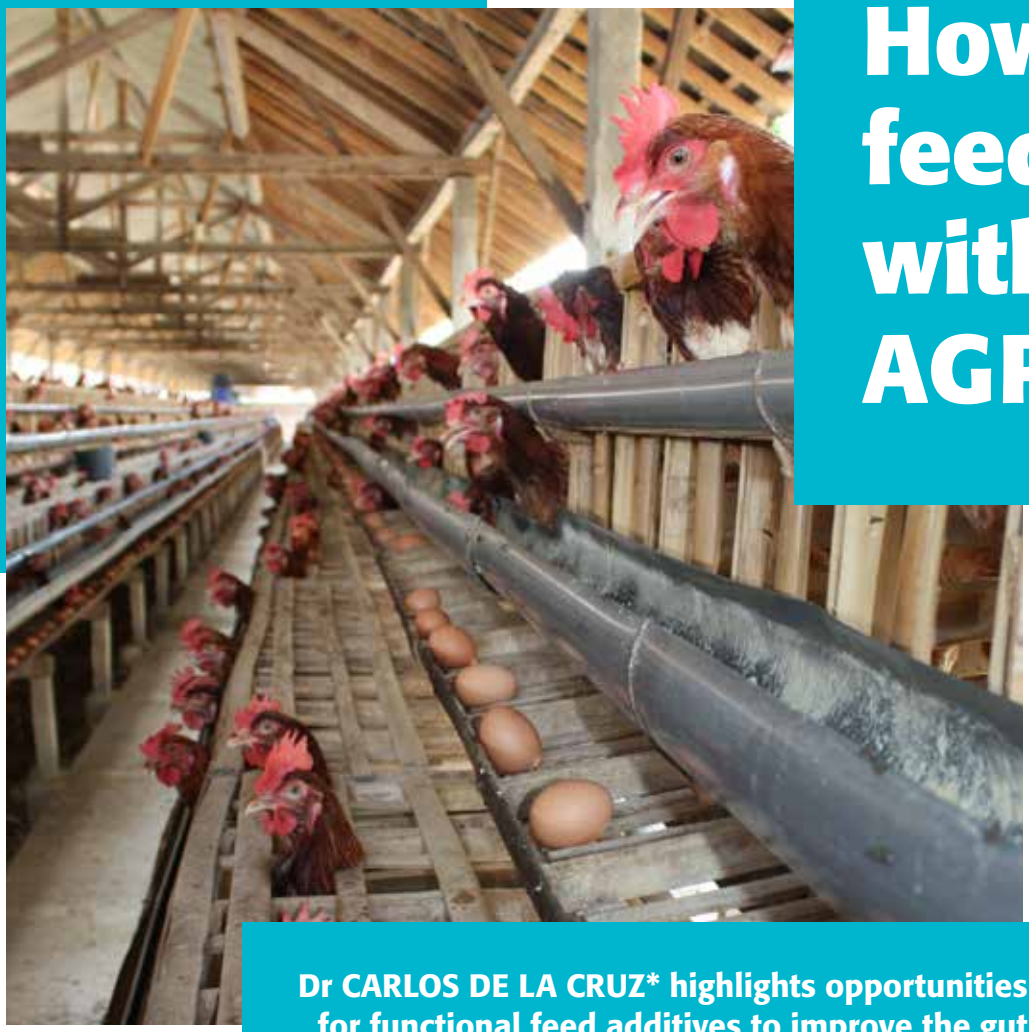
# How to feed layers without AGPs



**Dr CARLOS DE LA CRUZ* highlights opportunities for functional feed additives to improve the gut health of pullets and layers without the use of AGPs, from the perspective of human and animal nutrition.**

A growing population not only expects and needs affordable animal protein, also quality and safety are important components in the future of the industry. Consumers have raised awareness of the importance of food safety, due to previous food scandals associated with animal production. Nowadays, public, government regulatory agencies and the animal food industry are working to fulfill expectations in producing quality, safe products. Hence, animal production has developed in an efficient and sustainable manner, also considering animal welfare aspects. Lately, with the shift towards less antibiotic use worldwide as feed additive, there exist new opportunities for nutrition to promote health in production animals.

