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Sustainable Antibiotic-Free Broiler Meat Production

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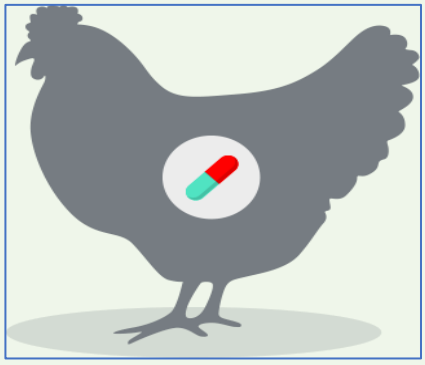
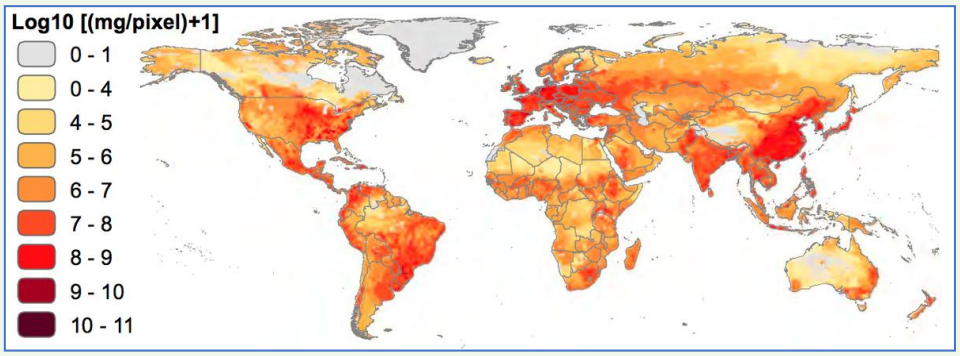
Introduction:

Indian Poultry Sector has been growing at around 8-10 percent per year annually over last Two decade. The total poultry market size including layer and broiler is estimated Rs.80,000 crore (DAHD 2017). Domestic poultry meat production (broiler carcass weight) estimated 3.5 million tones, which is known to be growing at over 10 percent for several years. (Laxminarayan *et, al* 2015) For Sustainable broiler production not only requires maximum productivity but, also, includes bird and human welfare and environmental protection. It is expected that this can be achieved by upgrading farming practices that are profitable, environmentally sound, good for communities, and antibiotic-free. However, raising animals without antibiotics is a challenge especially, antibiotic-free broiler meat production is a growing challenge, (Masud *et,al* 2020).

As several antibiotics frequently consumed by livestock are identical to use in humans, there is worldwide fear that antibiotic-resistant bacteria may be transferred from animals to humans, leading to severe public health concerns (Laxminarayan *et,al* 2016). Resistant bacteria with resistant genes can quickly spread among humans, animals, and the ecological community. Therefore, new approaches should be considered for antibiotic-free broiler production so they can be sustainably raised and marketed.



A large diversity of antimicrobials are used to raise poultry in most countries (Landers *et, al.,* 2012) A recent study estimating global antibiotic use in poultry in 2010 indicates that India accounts for 3% of global consumption and is among the top consumers worldwide, along with China, the United States, Brazil and Germany. Projections for 2030 estimate an overall increase of about two-thirds in animal antibiotic consumption worldwide. The use of antibiotics in animal feed, the study said, will increase by 82% in India by 2030, such use in chickens, in particular, is expected to triple in India by 2030 (Poole,*et al* 2013). The study found that globally Penicillins, Tetracyclines and Quinolones are some of the most widely used antibiotics, with the use of these antibiotics higher in countries.



Antibiotic are substance that can be destroy or inhibit the growth of microorganisms (Therapeutic agent). They are widely use in the prevention and treatment of infectious diseases. They are therapeutically use to protect health and welfare of human and animals. Some organisms are produced by microorganism but most of them are manufactured synthetically. Term antibiotic originally referred to any agent with biological activity against living organism. However, antimicrobial now refers to the substance with antibacterial, antifungal, antiviral or antiparasitic activity (CSE 2014).

