

Principles of Competitive Exclusion

Food Borne Pathogens: The Challenge

Food Safety is probably the biggest issue facing our poultry production systems today. Consumer confidence has a direct correlation to the safety and wholesomeness of the product they will purchase. Preventing contamination of poultry products with food borne pathogens, such as Salmonella and campylobacter spp., remains a considerable challenge for producers and integrations in our country. To help reduce the risk, yet at the same time document our strategies, we have turned to a risk reduction program called **HACCP** (hazard analysis critical control point).

HACCP programs or commonly referred to as On-Farm Quality Assurance programs are initialized by most of our poultry associations or supporting industries. HACCP is our opportunity to document our initiatives. Simply writing down what you do, do what you write down and record it qualifies us as leaders in minimizing the insults that consumers are concerned about. As auditors, we are accountable for our production processes and the inputs we utilize in the reduction of food-borne pathogens.

In relation to Salmonella, much is known about sources of flock infection, the means of bird transmission and the management factors needed for effective control. For our production flocks, infection can arise from vertical transmission from infected breeders, horizontal transmission from contaminated feed or replacements. Infection can also come from a variety of environmental challenges such as wild birds, rodents, insects and other factors that can support the viability of the bacteria. Since the poultry industry is on “wheels” every precaution must be made to instigate and follow strict bio-security principles.

To reduce the risk factors associated with salmonella and the other pathogens, the industry has installed programs to reduce the incidence. Programs such as vaccination (layers), sanitation/disinfection, feed acidifiers, the addition of complex sugars and most recently **Competitive Exclusion** has contributed immensely to the minimization of the pathogens. The bird, no doubt can handle an infectious dose (age dependant) but when the insult becomes to numerous, the immune system dwindles in its response to control the challenge. The bird needs support.

Competitive Exclusion

Background

The term competitive exclusion (CE) is used to describe the process by which beneficial bacteria exclude bad bacteria or pathogens. CE implies the PREVENTION of entry and establishment of a bacterial population into the gut. To succeed, the good bacteria must be better suited to establish or maintain itself in that gut environment.

In the past, under natural breeding conditions, the chick/poult received a competitive flora of beneficial bacteria from the hen and from the environment. However, under modern breeding conditions, clean breeder and hatchery environments, as well as separation of the chicks from their parents, the establishment of the gut intestinal flora (bacteria) is delayed. This delay makes the chick/poult very susceptible to colonization of unwanted, transient bacteria that might be found in the litter, pen mates or contamination in feed or water.

Nurmi, the father of Competitive Exclusion drew attention to the conditions under which chicks are produced and reared. As mentioned, they have no contact with mother hen and are placed in clean and sanitized

environments. This provides for little opportunity for growth of intestinal microflora. This deficiency, led Nurmi et al to the development of his or her own microflora that could be oral administered to the chick early in its life. In this way, an adult-type microflora was established and newly hatched chicks were protected from infection, that being, salmonella.

Commercial Application of Competitive Exclusion Treatment

Primarily, the treatment is a prophylactic measure that is aimed at increasing the resistance of chicks/poults to salmonella infection by compensating for the slow development of the native gut microflora under commercial conditions. For preventive use the young bird being treated should be salmonella free, otherwise the effect of the product will be minimal. Ideally, in our commercial industry, the aim is to administer the treatment at the earliest opportunity, post-hatch, before the chicks can be exposed to any salmonella.

Mode of Action

Before the chick hatches, its intestines are sterile but very quickly, after hatching; an intestinal microflora is produced. These micro-organisms are a vital part of the bird, both in the digestive process and in the resistance, exclusion of pathogenic organisms. The mode of action of the competitive exclusion bacterial cultures is for the bacteria to establish a physical barrier between the intestinal wall and the lumen of the gut. Through adhesion and multiplication the bacteria build a dense wall, which prevents an easy colonization of the intestinal cells by pathogenic bacteria such as salmonella. Literally there is a physical competition for the attachment sites on the gut wall. The earlier the attachment of the good bacteria, the better of physical exclusion of the bad bacteria. Anaerobic (not liking oxygen) bacteria attach firmly to the intestinal cell surfaces.

In addition to the physical barrier the establishment of the bacteria leads to the increased production of volatile fatty acids (VFA) and lactate. This leads to the lowering of pH in the intestine of young birds. This combination of low pH and high VFA concentration creates an unfavorable environment for many of the unwanted bacteria (salmonella, E.coli).

Another factor to consider, in the mode of action, is the production of antibacterial substances. These include ammonia, hydrogen peroxide, bacterial enzymes; bacteriophages and bacteriocins, all identified as substances that can inhibit enteropathogens.

