White paper

Improving antibiotic-free poultry meat production

Improving antibiotic-free poultry meat production

Edgar O. Oviedo-Rondón, DVM, MSc., PhD., Dipl. ACPV
Prestage Department of Poultry Science, College of Agriculture and Life Sciences.
North Carolina State University, Raleigh, NC 27695-7608

Introduction

The production of antibiotic-free (ABF) poultry is now a common trend worldwide, since growth promotant antibiotics (GPA) have been banned by some governments and because many consumers are increasingly avoiding food products that contain antibiotics. Despite GPA having been an excellent tool in controlling dysbacteriosis and enteropathogens in animal production for the past 50 years, the negative publicity of GPA in the media, as well as market trends and perceived marketing opportunities indicate that the majority of the poultry industry will or should now implement some level of ABF production.

Figure 1: Meat and processed food from chickens raised without antibiotic usage.

Many poultry companies have years of experience working with the ABF system. Some still have difficulties in controlling diverse health challenges, while others have had successful experiences, due to improvements in housing and changes in feeding, management, and health programs. These measures, implemented to control the multitude of factors that may affect intestinal health, incur additional costs. ABF systems can be profitable, as long as the prices of the final ABF products can cover the costs implicated in the investments necessary to develop these products.

There are numerous concepts around the ways that ABF systems in poultry meat production can be implemented or improved in order to reach flock health and welfare conditions, while improving productivity.

ABF production systems

What is the level of ABF production that the poultry company wants to achieve?

There are many categories in ABF production, depending on the type of certification, market claims or products to be offered to consumers. Some of these main groups are:

1. The standard ABF programs that allow use of chemical antibacterials, chemical anticoccidials, and ionophores, but no antibiotics.
2. Organic production with no antibiotics, ionophores coccidiostats, chemical anticoccidials, or chemical antibacterials like sulfonamides.
3. Systems like the U.S. Department of Agriculture (USDA) Process Verified Program called USDA-AMS Never Ever 3 (NE3) Program that does not allow chemical antibacterials such as sulfonamides or antibiotics, but will allow chemical or ionophore coccidiostats. In addition, no animal by-products or synthetic growth-promoting compounds are allowed in animal feed.

Each system may raise certain difficulties for producers managing flock health. For example, they could implicate higher costs of production, lower levels of productivity and difficulties in achieving low mortality and good poultry welfare.

Managing nutrients for successful ABF production

A common misconception surrounding ABF production is to focus only on intestinal disease control. Generally, the attention is placed on coccidia or specific enterobacteria like Clostridium or Salmonella. This misunderstanding comes from daily experiences that indicate these are the main health issues observed when any ABF program is implemented. However, the reality is these are the consequences and not the causes of the main issue. The excess of nutrients in the hindgut, from either high levels in the diet or suboptimal digestibility, cause microbial proliferation in the hindgut.

Figures 2 (left) and 3 (right): Figure 2 shows bad intestinal absorption of nutrients. Figure 3 shows a high presence of gases in the excreta as a consequence of intestinal dysbacteriosis.

Nutrients in excess, especially protein and fat, are not well digested and absorbed at the end of each feeding phase. This increases the microbial proliferation in the ceca. Appropriate digestibility can be achieved and maintained once there aren't too many nutrients in the diet. This can help control all microbes and the diseases that they generate. Therefore, phase feeding or increasing the dietary phases currently offered to improve feed formulation precision, according to animal needs, is necessary for ABF production.

Appropriate foregut digestibility is crucial to get the best from ABF production

The following steps are necessary to stimulate appropriate digestive function in all poultry species:

- Offer all feed ingredients with a granulometry or particle size that stimulate gizzard function
- Maintain water pH between 5 and 7, and water temperature between 16 and 25° C
- Add organic acids in feed or water to guarantee slightly acidic crop pH conditions
- Minimize the water hardness and alkalinity
- Avoid levels of calcium higher than the requirement for each age and productive phase
- Diminish the levels of additional fat, if possible, but maintain a minimum of 1% to stimulate gastric function and slow release of digesta from gizzard to the small intestine
- Use exogenous enzymes that help to degrade phytate, β-mannans, xylans and other non-starch polysaccharides

Exogenous enzymes are the second best tool to control bacteria proliferation in the intestines. They have been widely adopted due to the cost saving impact in diet formulation and as productivity enhancers. A secondary effect of all enzymes is their positive impact on gut Microbial Communities (MC). Exogenous enzymes reduce microbial proliferation by reducing the indigestible components of feed, the digesta viscosity or the irritation to the gut mucosa. Enzymes also generate metabolites that promote microbial diversity which helps to maintain more stable gut ecosystems that are more likely to inhibit pathogen proliferation.

