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Update on Alternatives to Antibiotic Growth Promoters for Poultry

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Introduction

In last few decades' global population is rising rapidly. Poultry is one of the best sources available to meet the requirements (especially for protein) because of its acceptance & lesser cost. The profits in poultry industry are depended up on 2 factors – FCR and disease resistance, these both traits are highly influenced by genetic potential, nutrition and management practices. To boost their growth and productivity, use of antibiotics in the sub-therapeutic doses was increased exponentially in last few decades which led to antimicrobial resistance, evolving of super bugs and increased incidence of disease outbreaks.

Key words: Growth, stressors, symbiosis, phytochemicals, coliforms.

Why antibiotics are used as growth promoters?

Many antibiotics in the sub therapeutic doses act as growth promoters or growth stimulants like Ionophores (Monensin, Salinomycin), Tetracyclines etc. The exact mechanism is still not clear but the possibility is antibiotics will decrease the intestinal bacteria load and increase availability of nutrients to bird so that it indirectly increases growth and performance. The ban/restrictions on them laid pressure on researchers and specialists to find suitable alternatives to antibiotics and to fight the determinants like pathogens, stressors (Salmonellosis, Colibacillosis, Coccidiosis, influenza etc.)

Suitable and sustainable alternative products should have characteristics like;

- Should not compete with the dietary nutrients in absorption and should not intervene in their metabolism and excretion,
- Should not chelate or precipitate the nutrients in the gut or in the system,
- Should not be inert in the gut and have good marginal safety,
- No residues in the meat,
- No side effects and long-term effects,
- Economical and easily available,

- Should not alter/decrease the FCR,
- No possible harm if they are released in to the environment intentionally or accidentally.

Not all compounds have every property, so they are used commonly in combination (to decrease the dose required and to have synergistic action).

Classification

They're classified based on how they increase the growth and performance of birds. They act indirectly by increasing the availability of nutrients, maintaining the gut health or by aiding in digestion/absorption or by abruption of factors that halts the growth.

- By increasing the availability of nutrients (Enzymes).
- By preventing establishment of pathogenic bacteria and biofilms in the gut (Synbiotics)
- By binding to the toxins in gut and having protective effect (Clay)
- By increasing the digestive capacity and turnover of bird (Organic acids)
- By killing or neutralising the pathogenic organisms in gut (Endolysins)
- By improving gut health and possessing antioxidant activity (phytochemicals)
- Anti-stressors (Chromium)
- Bio-engineering technology (CRISPR-Cas)
- Providing immunity to the disease (hyper-immune egg yolk antibodies)

List of Alternative Growth promoters to antibiotics: (Natural, Semisynthetic, Synthetic, Bioengineered)

1. Phytochemicals,
2. Prebiotics, Probiotics, Postbiotics, Synbiotics,
3. Enzymes, Acidifiers, Organic acids,
4. Toxin binders, Clay,
5. Peptides, Endolysins and other lysins, Bactericins,
6. Metallic elements,
7. Bacteriophages, Vaccines, CRISPR-Cas,
8. Hyper-immune Egg yolk antibodies (Monoclonal),
9. Secretion system inhibitors, Quorum sensing inhibitors,
10. Herbal products etc.

Discussion

Organic acids: They are short chain fatty acids when added to the feed, they alter the gut pH and promotes secretion of digestive juices. They increase the digestibility and aids in growth of bird. They also possess antimicrobial effect and decrease ammonia production in the gut.

Example// Malic acid, Tartaric acid.

Endolysins: This hydroxylase compounds directly act on the cell wall (Peptidoglycan layer), alters the homeostasis and prevents the growth of harmful bacteria. They are suitable alternatives to the antibiotics but their role is limited in promoting the growth.



Example// Bacterial Endolysins.

Antimicrobial peptides also have similar activity.

Postbiotics: This concept is relatively new and these compounds are secreted by various bacteria and fungi (Ex// *Aspergillus* sp.), they increase the lactic acid production in gut, enhances the digestion, stabilises the gut and increases the growth. They counter colonisation of pathogenic enteric bacteria.

Probiotics: Probiotics are live yeast (Ex// *Saccharomyces*) and bacteria (*Lactobacillus* Sp.) etc. These compounds when mixed and given in feed, they localise and multiply in intestine. They act as a protective barrier by preventing the pathogenic bacteria colonisation and functions as growth promoters. Example// *Bacillus subtilis* KC - against *Mycoplasma gallisepticum*.

Probiotics: They are saccharides (Ex// Fructans), they help in growth of beneficial bacteria and stabilizes the host gut microbiome. They are detrimental for pathogenic bacteria like *E. coli* and *Clostridium* Sp.

