J.Meat Sci., 2017, 12 (2) : 1 - 9

Review Paper

Concerns and Consequences of Industrial Livestock and Meat Production

M. Muthukumar* and P. K. Mandal [1]

ICAR-National Research Centre on Meat, Hyderabad
[1]Rajiv Gandhi Institute of Veterinary Education and Research, Pudhucherry

ABSTRACT

Meat has been consumed as a part of diet since pre-historic times and the fast growing population fuelled greater demand for meat and meat production. This led to gradual drive in modern livestock farming towards increased productivity and intensification. In the intensive farming, use of large numbers of chemicals/drugs to control or prevent infections or to promote more growth has become inevitable. When animals are treated with veterinary medicines according to the licensed conditions of dose, period of treatment and withholding period specified before slaughter, residues should be at levels that will not cause any effect on consumer health. However, improper and unethical use of various chemicals resulted in accumulation of unnatural substances in the meat food chain. The continuous consumption of meat and meat products contaminated with toxic residues induce changes in biotransformation of endogenous and exogenous compounds resulting in variety of health problems, particularly endocrine dysfunction, carcinomas and neurological disorders. Though traditional and natural methods of rearing of livestock is largely practiced in India, public awareness campaigns are urgently needed to alert farmers and professionals about the negative consequences of such misuse of drugs in animal on public health. On-farm practices and possible misuses of veterinary drugs need to be investigated to identify the source of such substances in carcasses. Detection and quantification of the drugs residues are also required to identify the main groups of veterinary drugs incriminated to improve the control system and the awareness at destination of stakeholders involved in the livestock farming and marketing sector. This article discusses about various issues related to antibiotics and hormones employed for growth promotion in meat animal production.

Keywords : *Meat animal production, Antibiotics and Anti-bacterials, Growth promoters*

Received : 30.12.2017 Accepted: 22.02.2018

INTRODUCTION

Agricultural production across the world has increased many folds to feed the ever increasing global population. Intensification of agricultural production is seen as a way of providing food security. Scientific discoveries and technological advances led to the present day industrial agriculture practice. Innovations in agriculture commenced in the late 19th century, generally paralleled developments in mass production in other industries that characterized the latter part of the Industrial revolution. Further, distribution of agricultural produce to very long distance became feasible due to developments in preservation technologies and transport networks (Fraser 2005; Zubir and Brebbia 2014).

Over the years food-animal production has been intensified. Industrial livestock production, also called as factory farming refers to the keeping food animals, such as cattle, poultry and fish at higher stocking densities. The intensive animal production is driven by the goal of achieving production of larger quantities of meat, eggs, or milk at the lowest possible cost (Gliessman 2015). Animals are confined at high stocking density to produce the highest output at the lowest cost by relying on economies of scale, modern machinery and biotechnology. The discovery of vitamins, antibiotics, drugs, pesticides and vaccines facilitated raising livestock in larger numbers by preventing/controlling disease.

Several agrochemicals and biologicals like antimicrobial agents, anthelmintics, hormones, disinfectants and vaccines are employed to maintain health and improve production (Coffman *et al.* 1999). Veterinary medicinal products are most common in foods of animal origin as the animals are directly exposed to them (Biswas *et al.* 2010). But this could be avoided, if used properly with sufficient withdrawal period. Further, breeding programs, feed supplements, health inspections, biosecurity measures and climate controlled facilities are also employed to produce animals more suited to the confined conditions and able to provide food products of consistent quality.

India largely practices traditional and natural methods of rearing livestock (Deb 2015). Intensive production of livestock and poultry employing various agro-chemicals like

*Corresponding author E-mail address: muthukumar55@rediffmail.com

antibiotics, hormone growth promotors, etc. in meat animal production to improve productivity and reduce cost of production is widespread in certain developed nations. There is a continuing debate over the benefits, risks and ethical questions of factory farming. The issues include the efficiency of food production, animal welfare, environmental pollution and health risks. Further, the usage of chemicals/drugs to control or prevent infections or promote more growth have the potential to end up as residues in animal products like milk and meat, if adequate measures are not practiced (Jeitzman 1994).

ANTIBIOTICS AND ANTIBACTERIALS

The term "antibiotic growth promoter" is used to describe any medicine that destroys or inhibits bacteria and is administered at a low, sub therapeutic dose. The growth promoting effects of antibiotics were first discovered in the 1940s. The use of antibiotics for growth promotion has arisen with the intensification of livestock farming. Infectious agents reduce the yield of farmed food animals and to control these, the administration of sub-therapeutic antibiotics and antimicrobial agents has been shown to be effective (Hughes and Heritage 2004).