Use of Antibiotics:

In poultry farming antibiotics use as Therapeutic Agents: for treatment of disease. The infected animal received a course of antibiotics, which usually involved high dose for relatively short period of time. As Prophylactic Agents: for prevention of disease. This involved sub-therapeutic doses of antibiotics to animals via feed or drinking water, when sign and symptoms of infection are absent but suspected. Antibiotics are given several days during the life cycle of broiler chicken and Growth promoter to increases growth rate and productivity. The use of growth promoters is characterized by administration of very low doses of antibiotics on regular basis, mostly over a lifetime of broiler and it given through feed. Antibiotics growth promoter is known to be suppress the gut bacteria leaving more nutrients for chicken to be absorb for greater weight gain. Research also shown that benefits from the use of growth promoter are more noticeable in sick animal or those houses in unhygienic and cramped condition (CSE 2014).

History Of Use of Antibiotics in Feed:

The discovery of the beneficial effects of antibiotics as feed additive on growth promotion was accidental. The growth promoter effect of antibiotics was revealed in the 1940s. Once it was observed that

animals fed dried mycelia of Streptomyces *aureofaciens* containing chlortetracycline residues enhanced their growth (Castanon *et,al* 2007) and within five years the addition of growth promoting antibiotics has become a common practice. Increasing antibiotic use is driving an increase in antibiotic resistance, in both humans and animals. Resistant bacteria can be transmitted between humans and animals through contact, food products and the environment. More antibiotics are used in animal than in humans, more often to promote growth or prevent diseases than to treat sick animals.

Regulations In India:

The market for processed chicken is growing, over 90 percent of domestic purchase are still through wet (Stagy) market due to traditional consumer preference for getting meat dress infrant. The process chicken market is expected to grow over 25 percent in the long term (Kryger *et,al.* 2010). Most existing standards for the amount of antibiotic residues permissible in food products relate to only seafood products, meant for export. Different state agencies however, from time to time, have issued guidelines on use of antimicrobials in food-animal production or recommended standards for permissible levels of antibiotic residues in food products. Some of these include:

The Second Amendment of the Drugs and Cosmetics Rules (2006) contain a list of 536 drugs that fall under Schedule H, which means they can be sold only based on the prescription of a Registered Medical Practitioner.

In 2007, poultry feed specification from the Bureau of Indian Standards recommended that antibiotics with systemic action not be used as growth promoters, and phasing out of antibiotics that act in the gut in five years.

In January 2012, the Central Drugs Standard Control Organization under the Ministry of Health and Family Welfare introduced a new norm in the country's Drugs and Cosmetics Rule that specifies the withdrawal period, or the timeframe for poultry, livestock and marine products to keep antibiotics off before they enter the food chain.

As per new insertion, eggs and milk products will have to be off antibiotics. This has to be maintained for seven days before the eggs and milk enter the food chain. The corresponding figure for poultry and livestock items will be 28 days. In 2013, a new category of H1 drugs was added through an amendment to the Drugs and Cosmetics Rules.

Use of these drugs now, including several important antibiotics, requires a prescription. Pharmacists must provide separate prescription documentation subject to review, and non-compliance with the regulations can incur penalties. In 2014, a circular was issued by the Department of Animal Husbandry, Dairying and Fisheries to its officials across India, advising them to use antibiotics judiciously for treatment of all food producing animals and animal feeding.

It also advised that the use of all antibiotics and hormones in animal feed should be stopped

immediately. Another directive issued in January 2015 by the Food Safety and Standards Authority of India outlines certain principles including limiting the use of antibiotics in livestock rearing.

The FSSAI, which defined standards for fisheries products through the Food Safety and Standards Regulations (FSSR 2011) has amended this regulation in 2017 to include standards for all food-animal products. Under the proposed Food Safety and Standards (Contaminants, Toxins and Residues) Amendment Regulation 2017 the tolerance limit of antibiotics and pharmacology active substances in food of animal origin will be clearly specified to ensure antibiotic residue in food from animals does not threaten human health**.** The amended regulation states that for a list of 21 antibiotics the tolerance limit, used in human beings and animals will be 0.01mg/kg for the following types of foods namely: (i) All edible animal tissue; (ii) Fats derived from animal tissues; and (iii) Milk. The amendments prescribe the maximum permissible limits of 21 antibiotics and 77 other veterinary drugs for use in food-animal production. The ministry invited stakeholder objections and suggestions, which will be placed before the FSSAI scientific panel on residues of pesticides and antibiotics. The panel's recommendations will be considered by the scientific committee and then the food authority for approval, following which it will be notified in the Gazette of India. Unfortunately, none of these recommendations have been formalized as laws so far. According to a critique of the situation even where there are rules prescribed there are no specifics, no timelines and no punitive measures mentioned, making them ineffective in practice.

