animal treatment. (Nonga et al., 2010). It was also observed that easy access to antibiotics similar to oxytetracycline, together with a lack of mindfulness, poor extension services, and inadequate practice procedures from manufacturers, can lead to mismanagement and overuse of the medicine and conceivably failure to observe the withdrawal period. All of these could contribute to the circumstances of high levels of antibiotic remains in meat (Darwish et al., 2013).

4. Effect of Heat Treatment and Freezing on Antibiotic Remainders

Studies have indicated that remainders in foods of animal origin and other animal products can be reduced or degraded to some position through processing styles. The majority of foodstuffs we take are processed before consumption. In this paragraph, we will explore the impact of different cooking styles on the destruction of antibiotic remains set up in foodstuffs. Studies have been conducted to assess the effects of cooking processes such as boiling, roasting, and microwaving on the reduction of residues. A study showed a 90% reduction of the original position of tetracycline was possible at a nonstop treatment of funk for 23.9, 53.2, and 106.6 min by microwaving, boiling, and riding, independently (Abou- Raya et al., 2013). Hussein and Khalil, (2013) reported a significant reduction in oxytetracycline remainders of 95.7 and 91.4 through frying and grilling, independently. Also, a reduction in antimicrobial remainders was observed by Mgonja et al (2017), whereby the mean concentration of OTC for boiled and barbecued beef samples was 69.45 ±41.93 ng/ g and 69.40 ±38.91 ng/ g, independently. Both the boiling and barbecuing procedures significantly reduced the OTC present in beef. A reduction in antimicrobial remainders was observed by Javadi et al., (2011) in the treated meat of cravens fed with boluses of doxycycline. The processes of boiling, microwaving, and riding was set up to reduce the antimicrobial remainders by 65, 100, and 25.2, independently, indicating a decline in doxycycline remainders. Still, cooking processes didn't fully exclude the remainder from processed meat samples (Javadi et al., 2011).

Generally, tetracycline (TC) remainders are considered unstable composites. The temperature during cooking has the largest impact on the loss of tetracycline remainders (Loksuwan, 2002; Hassani et al., 2008; and Abou-Raya et al., 2013). It was also shown that oxytetracycline residue in cattle liver, muscle, and lamb muscle was reduced during cooking processes including microwaving, boiling, grilling, reboiling, and frying (Javadi et al., 2011). Abou-Raya et al., (2013) studied the changes in the microwave oven, boiling, and cooking processes of TCs including oxytetracycline (OTC), tetracycline (TTC), chlortetracycline (CTC), and doxycycline in funk flesh and muscles, and determined the cooking time needed to make the cooked sample safer for consumption. The study of Rose et al., (1995) also suggested a decline in tetracycline remains by determining the reduction of oxytetracycline to half by heating it at 100, 80, and 62 °C in water for 2, 15, and 120 min, independently. It was also shown that cooking can reduce macrolide remains in meat indeed though it's demanded to observe the correct consumption of veterinary medicines in animals and the withdrawal period (Lolo et al., (2006). A study on enrofloxacin showed a drop of 28.8, 66.26, and 30.9 after boiling and microwaving in antimicrobial remainders after processing funk meat, nonetheless, the remainders might not be excluded fully (Abou- Raya et al., 2013). Another study by Lolo et al., (2006) showed the drop of enrofloxacin remains from 29 lg/ kg in raw funk leg samples to 16, 14, and 17 lg/ kg after boiling, frying, and microwaving, independently. The meat sample presented a drop of enrofloxacin remaining from 28.3 lg/ kg in raw funk to 12.3, 16, and 10.7 lg/ kg formerly boiled, fried, and microwaved, similarly (Akerman et al., 2007).

Inconsistency, Hussein et al., 2008 and Hussein and Khalil, 2013) stated that there was no observed significant effect of frying and grilling on the drop of enrofloxacin residue remains in toaster fillet samples, with reductions of 25.6 and 33.3. Sulfonamides were set up to be unchanged in long-term freezing surroundings (Rose et al., 1995). Cold storage might also act as a factor in the reduction of antibiotic remainders in frozen samples. In a study conducted by O'Brian et al., (1991), administered with ampicillin, chloramphenicol, oxytetracycline, streptomycin, or sulfadimidine were also massacred two hours after an intramuscular administration in the neck, and the cadavers were also hung and firmed for 5 to 7 days. The study went further by measuring the zone of inhibition in microbiological assays which indicated the presence of biologically active remainders. It was shown that both ampicillin and chloramphenicol situations were reduced by cold storage, with a minimum period seen in oxytetracycline, streptomycin, and sulfadimidine (O'Brian et al., 1991). It was also observed that time could affect the stability of remainders in muscle samples. A good illustration is penicillin G, which degrades after time. A study by Boison et al., (1992), stated that penicillin G is stable in cold storage but degrades more freely in muscle samples, nearly 50 percent was lost after 10 days at -20 °C, and the medicine was undetectable after 60 days. Still, penicillin G is stable in serum and muscle samples when stored at -76 °C, indeed at 189 days after a bloodbath.

The effect of the freezing was also detected on OTC remainders of beef kept at -20 °C for 60 and 120 days. The results showed the mean reduction of OTC remainders before freezing was 191.71 ±90.21 ng/ g and after freezing at -20 °C for 60 and 120 days were166.40 ±86.49 ng/ g and133.50 ±83.24 ng/ g independently. These results revealed a significant ($p<0.05$) reduction of OTC remainders by 30 after 60 days and by 65 after 120 days of freezing at -20°C (Mgonja, 2018).

5. Conclusion and Recommendations

Food contamination with antibiotics, particularly in meat and milk, is a major concern for human health. The use of antibiotics in food-producing animals is still growing. It must be noted that antibiotics in food can be innately poisonous and can have a cumulative effect. Nonetheless, there are also some troubles related to not using antibiotics in the proper way. The threat-benefit analysis for the operation of the medicine in product animals must be done. Prohibition of antibiotic use in the product of animals may not be a stylish approach. It's likewise significant to ensure that antimicrobial agents in animal products are controlled by applicable authorities, and meat and internal organs should be examined for medicine remainders before being passed fit for consumption. Some experimenters indicated that cooking and freezing styles may influence antibiotic residue situations. Nonetheless, it may not be considered as a volition for the elimination of remainders, as it doesn't assure the complete elimination of antibiotic remainders from animal-grounded food. Use must be supervised by nonsupervisory authorities regularly to help against abuse in animals. Antibiotics that have been distributed as critically essential by the veterinary feed directive shouldn't be taken for animal treatment. Inappropriate antibiotics administration is due to a lack of awareness and the proper use of it. In some African countries, medicines or even mortal medical formulas are sold in supermarkets. The knowledge concerning the proper use of antibiotics in animals on mortal health and the increase in the rational use of antibiotics in animals should be also emphasized. Antibiotics used as growth promoters or for any other purpose must be reduced by furnishing good ranch operation practices and furnishing a clean terrain for animals. AGP backup's similar use of prebiotics, and probiotics, as good ranch practices, and accepted antimicrobial agents need to be encouraged. The use of antibiotics as feed complements must be stopped. Each country should agree to have National monitoring of antibiotic remainders in foods and updating of the maximum standard limits of remainders. Simple and profitable field tests need to be established to detect antibiotic remainders in animal products, and ethnoveterinary practices might be supported. The temperature operation in meat, milk, and eggs could inactivate antibiotic pollutants in foods. The freezing of animal-derived foodstuffs may also contribute to the loss of some antibiotic impurities or leftovers.

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