The relative persistence of antibiotics in animal tissue varies widely depending on the compound and the method of administration. Shot gun therapy, illegal use, excess use, improperly prepared / labelled feed, non observance of drug withdrawal time led to the occurrence of residues in milk and meat.

Occurrence of residues depends on many factors like the formulation, dosage and the mode of administration, age of the animal, disease condition and husbandry practices (Mitchell *et al.* 1998).

Use of antibiotics and antimicrobial as growth promoters: Intensive feed lot cattle production system which practice feeding with high energy rations and low roughage demands antibiotic use in feeds. Nearly all large scale and intensive meat production in developed countries involved continuous administration of in-feed antibiotics because of purported growth promotion and "disease prevention" effects in animals fed continuous antibiotics (Collignon *et al.* 2005). A number of developed countries such as USA, Canada, Australia and Japan have been practicing intensive feed lot cattle production systems and have been resorting to antibiotic use for growth promotion.

Antibiotics are widely used in food producing animals in the United States (FDA 2013). Approximately 80 percent of the antibiotics sold in the United States are used in meat and poultry production. Overall, the available data reveals that drug companies sold or distributed around 10,000 MT of antibiotics for use in food animals in 2012 in the United States, and 8,000 MT in Europe. The total figure for US use as reported by the US Federal Drug Administration is 15,000 MT, which includes ionophores (Elliott 2015).

Australian cattle farmers employ a range of ionophores, namely lasalocid, monensin, narasin and salinomycin. They also employ flavophospholipol and the macrolide oleandomycin. The glycopeptide avoparcin is still used in pig and poultry farming and in rearing cattle in Australia (Prasad and Smith 2013). Ionophores are also used extensively in New Zealand and Latin America (EC Directorate-General XXIV 1999). Canadian livestock consume more than 1.6 million kilograms of antibiotics every year, according to the Canadian Animal Health Institute. Today, about 80 per cent of the antibiotics consumed in Canada are destined for livestock (Miller 2015). On 1 January 2006, the European Union banned the non-medicinal use of antibiotics in livestock production. In 2011, the EU voted to ban the prophylactic use of antibiotics, alarmed at signs that the overuse of antibiotics is blunting their use for humans (Gilbert 2012).

Based on the study conducted by Van Boeckel *et al.* (2015), it is found that the annual use of antimicrobials globally for cattle, chicken and pig production is 45,148 and 172 mg/kg of animal, respectively. This study also predicted a 67% increase in global consumption of antimicrobial in livestock production from 2010 to 2030. By 2030, the consumption will increase to 105,596 tonnes compared to 2010 consumption of 63,151 tonnes. It is reported that around one third increase in consumption of antimicrobials in livestock is pertaining to changes in livestock rearing practices in middle income countries.

While most countries banned antibiotics known to be toxic for human, e.g., chloramphenicol or avoparcin from animal food production, these banned drugs are still reported to be used in developing countries (Shukla *et al.* 2011). The study on occurrence of antimicrobial drug residues in pork meat in Madagascar by the Premi test technique (based on the inhibition of the growth of *Bacillus stearothermophilus*, allows screening meat for the residues of â-lactams, Cephalosporines, Macrolides, Tetracyclines, Sulphonamides, Aminoglycosides, Quinolones, Amphenicoles and Polypeptides) revealed that there was a high incidence rate of drug residues, with 37.2 %

meat samples being contaminated. A significant increase was observed between year 2010 and 2011, with 32 and 39%, respectively (Rakotoharinome *et al*. 2013).

Very few studies were carried out to estimate antibiotics residues in livestock products in India. Recent survey conducted at Nagaland by Fahrion *et al.* (2014) revealed that 4.5% pork samples tested were positive and thus contained traces of antibiotic residues. Nirala *et al.* (2017) reported that out of total number of 250 milk samples randomly collected in North Bihar region, five samples for tetracycline and two for oxytetracycline, two for sulfadimidine and one for sulfamethoxazole were found to contain residues above MRL values but no sample of enrofloxacin and ciprofloxacin were found to concentration above MRL values i.e., 0.1 μg/ml. Similarly, Biswas *et al.* (2007) found that out of 122 export buffalo meat samples collected from different parts of India, only 5 samples showed detectable concentration of oxytetracycline residues but were lower than the maximum residue limits set by Codex Alimentarius Commission. Residues of tetracycline and chlortetracycline were absent in all samples.