Importance of Antibiotic Free Broiler Production:

Broiler farming play important role in enhancing income and mitigate demand of poultry meat in urban, semi urban and rural area. Poultry sector contributes 1% of national GDP and 14% of national livestock GDP. Near about 70% of contribution of broiler meat in meat industry. It provides directly or indirectly employee about 6 million people. Indian poultry is one of the fastest growing with about 8.5% growth annually from last 2 decade.

Generally, farmers in developing countries use antibiotics deliberately to promote growth without any veterinary consultation. Additionally, shockingly, 88% of producers did not adhere to the required antibiotic withdrawal time before marketing (Sarker *et,al* 2018). On the other hand, only 10% of farmers stopped using antibiotics before marketing, and only 2% of farmers withdrew antibiotics at least seven days before marketing. Still, they did not always follow this withdrawal protocol (Sultan *et,al* 2016).

The nontherapeutic use of antibiotics increases the residual accumulation more than medically necessary to use and, thereby, increases the incidence of antimicrobial resistance. The consumption of residual medicines through animal food products (e.g., meat, milk) is assumed to initiate resistance development in humans. Besides, commensal bacteria of livestock are often present in fresh meat, which can serve as reservoirs of resistant genes to be relocated to pathogenic bacteria in humans (Landers *et,al* 2015).

Prospect of Antibiotics Free Meat Production:

In veterinary practice, farmers are purchase of medicines without a prescription is common in developing countries. This can lead to an inadequate course of treatment, incorrect antibiotic selection, indiscriminate and excessive use, and enhanced residual deposition in animal bodies (1) If veterinarian, medical store followed regulation will minimize the effect of antibiotic residue in broiler meat.

Now consumer demanding safe, hygienic and antibiotic free broiler meat. There for, market is developing in antibiotic free market particularly in urban and semi urban area. In Online market and chain market increase demand for sale safe, antibiotics Free meat and its prospective growth up to 25% in coming years. The challenge is to produce antibiotic free meat.

One option would raise to alternative to use of antibiotics are, by using of Probiotics, Prebiotics Amino acids, Enzyme, Medicinal Plants are use in the fed of broiler to sustain growth production.

General Strategy for Antibiotic Free Broiler Meat Production:

Sr. No.	Strategy	Action Plan
01	Apply minimum 14 days interval for new flock entry	Reduce frequency of pathogen
02	Maintain dry litter	Reduce ammonia level, and stocking time, improve ventilation
03	Disposal of dead bird regularly	Minimize bacterial load and prevent cannibalism
04	Use Coarse Grain to finest	Upgrade the role of gizzard and digestion
05	Use Probiotics supplement in early stage of broiler feed	Establish healthy gut microorganisms and increase growth performance
06	Apply good sanitation program for drinking water	Reduce contamination of bacteria and remove biofilm from the pipeline, regulator and nipple drinker
07	The Addition of Ingredients like Wheat, Barley, and Oats	Minimize Gut Damage and Subsequent Enteritis
08	Add Exogenous Enzymes	Exploit Extraction and Digestion of Nutrients and Minimize the Viscosity of Digesta.
09	Add Essential Oil Extract to Feed	Maintain Bacteria at Safe Levels and Improve Intestinal Health
10	Maintain Good management Practice	Minimize stress
11	Follow Good Bio-security Practices	Reduce the Opportunity for Disease
12	The Addition of Ingredients like Wheat, Barley, and Oats	Minimize Gut Damage and Subsequent Enteritis
13	Add Exogenous Enzymes	Exploit Extraction and Digestion of Nutrients and Minimize the Viscosity of Digesta.