Feed and water quality

Good quality feedstuffs are essential for optimum digestibility. Therefore, every single feedstuff should be evaluated for its quality and for possible factors that may affect digestion.

Did you know?

Companies with ABF production programs need to place more emphasis on avoiding levels of mycotoxins in feedstuffs that exceed recommended limits. Grain damage and conditions that could increase mold and insect spoilage must be minimized. Fats and oils with rancidity should be rejected. Proper fat storage conditions should be frequently revised in order to control rancidity development within the feed mill. Antioxidants and mycotoxin binders become more necessary in ABF programs.

Water quality and sufficient consumption of water is also important in aiding proper digestion. The physicochemical characteristics should be measured and controlled and the pH should be maintained slightly acidic, between 5 and 7, because basic water pH reduces the activity of most enzymes.

In the same way that water deprivation can cause intestinal issues, feed withdrawal during grow out should be avoided completely in ABF programs. After 5 or 6 hours of feed withdrawal, gut mucosa traits shift, making chickens more susceptible to mucoid enteritis. Feed withdrawal stimulates mucin production by goblet cells in the intestinal mucosa. This extra mucin is avidly used by bacteria, irritating the mucosa, generating more mucus and inflammatory reactions. The disruption in mucus properties facilitate adherence of enteropathogens and coccidia infection.

Alternative products to modulate gut microflora

Some feed additives and mineral levels can help to maintain healthy MC in all gut regions. This can occur independently of feed withdrawal, intestinal infections with coccidia, or heat stress and even maintain the normal diversity of MC observed in control groups of chickens. Therefore, these products become an additional tool for ABF production.