Harmful effects of use of antimicrobial as growth promoters: The major concerns of antibiotics residues are allergic reactions and antibiotic resistance. The national research Council and Institute of Medicine have noted a link between the use of antibiotics in food animals and the development of bacterial resistance. Similarly, scientists in Centre for Disease Control and Prevention (CDC) reported new type of Salmonella called Newport 9+ which is resistant to 9 antibiotics.

As little as 10 micrograms of pencillin can cause an allergic response in sensitive individuals. This is equivalent to a residue level of 0.1 ppb in 100g of meat or milk. The overuse of antimicrobials such as tetracyclines, sulphonamides, aminoglycosides, beta lactam derivitives etc. in animal production or their residues in food system pose potential allergic reactions in sensitized individuals, but subtherapeutic and therapeutic levels may perturb human gut microflora (Paige *et al.* 1997). Aplastic anaemia with chloramphenicol and carcinogenic effects by sulfonamide drugs and nitrofurans are also of public health importance.

In general, the effect of antibiotic residues in meat is insignificant when compared with the issue of selection and amplification of antibiotic resistant strains of bacteria. Antibiotic resistance determinants selected in this manner may have various routes by which they may compromise the therapeutic use of antibiotics (Hughes and Heritage 2015).

The use of small dose of antibiotic in food producing animals over the life time as growth promoter can harm public health through the following sequence of events (CDCP 2013):

- Use of antibiotics in food-producing animals allows antibiotic-resistant bacteria to thrive while susceptible bacteria are suppressed or die
- Resistant bacteria can be transmitted from food-producing animals to humans through the food supply
- Resistant bacteria can cause infections in humans
- Infections caused by resistant bacteria can result in adverse health consequences for humans

Antibiotic resistance compromises the ability to treat the infections and is a serious threat to public health. Centre for Disease Control and Prevention, USDA estimates that in the United States, more than two million people are sickened every year with antibiotic-resistant infections, with at least 23,000 dying as a result (CDC 2013). The increasing number of antibiotic resistant infections appearing in the community and acquired during international travel represent a looming public health issue (Prasad and Smith 2013). So it is mandatory to follow withdrawal periods for antibiotic compounds when using in animal production to safeguard public health. Withdrawal period is a time between the last dose of antibiotic given to food animals and consumption of food animals or food derived from it. It needs to be mentioned on the antibiotics that are used for animals and if not mentioned properly it is considered to be as 28 days in Indian context (CSE 2014).

Recommendations of scientific committees on use of antimicrobial as growth promoters: Scientific expert bodies for more than two decades have concluded that there is a connection between antibiotic use in animals and the loss of effectiveness of these drugs in human medicine. The World Health Organization (WHO) describes anti-microbial resistance as a looming crisis in which common and treatable infections will become life threatening. The WHO Global Strategy for Containment of Antimicrobial Resistance recommends that governments "terminate or rapidly phase out the use of antimicrobials for growth promotion if they are also used for treatment of humans (WHO 2001). Recommendations from WHO's 2001 global strategy for reducing the risk from the use of antimicrobials in food animals include:

- Require obligatory prescriptions for all antimicrobials used for disease control in food animals.

- Terminate or rapidly phase out the use of antimicrobials for growth promotion if they are also used for treatment of humans.
- Create national systems to monitor antimicrobial usage in food animals.
- Introduce pre-licensing safety evaluation of antimicrobials with consideration of potential resistance to human drugs.
- Monitor resistance to facilitate identification of emerging health problems and actions to protect human health.
- Develop guidelines for veterinarians to reduce overuse, misuse of antimicrobials in food animals.

The World Organisation for Animal Health (OIE), United States Food and Drug Administration and the World Health Organization plan to urge governments to put vets in charge of allocating the drugs and to ban preventative use. In 2003, an expert workshop co-sponsored by the World Health Organization, Food and Agricultural Organization, and World Animal Health Organization concluded that "there is clear evidence of adverse human health consequences due to resistant organisms resulting from non-human usage of antimicrobials". These consequences include infections that would not have otherwise occurred, increased frequency of treatment failures (in some cases death) and increased severity of infections (EC 1999).

American Medical Association is opposed to the use of antimicrobials at non-therapeutic levels in agriculture or as growth promoters, and urges that non-therapeutic use in animals of antimicrobials (that are used in humans) should be terminated or phased out (Kahler 2001**)**. Addressing the problem of bacterial resistance to antimicrobial agents and the need for surveillance, American Public Health Association (APHA) urged FDA to work for regulations eliminating the non-medical use of antibiotics and limiting the use of antibiotics in animal feeds. In 2004, APHA passed a resolution urging bulk purchasers of foodstuffs to adopt procurement policies that encourage and, where feasible, require procurement of meat, fish, and dairy products produced without nontherapeutic use of medically important antibiotics. Infectious Diseases Society of America (IDSA) supports efforts to phase out the use of antimicrobial drugs for growth promotion, feed efficiency, and routine disease prevention in food animals.