Undefined Versus Defined

The most effective treatment material for controlling salmonella colonization in chicks is that obtained from the ceca or colon from adult, salmonella-free chickens. The caecum is the main site for salmonella colonization in the young bird, however in the older birds this organ contains the most abundant and varied microflora of any region in the gut. Undefined preparations of cultured cecal microflora are commercially available internationally (Aviguard, Broilact). These undefined preparations of live bacteria, originate from normal, healthy, adult chickens, which are free from specific pathogenic micro-organisms and is quality controlled. Recently the World Health Organization (WHO) has recognized the need to establish a separate category for these products. The category is called “Normal Avian Gut

Flora”.

Undefined treatment preparations are effective, probably because of their complexity and the fact that they include most elements of the normal microflora. Hence, they are highly compatible with the recipient birds and can be expected to form a stable association with the new host. The disadvantage is that the initial or donor host must be screened for many pathogens that could be present before it is used to manufacture the final product. However, these products have been used for many years without any adverse effects.

Because of the controversy over undefined cultures the industry quickly created the opportunity to market defined cultures (Interbac, Pre-empt). Defined cultures have the obvious advantage in being able to use CE preparations under commercial conditions with completely defined strain composition. Not only could the inclusion of any potential avian or human pathogen be avoided but also quality control of the treatment product during manufacture would be facilitated. Their efficacy in the field still needs to be determined as many challenges and stress factors cause inconsistent growth patterns on these bacteria therefore questionable viability and protection.

Routes of Administration

Competitive exclusion commercial products, like most live vaccines are administered in the same way. The most widely used method at this time is via water application and via coarse spray. Like most day one bronchitis vaccines the coarse spray method is accomplished via a cabinet sprayer, preferably, as soon as hatch is complete. Remember the critical step in CE administration is as soon as possible after hatch or during hatch? Many trials have been conducted looking at the efficacy and safety of hatchery spray. Yes, during hatch at about 50% hatch, a coarse spray of CE culture is administered into the ventilation airflow of the incubator. As airflow disseminates across the surface of the trays and chicks the culture is disseminated also.

In-ovo inoculation has been investigated. Research proved that a degree of efficacy against a known challenge of salmonella occurred. The drawback to the procedure was the reduction in hatchability. Stay tuned for the in-ovo method to develop.

Since this time there has not been a lot of progress in this administration method. A method gaining wide acceptance today is the mixing of the cultures with a feed grade gel product. These products; (gels, polenta) are formulated with the CE culture. The final product is usually administered to day old birds via the chick box. A measured amount is cut into designated blocks and placed in the box. Usually green, resembling natural droppings, the chicks readily consumes the final product. Benefits of intestinal seeding of the chick's gut with the CE culture and water/vitamin consumption with the carrier are experienced.

Practical Application in the Poultry Industry

1) Day of age

This is the most widely used and published time of delivery. The importance of early administration the CE product is critical, as the birds naïve gut waits for a source of microflora, similar to what mother hen and flock gave it in the natural process. Due to the infectious pressures and stress in the chicks environment the early administration of CE cultures is critical to provide the barrier needed to resist pathogenic bacteria

colonization. Therefore the earlier the better.

2) After anti-microbial treatment

Anti-microbial treatments not only kill the insulting organism but also do have the capability to disrupt the normal balance of the gut micro-organisms. Some antibiotics have activity against anaerobic gram-positive bacteria, which are the basis of the CE effect. CE cultures, post-antibiotic treatment restore a healthy flora and prevent pathogenic re-colonization. The timing of application post antibiotic therapy must be determined by consulting with the manufacturer. A rule of thumb to consider is 48 – 72 hours post treatment with the designated antibiotic.

3) Stress

There is general consensus that times of stress not only cause immunosuppression but also cause possible interference with the establishment of protective microflora. Hence, physiologic stress such as high-low temperatures, feed deprivation, moving and vaccination can all attribute to a gut imbalance. To help reduce the risk of opportunistic pathogen load, one may consider the application of a CE culture post stress.

Conclusion

The consideration and implementation of a biological product in poultry production such as CE cultures is very exciting. In a world demanding back to basics, keeping it biological rather than chemical, the use of CE products become paramount. Their use, timing and application will grow as the research and field experience comes rolling in. Already research is rolling across our journals with respect to the use of CE cultures in minimizing Salmonella risk, yet at the same time there is high consideration to their use in reducing E.coli, clostridium spp and campylobacter spp loads. Research into the application methods race against time to provide the earliest means to colonize the young birds gut before active pathogenic colonization can occur.

As a producer it is critical that one works with registered companies in products that have registration documentation and research comments. Any other products without a firm commitment to research and documentation could lead you down the path of “Foo-Foo dust” philosophy. Stay tuned as more products come to fruition as government agency register and commit to their application.

“Personal Power is the Ability to Take Action”

Acknowledgements

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