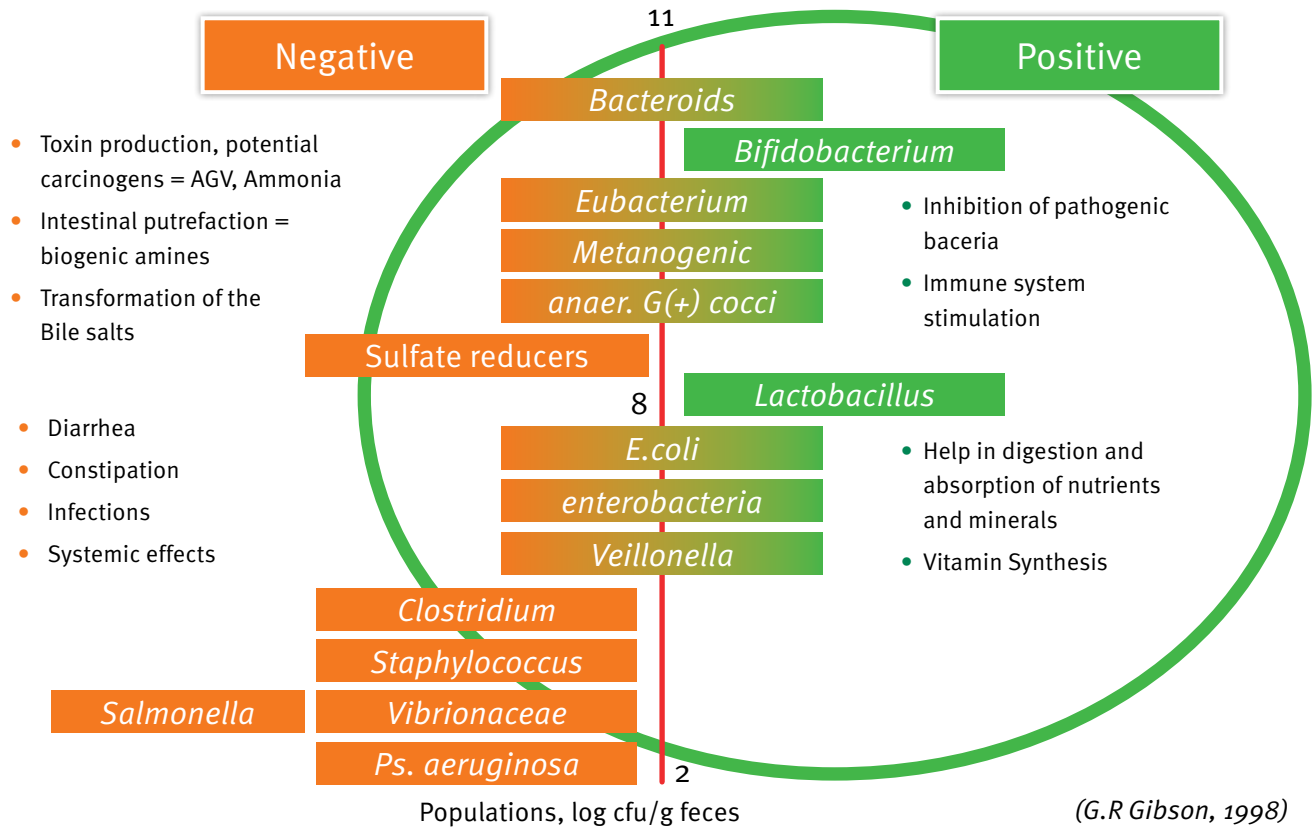


Figure 4: The role of the gut microbial communities in the gastrointestinal tract (GIT).

Alternative new feed additives

A number of feed additives may be included in feed to improve gut health, such as probiotics, prebiotics, enzymes, organic acids and essential oils (plant extracts, herb extracts, phytobiotics):

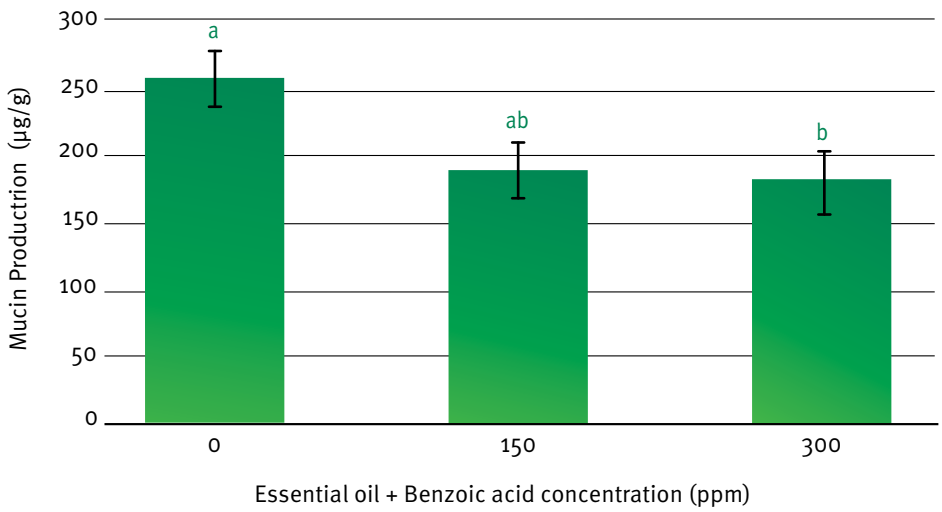
- Probiotics introduce desirable live microorganisms into the GIT
- Prebiotics promote the growth of desirable bacteria in the GIT
- Enzymes help to eliminate the anti-nutritional effects of water-soluble polysaccharides, and/or change the substrates to improve proliferation of some beneficial MC
- Organic acids cause the inhibition of bacterial growth
- Essential oils can support gut microflora balance, stimulate digestive enzyme production and the immune system

The combination of probiotics and prebiotics can be referred to as synbiotics. Each type of product has demonstrated varied efficacy while administered independently or in combinations. It is important to point out that each product group discussed is a big category, as broad as antibiotics, and consequently almost each product has a unique characteristic and effect. Only appropriate testing, use, and rotation can guarantee its success in a sustainable ABF program.

Essential oil (EO) blends

A category of phytobiotics, EO blends are mixtures of phytochemical compounds with selective antimicrobial properties, such as carvacrol, thymol, cinnamaldehyde, among others. Some specific EO blends have shown promising results towards the reduction of Clostridium perfringens colonization and proliferation and control of coccidia infection, consequently helping to reduce necrotic enteritis. Additionally, a combination of EOs with benzoic acid has shown a reduction in the mucin production in the small intestine for broilers.

Graph 1: Effects of essential oil blend on ileal mucin production in broilers at 46 d



House environment and biosecurity

Proper house environmental conditions should be observed for effective ABF production. Optimum temperature, air velocity, and relative humidity according to the age, phase of production and size of the birds should be considered. Any bird under environmental stress, due to heat, cold, very dry or very humid air could have their feed intake patterns and intestinal motility affected, causing reduced digestibility. Lighting programs may also impact feed intake behaviors, motility and digestion. Light intensities lower than 10 lux and 4 to 6 hours of total darkness per day improve feed conversion ratios indicating slower feed intake and better digestibility. Good house ventilation is key for ABF programs to minimize condensation, litter moisture, and caking. Keeping litter moisture below 30% is the goal, but it is also important that litter does not become too dry.