Misuse and overuse of antimicrobial drugs create selective evolutionary pressure that enables antimicrobial resistant bacteria to increase in numbers more rapidly than antimicrobial susceptible bacteria and thus increases the opportunity for individuals to become infected by resistant bacteria (FDA 2012). On 11 April 2012, the FDA announced a program to phase out unsupervised use of drugs as feed additives and, on a voluntary basis, convert approved uses for antibiotics to therapeutic use only, requiring veterinarian supervision of their use and a prescription. In the new guidelines, the FDA is moving to eliminate the use of medically important antibiotics for production purposes – specifically, for growth promotion and feed efficiency. Henceforth, therapeutic use of such antibiotics will fall under the supervision of licensed veterinarians.

HORMONES AND REPARTITIONING AGENTS IN MEAT PRODUCTION

Hormones are used in animal production because they allow animals to grow larger and more quickly on less feed and fewer other inputs, thus reducing production costs, but also because they produce a leaner carcass more in line with consumer preferences for diets with reduced fat and cholesterol (NCBA 2006). Other types of drugs viz., certain beta-agonists, such as clenbuterol and some tranquilizers such as diazepam have also been used to reduce the ratio of fat to lean. Ractopamine, a beta-agonist that mimics stress hormones increases the rate at which animals convert feed into muscle. Trenbolone acetate, an anabolic steroid is used to increase muscle mass in cattle (Armstrong *et al.* 2004, Mandal 1995).

Use of hormone growth promoters: In the United States, hormones have been approved for use since the 1950s and are now believed to be used on approximately two-thirds of all cattle and about 90% of the cattle on feedlots. The United States Food and Drug administration has approved hormones estradiol, progesterone, testosterone, zeranol and trenbolone acetate. In large U.S. commercial feedlots, their use approaches 100%. Three natural steroid hormones (estradiol, testosterone, and progesterone), and three synthetic surrogates (zeranol, melengestrol, trenbolone) remain in widespread use by US and Canadian beef cattle producers to boost growth and production (Meyer 2001; Swan *et al.* 2007).

In addition to the United States, other countries viz. Canada, Australia, New Zealand, South Africa, Mexico, Chile, and Japan have approved the use of growth promoting hormones in beef production. The use of hormone growth promoters (HGP) to increase growth rate is a widespread practice in the Australian beef cattle industry with around half of both grain-fed (feedlot) cattle and northern Australia pasture-fed cattle

Table 1: Maximum residue limit of antimicrobial agents set by Codex

Sr. No.	Name of the compound	ADI (μg/kg bw)	Residues in muscle (μg/kg)				
			Cattle	Sheep	Poultry	Pig	
1	Chlortetracycline/ Oxytetracycline/ Tetracycline	0-30		200			
2	Benzylpenicillin/ Procaine benzylpenicillin	30*	50	-	50	50	
3	Amoxicillin	0 - 0.07	50	50	-	50	
4	Colistin	0 – 7		150			
5	Dihydrostreptomycin/ Streptomycin	0 – 50		600			
6	Erythromycin	0 – 0.7	-	-	100	-	
7	Gentamicin	0-20		100	-	-	100
8	Lincomycin	0-30	-	-	200	200	
9	Monensin	0-10	10	10	10	-	
10	Neomycin	0-60	500	500	500	-	
11	Sulfadimidine	0-50	100**				
12	Tylosin	0-3	100	-	100	100	
13	Chloramphenicol			Not permitted in food producing animals			
14	Furazolidone			Not permitted in food producing animals			
15	Nitrofural			Not permitted in food producing animals			

* person / day ** Not specified

are implanted (Hunter 2010). Australian beef producers are using trenbolone as growth stimulator. Although hormonal growth promoters are not approved for use in veal calves, recent Canadian surveys showed residues of the synthetic hormone trenbolone in 32-40 % of liver samples from veal calves. The use of hormones in beef production, however, is not allowed in the European Union, or in other European countries that assume many of the rights and obligations of the EU single market. The use of HGPs on farm animals was banned by the EC in 1988. This ban was extended in 1989 to include the importation of beef and beef products from countries allowing the use of HGPs (Johnson 2015).