Antibiotic Alternative:

From last two decade poultry farmers have been extensively use antibiotic in broiler poultry feed for weight gain. (By adding antibiotics FCR rate increase by 4%). Additionally, birds are prevented from diseases like Coccidiosis and Necrotic enteritis. Additionally, by removing Antibiotics in feed could, the production cost of broiler farm could increase and this cost should be recovered from increasing poultry

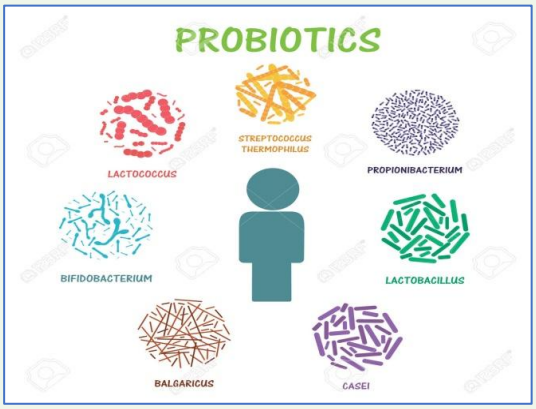
meet cost. While altering antibiotics there should be take care of the alternative should be provide low mortality rate and get adequate level of yield. With preserving environmental and consumer health. Also, alternative have good support of research with good effect similar to growth promoting antibiotics. As considering nutritional aspect many alternatives has been studied for sustainable alternative to antibiotics (Haque *et,al* 2020).

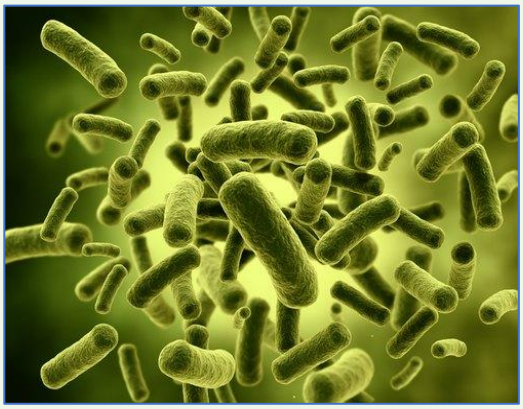
The most popular alternatives are-

1. Probiotics and Prebiotics
2. Organic Acids (Acidifiers)
3. Amino Acids and Enzymes
4. Phytogenic feed additives (Thyme, Garlic, Turmeric, Black cumin etc.)

Probiotics:

Probiotics are yeasts and live bacteria that confer beneficial effects on the health if administered in adequate doses (WHO, 2001). Probiotics can replace antibiotics by changing the intestinal microbiome, thereby producing some of the effects of antibiotics. For example, feed supplementation with probiotics improves the feed efficiency and intestinal health and, ultimately, facilitates the faster growth of broilers by reducing the intestinal pH, altering the intestinal bacterial composition, and improving digestive activity (Ghasemi et,al 2014, Gianninos et,al 2012). Probiotics stimulate endogenous enzyme production, which reduces the production of toxic substances and increases vitamins and/or antimicrobials such as bacteriocins (Hassanein et,al 2010). It has been reported that bacteriocins inhibit the production of toxins and the adhesion of pathogenic microbes (Pan *et,al* 2014).





Probiotics increased the meat quality of poultry by affecting the fat and protein contents (Hasssanein *et,al* 2010, Popova *et,al* 2017). Some important are Lactobacillus acidofilus. L. Bifidus, L.casai, L.Lactis, Bifidobacterium bifidum, Aspergillus oryzae. Lactobacillus acidophilus produces lactic acid and enzyme amylase. Lactobacillus Casai complement the growth of lactobacillus acidophilus. Bifidobacterium bifida is found commonly mother milk and intestine of human and animal. Aspergilus oryzae produce enzyme cellulose. They are essential in improving the water-holding capacity, color, pH, oxidation stability, and the chemical composition of meat, such as the fatty acid content (Popova et,al 2017). Feed supplemented with *B. licheniformis* improves the juiciness, flavor, and color of broiler chicken meat (Liu

et,al 2012), which is appreciated by consumers (Mehdi et,al 2018).

Probiotic supplementation also lessens parasitic infestation in chickens (Giannenas et,al 2012). Probiotics exert coccidiostatic effects on Eimeria tenella, maintain intestinal health, and reduce the spread and risk of coccidiosis in broiler production systems [81].