Did you know?

In flock management, it is important to allow the flock more space during the brooding period, between the first and second week of age. This helps avoid excessive competition for feed, drink and physical space, which can cause stress.

Flock health

Preventing coccidiosis and necrotic enteritis are normally the main concerns during ABF production. In cases where no anticoccidial medications are allowed, coccidiosis vaccines and litter management are the principle ways to control Eimeria spp. Cocci vaccination for broilers has been applied in traditional poultry production systems and new ABF programs for years, in many countries. However, control of other intestinal parasites, worms and poultry diseases which have an impact on intestines and immunity, is also necessary when working to improve health programs for the whole ABF production cycle. Proper vaccination of breeders, and at the hatchery, can aid to prevent Newcastle, infectious bursal disease, and infectious bronchitis. Specific vaccines for Salmonella or E. coli could be applied to breeders to minimize the impact of these common pathogens in the progeny.

Biosecurity practices – why they are important:

Daily functional biosecurity practices are necessary to ensure breeder flocks and grow-out farms are free of *Mycoplasma gallisepticum* and *Mycoplasma synoviae*. Practices include:

- Bio-exclusion, limiting visitors, vehicles and equipment that visit other poultry farms
- Bio-containment, isolating the houses, controlling insects, rodents and entry of wild birds and other animals to the houses

Improving breeder health

Broiler breeder nutrition is fundamental for adequate development of their progeny. Embryo development is totally dependent upon egg nutrients deposited by hens. Specific nutrients such as vitamin D, trace minerals, carotenoids, and fatty acids play key roles in immunity and gut development. Hens affect embryo nutrition and development by eggshell properties, such as egg porosity and shell thickness, which determine conductance. Eggshell conductance dictates the capacity of eggs to exchange gases and water vapor, consequently affecting embryo yolk and general nutrient utilization.

These physical factors, especially the capacity to obtain sufficient oxygen, limit the type of metabolism, rates of tissue development, and embryo growth. This is more important during the last three or four days of incubation prior to hatch, in the plateau stage of oxygen consumption when development of many tissues, including GIT, bones and muscles, is at its fastest rate. As breeders can transfer intestinal microbes and immunity to their progeny, companies practicing ABF programs should make sure that intestinal health is adequate in breeders and that their vaccination programs are effective, to prevent issues in the progeny.

Research findings indicate that elevated temperatures during the last phases of incubation reduce GIT tissue mass and enzymatic activity

For example:

- The average weight of chicks is reduced by 5%, which corresponds to 2-3 grams
- The relative size of the proventriculus, gizzard and intestine was reduced by 13, 14 and 16%, respectively.
- At hatch, suboptimal incubation reduced intestine length.
- Maltase enzyme decreases dramatically from overheated chicks compared to chicks incubated at optimum eggshell temperatures.

These effects have implications in the digestive capacity of the chicks and probably in the incidence of intestinal problems and resistance to parasites.

Suboptimal incubation generally tends to increase the hatch window causing some chicks to either hatch too early, 36 to 48 hours before pulling chicks out of hatchers, or too late. Both conditions cause issues with development of the lymphoid tissue associated to the gut and general immunity. Chicks without access to feed and water for 48 hours post-hatch showed a delay on all immunity responses in the ceca and colon and on colonization of lymphocytes in the bursa. This causes reduced immune activity during the first two weeks of life when the majority of primo vaccinations are applied and birds have their first contact with potential enteropathogens.

Discover our eubiotics portfolio ›

Conclusion

The ABF programs for poultry meat production are becoming more common. To make these programs successful, extra attention needs to be placed on the whole production system. Not only are feed, feed additives or enteric pathogen control important, but also housing management, water quality and biosecurity at breeder and grow-out levels. Even proper hatchery conditions should be improved to make ABF programs successful.

On the nutritional side, feed formulation precision and phase feeding should be used. Feed processing, using coarse grinding or whole grains, is necessary to stimulate gizzard function and peristalsis. Also, more stringent feed quality assurance programs should be implemented. The use of exogenous enzymes play a key role in aiding improved digestibility and mitigating the negative impact of some antinutritional components. Feed additives with eubiotic characteristics are important tools to modulate microflora whenever any of the other factors previously reviewed cause bacteria proliferation, and therefore help increase productivity in ABF programs.

References available on request.