Harmful effects of use of hormone growth promoters: It is widely acknowledged that the use of these hormone growth promoters results in residues in meat (Henricks *et al*. 2001; Stephany 2001). Hormone residues in U.S. beef may be linked to high rates of breast and prostate cancer, as well as to early-onset puberty in girls (Stokes 2009).

In most countries, hormone containing implants are available "over the counter". Given this widespread availability of the implants and the incentive provided by the enhanced growth and feed utilisation efficiency resulting from hormone use, it is likely that some degree of misuse will occur. Improper placement of the implants (i.e. in tissue used for consumption rather than in the ears which should be discarded), off-label use, including use in non-approved animals (e.g. veal calves and pigs), overdosing and use of black-market non-approved hormones could result in over exposure of humans consuming beef from the affected cattle. The misplaced implants and black market drugs comprise the risk that extremely high levels of residues of hormones remain in edible tissues of animals.

In addition, it has to be noted that the contemporary use of growth promoting hormones and veterinary therapeutics drugs increases the prevalence of undesirable residues in edible tissues of bovines (EC 1999). Although the USDA and FDA claim these hormones are safe, there is growing concern that hormone residues in meat and milk are harmful to human health, animal health and the environment. Human exposure and risk are in particular increased by the fact that regulatory controls over residues of hormones in meat placed on the market are deficient in the USA and are insufficient in Canada (Hines 2000).

Estradiol stimulates cell division in hormonally sensitive tissues thereby increasing the possibility for accumulation of random errors during DNA duplication. This increased cell proliferation also has the effect of stimulating growth of mutant cells (Henderson and Feigelson 2000). Some synthetic anabolic agents such as diethylstilbestrol have been reported to be responsible for development of breast in children and menstruation in infant girls. European Union banned the use of these hormones. EU believes that these compounds are responsible for cancer and increased level of estrogenic male infertility because of carcinogenic potential. Ractopamine is reported to result potential harmful effects on animal health and human health when residues are present in the meat. Ractopamine is known to affect the human cardiovascular system, and is thought to be responsible for hyperactivity. It may also cause chromosomal abnormalities and behavioural changes (Donia and Salama 2015). Trenbolone acetate has a negative impact on human health with a variety of side effects like increased blood pressure, insomnia, aggressiveness, baldness, etc.

The natural steroid hormones (estradiol, testosterone, and progesterone) and synthetic surrogates (zeranol, melengestrol, trenbolone) may pose endocrine, developmental, immunological, neurobiological, immunotoxic, genotoxic, and carcinogenic effects, particularly for susceptible risk groups (such as prepubertal children). Use diethyl-stilbesterol in meat production known to have strong carcinogenic effects and are banned from use in food animals. The toxicological and epidemiological data reviewed by the commission panels do not allow a quantitative estimate of the risk, leading to the European Food Safety Authority's Scientific Panel's conclusions that no threshold levels can be defined for any of the natural steroid hormones (estradiol, testosterone, and progesterone), and synthetic surrogates (zeranol, melengestrol, trenbolone) hormones (EFSA 2007).

Recommendations of scientific committees on use of hormone growth promoters: European Food Safety Authority's Scientific Panel on Contaminants in the Food Chain (CONTAM) concluded that at present, epidemiological data provide convincing evidence for an association between the amount of red meat consumed and certain forms of hormone-dependent cancers. Whether hormone residues in meat contribute to this risk is currently unknown. The CONTAM panel concluded that the new data that are publicly available do not provide quantitative information that would be informative for risk characterisation (Levy 2010).

American Public Health Association opposed to the use of hormone growth promoters in beef and dairy cattle production, and strongly recommends that the FDA should act with public health precaution to ban the use of hormone growth promoters on the basis of certain exposure and possibility of human health risks, pending long-term epidemiological data demonstrating such exposures to be without harm to workers or the population as a whole. Hospitals, schools, and other institutions, especially those serving children, should preferentially purchase food products from beef and dairy cattle produced without such hormones. Companies producing and retailers offering products produced without recombinant bovine growth hormone (rbGH) or other hormones should retain their right to label such products in an easily readable and understandable fashion so that consumers in the free marketplace can be equipped to make an informed choice about which brands they buy. Public health organizations should support increased federal research to better delineate mechanisms of harm from hormone-disrupting chemicals in food and the environment and to assess the cumulative public health impact from low level exposure to multiple such chemicals, including to fetuses, infants and children (APHA 2014).