Synbiotics: combination of prebiotics and probiotics (work synergistically).

Enzymes and Binders: Many nutrients in the feed are excreted without proper digestion. Its due to the presence of anti-nutritional factors & chelation of nutrients with them. Enzymes helps in breaking this bond (Example// Phytase for Phosphorus). By breaking the chelation, they increase availability of nutrients required for the growth.

Toxin binders bind to the toxins in the feed/gut produced by pathogenic bacteria like *Clostridium* Sp. thus improves the gut health and performance of the birds.

Phytochemicals: also called plant nutraceuticals / phytobiotics. they are derived from plants, herbs or plant-based products. The active ingredient in Phytochemicals are polyphenols and flavonoids. They possess antioxidant, antimicrobial and lipid lowering capacity and has immune-stimulant property. the properties of each compound varies so they can be used alone or in the combination.

Example// Rosemary, Pumpkin seeds etc.

Bactericins: they are derived synthetically (Ribosomally) from various bacteria, they have bacteriostatic and bacteriocidal properties against pathogens and aids the growth of opportunistic and guy friendly bacteria.

Example// *Lactiplantibacillus plantarum* inhibits growth of *Salmonella* Sp.

Metallic Elements: Elements like Copper, Zinc fights the disease and improves the growth of birds. The inclusion level of these elements should be carefully monitored and maintained as overdosing can lead to toxicity. for poultry, chromium is used as anti-stress supplement.

Bacteriophages: these viruses attack bacteria; they propagate and replicate inside them. They are strain specific. it is shown that the optimum levels of bacteriophages inclusion in the feed can promote the growth of symbiotic gut flora by killing pathogenic bacteria thus increasing growth and performance. Bacteriophages preparations are low in cost. Many strains are developed to kill bacteria species like *Campylobacter* sp. and *E. coli* etc.

Hyper-immune Egg Yolk Antibodies: They are produced by repeated administration of antigens to the mother hen and the developed monoclonal antibodies vertically passes to the egg. This Ig Y really



helpful in fighting many infections especially enteric disease. The use of these IgY in field is relatively less.

Clay: they are phyllosilicates, they have stratified layers of oxygen, silicon and aluminium. They have great affinity and adsorption capacity of toxins produced by various fungus, bacteria and also bind to the metals. They neutralize them, relieves gut from harmful compounds and promotes the growth of bird. they exact mechanism is still not clear.

Vaccines: Vaccines produce immunity against various diseases and indirectly aid them to grow disease free and they also decrease the load of antimicrobials.

Acidifiers: they aid in growth by altering the gut pH, they decrease the colonization of harmful enteric bacteria and increases the digestibility of nutrients.

CRISPR-Cas: this Bio-engineering technology used as a gene editing tool in poultry. The sequence of gene (engineered) makes the bird less susceptible/resistant to many diseases like Avian influenza etc. They help in improving the overall health of poultry and promotes the growth. The only limitation of this technology is cost.

Secretion System Inhibitors: They promote the growth by inhibiting the replication of pathogenic bacteria.

Example// Harmine - inhibits T3SS (Type 3 secretary system) – used against Salmonella sp.

Quorum Sensing Inhibitors: they abrupt the signalling mechanism in bacteria, thus decrease infectivity and pathogenicity of the disease.

Example// Quercetin.

Herbal Products: many household compounds can be used in backyard poultry as growth promoters. Example// Indian ginseng (Anti stress, Immuno-stimulant), Ginger (carminative and antioxidant), Mint (antioxidant) etc. The efficacy and use of this products in the feed as inclusions should be done after the sound research and under the guidance of veterinarian.

Limitations for using above alternatives:

- No Adequate research and knowledge regarding them as growth promoters.
- Lag in Recognition.
- Cost involved in bio-engineering technology. Not all alternatives are sustainable.
- Mis-dosing shows harmful effects (heavy metals).
- Non availability of the products.
- Misconceptions regarding using of them in the poultry industry.

Conclusion

Discontinuing antibiotics in the poultry industry as growth promoters may decreases the abuse and the problem of a rising of resistant bacteria in future from poultry sector up to some extent but it didn't solve the whole problem of increased outbreaks in poultry due to Salmonellosis, Camphylobacteriosis, Colibacillosis, Coccidiosis etc. and the pressure on poultry sector in order to meet the protein requirement of the world. The new alternatives using should address both fight against the infections and promoting the growth of birds simultaneously. The knowledge regarding them should be disseminated to field level and regulations to be made to avoid product abuse.