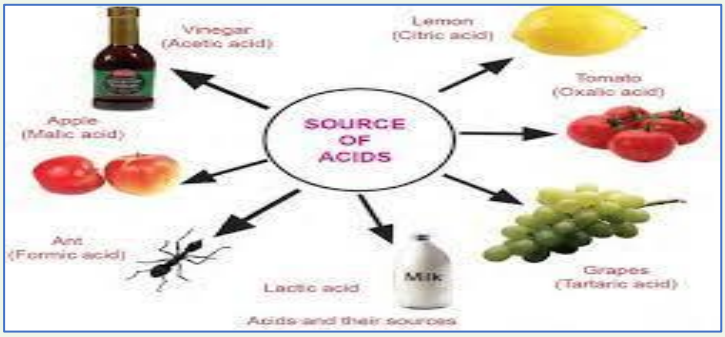
Prebiotics:

The nondigestible components of feed that exert potential beneficial effects on the health are known as prebiotics. Most prebiotics are fermentation products consisting of oligosaccharides and short-chain polysaccharides (Jozefiak *et,al* 2008). Their fermentable properties stimulate the growth and activity of beneficial bacteria in the ileum and cecum and contribute to a healthy intestinal tract and, ultimately, increase poultry productivity (Moralez -lopez et,al 2009, Zhang *et,al* 2005). They are also considered as excellent alternatives to antibiotics. Prebiotics alter cecal proteobacteria composition and increase broiler growth (Park *et,al* 2016). Products containing high levels of mannose and mannoprotein in the feed tend to increase villus cell numbers in the intestines (Baurhoo *et,al* 2017) and are essential for improving intestinal health, thereby producing healthier poultry.

Probiotics exert their beneficial effects on the host by selectively feeding the harmless bacteria (*Lactobacillus)* thus improve their activities at the expense of the harmful ones. Prebiotics selectively fermented by beneficial microflora into lactic acid, Lowered pH in GI tract. Inhibiting colonization of pathogenic bacteria (*E coli*, *Salmonella*, *Clostridia* etc). *Salmonella*, *E. coli* and many other gram-negative harmful microbes are unable to utilize these oligosaccharides and therefore their growth is inhibited. SCFA like Acetate and propionate produced are having gluconeogenic effects while butyrate is a major source of energy for intestinal epithelial cells. Non-digestible oligosaccharides stimulate absorption of several minerals like calcium, magnesium, zinc and iron Increase immune status

Organic Acid:

Organic acids are conservation agents widely known for protecting feed from microbial spoilage and improving the nutrient digestibility in poultry (Kum et,al 2010). Organic acids include carboxylic acids that carry a hydroxyl group on the alpha-carbon, such as malic, lactic, and tartaric acids, and pure monocarboxylic acids, including acetic, formic, butyric, and propionic acids. Organic acids can inhibit the microbial growth by disrupting bacterial enzymatic reactions and decreasing the transport



of acidic compounds by nonionic diffusion through the membrane (Cherrington *et,al* 2010). It has been reported that adding organic acids to feed may improve the growth, feed conversion rate, and feed utilization of broilers (Hassan *et,al,* Nava *et,al,* 2009, Adil *et,al* 2020). While drinking water is a risk factor for spreading campylobacter infection in broilers, Chaveerach et al. demonstrated that organic acid-treated drinking water can potentially prevent campylobacter infection in broiler flocks without any damage to gut epithelial cells (Chavirrah *et,al* 2004). Blends of formic and propionic acids in drinking water for chickens can generate homogeneous and distinct populations in the intestinal microbiota and increase *Lactobacillus* spp. colonization in the ileum (Izat *et,al* 1990), which can be a substitute for antibiotics used to reduce pathogenic bacteria in the gastrointestinal tract (GIT). These changes in the intestinal microbiota and increased *Lactobacillus* populations suggest that organic acids can substitute for antibiotics such as bacitracin to reduce pathogenic bacteria in the GIT (Nava et,al 2009). Additionally, organic acids have the potential to inhibit *E. coli* infection (Izat *et,al* 1990), and a supplementation with 2% citric acid can improve the gut health (Mohmmadgheri *et,al* 2016). It has been reported that formic acid, an extensively studied