Table 2: Codex regulations on hormonal growth promoters

Sr. No.	Name of the compound	ADI (μg/kg bw)	Residues in animal muscle (μg/kg)
1	17 ß Estradiol	Unnecessary	Unnecessary*
2	Testosterone	0 - 2	Unnecessary
3	Progesterone	0 - 30	Unnecessary
4	Zeranol	0 – 0.5	2
5	Melengestrol acetate	0 – 0.03	1
6	Trenbolone	0 – 0.02	2

*Residues resulting from the use of these substances as a growth promoter in accordance with good animal husbandry practice are unlikely to pose a hazard to human health

Some trade implications on use of hormone in beef cattle production: Russia bans both chilled and frozen beef and also offal imports from Australia on Ractopamine use (Levy 2010). During 2012, Kazakhstan has introduced a temporary sanitary measure to ban the import and sale of meat of the chilled beef from Australia which was found to contain trenbolone acetate on the results of sanitary-epidemiological examination (Mukhtarov 2012). In 2013, Russian veterinary services proposed a total ban on imports of meat from Canada due to the use of ractopamine (Vorotnikov 2013). The importers of Brazilian beef, including Russia, the European Union, China, Iran, Egypt, Chile, Belarus and Kazakhstan have formally prohibited the use of ractopamine. These markets accounted for nearly half of Brazil's beef export (Anon 2013).

REGULATIONS AND STATUTARY LIMITS

The regulation handled by each country throughout the world has a tendency towards uniform approach. But much greater enforcement has been with the passage of WTO with sanitary and phytosanitary measures. The USDA and the FDA are responsible for monitoring meat and poultry products for animal drug residues in US. The USDA-FSIS conducts the National Residue Programme (NRP) to prevent animals with violative amounts of drug residues from market samples through extensive on-site sampling technique (FSIS-USDA, 1998). The FDA Centre for Veterinary Medicine (CVM) is responsible for setting tolerances and enforcement depends on FSIS findings (FSIS-USDA, 1999). The other international organizations include European Agency for the Evaluation of Medicinal Products (EMEA) Office International des Epizootics (OIE) and Burea of Veterinary Drugs in Canada.

International organization such as Codex Alimentarious Commission (CDC) have taken initiation of harmonization of chemical residues in food through establishment of statutory limitations viz, Maximum Residue Limits (MRL), Acceptable Daily Intake (ADI) levels etc. However, all these statutory limitations are important principles of risk assessment of residues in foods including meat.

CONCLUSIONS

Though the risks of using antibiotics and hormone growth promotors could not be demonstrable in quantitative terms all the times, but qualitatively demonstrated by several scientific bodies. Increased incidence of antibiotic resistance in microbes and hormone residues in meat as a result of increased use or abuse of antibiotics and growth promoting hormones, control on use of these chemicals to be planned and monitored. Unless adequate measures are taken, the problem of increased number of antibiotic resistant microbes and presence of hormone residues in meat could not be fully checked. These agro-chemicals should be used only under veterinary oversight and only to manage and treat infectious diseases, not to promote growth. Further, antibiotics must be used judiciously in humans and animals because both uses contribute to not only the emergence, but also the persistence and spread of antibiotic-resistant bacteria. It could be appropriately recommended from the available literature that as a precautionary measure consumption of meat from countries that have no practice of using HGPs and antibiotics for growth would always be better. Organic food production has primarily come up because of the harmful effects of chemical residues including that of hormones, antibiotics, pesticides and other heavy metal contaminants.

In India, where majority of the animals are raised by many small holders with natural grazing and agri-byproducts feeding, the practice of using antibiotics or hormone as growth promoters does not exist. It would be more appropriate not to ape the developed countries model of meat production, considering the negative implications of such industrial intensive large scale feed lot production with antibiotic and hormone growth promotors. However, continuous monitoring progranmme involving more number of samples is required to accurately assess the level of various chemical residues in animal feed and fodder, environment and various animal foods. This is not only essential to ensure the public health but also the absence of chemical residues will enhance the export of various animal products.

REFERENCES

Anon (2013) Brazil's exports impacted by beta agonist use. https:// www.beefcentral.com /trade/ trade-brazils-exports-impacted-by-beta-agonist-use/

APHA (2014) http://www.apha.org/ policies – and – advocacy / public – health – policy – statements/policy-database/ 2014/07/09/13/42/opposition-to-the-use-of-hormone-growth-promoters-in-beef-and-dairy-cattle-production

Armstrong TA, Ivers DJ, Wagner JR, Anderson DB, Weldon WC, Berg EP (2004) The effect of dietary ractopamine concentration and duration of feeding on growth performance, carcass characteristics and meat quality of finishing pigs. J Anim Sci 82: 3245–3253

Biswas AK, Rao GS, Kondaiah N, Anjaneyulu ASR, Mendiratta SK, Prasad R, Malik JK (2007) A simple multi-residue method for determination of oxytetracycline, tetracycline and chlortetracycline in export buffalo meat by hplc-photodiode array detector. J Food Drug Anal 15 (2): 1-6

Biswas AK, Kondaiah N, Anjaneyulu ASR and Mandal PK (2010). Food Safety Concerns of Pesticides, Veterinary Drug Residues and Mycotoxins in Meat and Meat Products. Asian J Anim Sci 4(2): 46-55.