Blend of organic acids on growth performance:

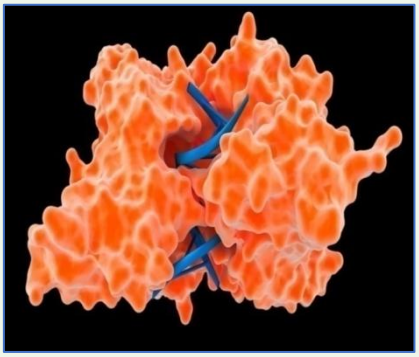
Blending type (mixtures) of organic acids have synergistically positive effects of individual organic acid. Feeding of blend of Lactic acid, formic acid, and citric acid improved growth performance (Alcicek et. al., 2004). Feeding of diets containing 2g/kg blends of propinonic acid and formic acid improved growth performance (Gunal et. al., 2006). Feeding of diets containing 1g/kg blends of formic acid, propionic acid, calcium propionate, and ortho-phosphoric acid improved growth performance (Samanta et. al., 2008).

Enzymes:

Broiler feeds are supplemented with amino acids and enzymes to increase the feed conversion. These enzymes are produced by fermenting fungi and bacteria. Enzymes enhance the digestibility of the feed by facilitating the degradation of proteins, phytates, and glucan.

For example, it has been reported that broiler diets of wheat and barley supplemented with endo-b-1-4-xylanases and b-1-3, 1-4-glucanases can improve the digestibility of the feed (cowieson et.al 2006).

Another study reported that a phytase enzyme improved daily weight gain by increasing the villus width and decreasing the crypt depth. Lysins are bacteriophage endolysins that could be an alternative therapeutic option instead of antibiotics. Lysins are phage-encoded peptidoglycan hydrolases that cause lysis of bacteria by cleaving peptidoglycan when applied exogenously to Gram-positive bacteria (Fenton *et,al* 2006, Rios *et,al* 2016). The antibacterial efficacy of several lysins has been reported; for example, peptidases, amidases, and lysozymes showed antimicrobial potential against C. perfringens in poultry (Velozhatsev *et,al* 2011).



Phytogenic Feed Additives:

Phytogenic feed additives (PFAs), also known as phytobiotics or botanicals, are derived from plants, herbs, and spices and can improve animal health. PFAs are reported to positively affect growth by improving the feed conversion ratio (FCR), boosting the immune system, and reducing stress. Several recent studies also showed that phytogenic feed additives promoted broiler chicken growth and could be used as an alternative to antibiotics (Windisch *et, al* 2008, Frankic *et, al* 2009, Li *et, al* 2015). Another study demonstrated that including *Lippia javanica* in broiler feed at 5 g/kg enhanced the broilers' daily gain and slaughter weight.

Phytogenic extracts of *Lippia javanica* leaf can stimulate glycolysis and increase energy production utilization and, thus, growth (Mpofu et,al. 2016). They can also improve the fatty acid profile of broiler chicken meat (Mpofu *et,al*. 2016). It has been reported that the use of garlic (5 g/kg) and black pepper powder (1 g/kg) in broiler feed could enhance broiler chickens' weight gain and consumption index (Kirubakaran *et, al* 2016). Thus, PFAs have the potential to replace antibiotics in the poultry industry. On the other hand, there are also essential oils, the hydrophobic concentrated liquid of odoriferous and volatile aromatic compounds, which can be of plant origin (natural) or synthetic. The crucial vital oils in broiler production are trans-cinnamaldehyde, thymol, eugenol, and carvacrol. They interfere with the bacterial enzymatic system and modulate inflammation and immune responses. They are excellent alternatives to growth-promoting antibiotics such as Avilamycin for increasing chicken production (Khattak *et,al* 2014, Pirgozliv *et,al* 2015). Essential oils also have a significant role in preventing and controlling necrotic enteritis in chickens (Jerzsele *et,al* 2012). Furthermore, it was reported that supplementing with essential oils such as oregano (*Origanum* genus) in broiler feed at 300–600 g/kg increased the average daily gain of broiler chickens (Pirgozliv *et,al* 2015). Therefore, essential oils should be used as an alternative to antibiotics in the poultry industry.

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