CDC (2013) Antibiotic resistance threats in the United States. http://www.cdc.gov/ drugresistance /pdf/ar-threats-2013-508.pdf.

CDCP (2013) Office of infectious disease antibiotic resistance threats in the United States. http://www.cdc.gov/drugresistance/threat-report-2013

Coffman JR, Beran GW, Colten HR (1999) The use of drugs in food animals: benefits and risks. National research council (US) committee on drug use in food animals. National Academies Press, Washington, DC

Collignon P, Wegener HC, Braam P, Butler CD (2005) The routine use of antibiotics to promote animal growth does little to benefit protein undernutrition in the developing world. Clin Infect Dis 41: 1007-1013 http://cid.oxfordjournals.org/ content /41 /7/ 1007 .full.pdf+html

Deb SM (2015) Traditional livestock production and growth opportunities in India. Proc Int Grassland Cong 2015-Keynote Lectures.

Donia A, Salama (2015) Food additives. In: Mammalian toxicity, (ed) MB Abou Donia, John Wiely and Sons Ltd., West Sussex, United Kingdom.

FSIS-USDA (1998) National Residue Programme Report. USDA, Washington DC

FSIS-USDA (1999) The impact of Pathogen Reduction / HACCP on Food Animal Production Systems. USDA, Washington DC

EC (1999) Opinion of the scientific committee on veterinary measures relating to public health. Assessment of potential risks to human health from hormone residues in bovine meat and meat products. http://ec.europa.eu/food/fs/sc/scv/out21_en.pdf

EC Directorate-General XXIV (1999) Consumer policy and consumer health protection, II. Options of the scientific steering committee on antimicrobial resistance. http://ec.europa.eu/food/fs/sc/ssc/out50_en.pdf

EFSA (2007) Opinion of the scientific panel on contaminants in the food chain on a request from the European commission related to hormone residues in bovine meat and meat products. The European Food Safety Authority J 510: 1-62

Elliott K (2015) Antibiotics on the farm: Agriculture's role in drug resistance. CGD Policy Paper 059, Center for Global Development, Washington, DC http://www.cgdev.org/publication/antibiotics-farm-agricultures-role-drug-resistance.

Fahrion AS, Jamir L, Richa K, Begum S, Rutsa V, Varijaksha PS, Padmakumar, Deka RP, Grace D (2014) Food safety hazards in the pork chain in Nagaland, North East India: Implications for human health. Int J Environ Res Public Health 11: 403-417

FDA (2012) #209 Guidance for industry: The judicious use of medically important antimicrobial drugs in food-producing animals. http://www.fda.gov/ downloads / AnimalVeterinary/GuidanceComplianceEnforcement/GuidanceforIndustry/UCM216936.pdf

FDA (2013) Summary report on antimicrobials sold or distributed for use in food-producing animals.http://www.fda.gov/downloads/ForIndustry/UserFees/AnimalDrugUserFeeActADUFA/UCM338170.pdf.

Fraser D (2005) Animal welfare and the intensification of animal production : An alternative interpretation. Food and Agriculture Organization of the United Nations.

Gilbert N (2012) Rules tighten on use of antibiotics on farms. Nature, 481 (7380): 125

Gliessman SR (2015) Agroecology: The Ecology of sustainable food systems. 3rd edn. CRC Press, New York.

Henderson BE, Feigelson HS (2000) Hormonal carcinogenesis. Carcinogenesis 21(3):427–433

Henricks DM, Gray SL, Owenby JJ, Lackey BR (2001) Residues from anabolic preparations after good veterinary practice. Acta pathologica, microbiologica, et immunologica Scandinavica, 109:273–283

Hines C (2000) Localization: A global manifesto. Earthscan, London

http://www.keepantibioticsworking.com/new/Library/Uploaded Files/American_ Public_ Health_ Association_ Policy_ Numb.htm

Hughes P, Heritage J (2004) Antibiotic growth promoters in food animals. In: Assessing quality and safety of animal feeds. FAO, Rome

Hughes P and Heritage J (2015) Antibiotic growth promoters in food animals. http://www.fao.org/docrep/article/agrippa/555_en.htm

Hunter RA (2010) Hormonal growth promotant use in the Australian beef industry. Beef Prod Sci 50: 637-659

Jeitzman RJI (1994) Residues in food producing animals and their products: Reference materials and methods. Blackwell Scientific Publications, London

Johnson R (2015) The US - EU beef hormone dispute. Congressional Research Service R40449. https://www.fas.org/sgp/crs/row/R40449.pdf

Kahler SC (2001) Eliminate nontherapeutic antimicrobial use in agriculture: AMA. J Am Vet Med Assoc 219(3): 287, 293

Levy LS (2010) The use of hormonally active substances in veterinary and zoo-technical uses. The continuing scientific and regulatory challenges. In: Analysis for hormonal substances in food producing animals. (ed) JF Kay, The Royal Society of Chemistry, Cambridge, UK

Mandal PK (1995) Role of beta agonists in meat production and their effects on meat quality. Beverage & Food World 22(6): 18-20.

Meyer HH (2001) Biochemistry and physiology of anabolic hormones used for improvement of meat production. Acta pathologica, microbiologica, et immunologica Scandinavica, 109: 1–8

Miller A (2015) Your food: Antibiotic use in Canada and its implications for human health. http://globalnews.ca/news/2041743/your-food-antibiotic-use-in-canada-and-its-implications-for-human-health/

Mitchell JM, Griffiths MW, McEwen SA, McNab WB, Yee AJ (1998) Antimicrobial drug residues in milk and meat: causes, concerns, prevalence, regulations, tests, and test performance. J Food Protect 61: 742-756

Mukhtarov D (2012) Kazakhstan bans meat imports from Australia. Trend News Agency. https://en.trend.az/business/economy/2272937.html

NCBA (2006) Fact sheet: Growth promotant use in cattle production. http://www.beef.org/uDocs/Growth%20promotants% 20fact%20 sheet% 20FINAL_4%2026%2006.pdf

Nirala RK, Anjana K, Mandal KG, Jayachandran C (2017) Persistence of antibiotic residue in milk under region of Bihar, India. Int J Curr Microbiol Appl Sci 6 (3): 2296-2299

Paige JC, Tollefson L and Miller M (1997) Public health and drug residues in animal tissues. Vet Hum Toxicol 30: 162-169

Prasad S, Smith P (2013) Meeting the threat of antibiotic resistance: Building a new frontline defence . Occasional Paper Series , Issue 7 , July 2013 .http : // www .chief scientist . gov.au /wp-content/uploads/OPS7-antibioticsPRINT.pdf

Rakotoharinome M, Pognon D, Randriamparany T, Ming JC, Idoumbin J, Cardinale E, Porphyre V (2013) Prevalence of antimicrobial residues in pork meat in Madagascar. Trop Anim Health Prod DOI 10.1007/s11250-013-0445-9

Shukla P, Bansode FW, Singh RK (2011) Chloramphenicol Toxicity: A Review. J Med Sci 2: 1313–1316

Stephany RW (2001) Hormones in meat: different approaches in the EU and in the USA. Acta pathologica, microbiologica, et immunologica Scandinavica, 109: S357–S364

Stokes (2009) School lunch and breakfast programs. Critical food issues: Problems and state of art solutions world wide. Volume 1. Environment, agriculture and health concerns. (ed) LE Phoenix, ABC Clio, California

Swan SH, Liu F, Overstreet JW, Brazil C, Skakkebæk NE (2007) Semen quality of fertile US males in relation to their mothers' beef consumption during pregnancy. Hum Reprodn 22:1497–1502

Van Boeckel TP, Brower C, Gilbert M, Grenfella BT, Levina SA, Robinsoni TP, Laxminarayan R (2015) Global trends in antimicrobial use in food animals. Proc Natl Acad Sci, Washington, DC. www.pnas.org/cgi/doi/10.1073/pnas.1503141112

Ventola CL (2015) The antibiotic resistance crisis. Part 1: Causes and threats. Pharm Ther 40(4): 277–283

Vorotnikov V (2013) Russian considers banning meat from Canada. https://www.globalmeatnews.com/Article/2013/07/24/Ractopamine-violation-prompts-Russia-to-consider-Canada-meat-ban

WHO (2001) Global strategy for containment of antimicrobial resistance. http://www.who.int/drugresistance/WHO_Global_Strategy_English.pdf?ua=1

Zubir SS, Brebbia CA (2014) The Sustainable city VIII (2 Volume Set): Urban Regeneration and sustainability. WIT Press, Southamptan, UK