In order to achieve ambitious performance targets, animals have to express their genetic potential. For that reason, nutritionists should not solely focus on animal performance; growth/egg production performance as the primary outcome. One of their main tasks should be to optimize the digestive tract as well, in particular its absorption capabilities. Opportunities to optimize health of the layer and pullets, preventing pathogenic insults that may directly or indirectly affect production performance are often overlooked. We must ensure birds optimize the digestion and absorption of nutrients, minimize gastrointestinal illness, stabilize and/or positively modulate the microbial ecology, and enable the bird to mount an effective immune response.

Birds are continuously exposed to stressful conditions, such as changes in feed, poor water quality, heat stress, high stocking densities,

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pathogen challenges and other forms of stress, causing intestinal microbial imbalances that have an adverse impact on gut health. Solutions to these challenges are critical.

## Gut health challenges in egg production

The main gut health challenges in egg production are best described by dividing the bird cycle into rearing (from day one to 5% of production) and egg production (5% of production to culling or molting). On arrival in the rearing house, birds are exposed to constant stressors (vaccination, beak trimming, transportation, etc.) which usually result in feed intake depression. With a gut still in an immature state, and in some cases (countries) birds being automatically provided with antibiotics in the first 3 to 5 days, gut development (physiologically and immunologically) and microbiome establishment is an up-hill struggle. Since the main focuses are uniformity of flock, body weight and sexual maturity at the expected age, the microbial ecosystem is often not considered. In contrast, the laying period objectives are optimization of feed utilization, achievement of maximum production and maintaining egg quality. Lack of uniformity, bacterial enteritis, necrotic enteritis (NE), dysbiosis (microbial imbalance), focal duodenal necrotic(FDN) combined with physiological stress due to hormonal changes make it difficult to accomplish such objectives. Later in the production cycle, further challenges are associated with a compromised gut health (leaky gut) and reduction in villi length associated with reduction of nutrient absorption, especially minerals. As a consequence, there are potentially increased cracked eggs, micro cracks and dirty eggs and reduction of the percentage of lay.

According to a survey conducted by the Association of Veterinarians in egg production (2014) in the USA, coccidiosis was ranked as the most challenging threat in pullets during rearing, regardless of housing system (cage or non-cage); whereas colibacilosis was the main problem in cage housed layers, with cannibalism a significant issue in cage-free housed birds. In the same feedback exercise, veterinarians indicated that gastrointestinal problems affect 50% of the flock when birds are laying eggs, versus 40% when birds are growing. Other health issues also mentioned were viral diseases related to the respiratory system, not forgetting that such viral challenges may drive the proliferation on secondary bacterial diseases leading to performance losses.

The gut is the largest immunological organ in the body. Therefore, a more robust gut should make for a healthier animal which, in turn, digests and utilizes nutrients better. Layers can maximize feed utilization efficiency for egg production, only when a

**Table 1: Influence of granulometry on the performance of layers (23-51 weeks of age)**

| Particle size (mm) | Normal % | Fine % | Difference |
|---|---|---|---|
| <0.5 | 9 | 31 | |
| >3.2 | 10 | 0 | |
| 0.5 – 3.2 | 81 | 69 | |
| >1.6 | 65 | 21 | |
| Laying rate (%) | 93.9 | 90.7 | -3.2 |
| Egg weight (g) | 63.3 | 62.7 | -0.6 |
| Egg mass (g/day) | 59.43 | 56.87 | -2.56 |
| Feed intake (g/bird/day) | 118.1 | 114.2 | -3.90 |
| Weight at 33 weeks (g) | 1,930 | 1,883 | -47 |

Joly 2007, Nestor Gonzales 2008

**Figure 1: Dietary protein has a significant effect on gut health.**

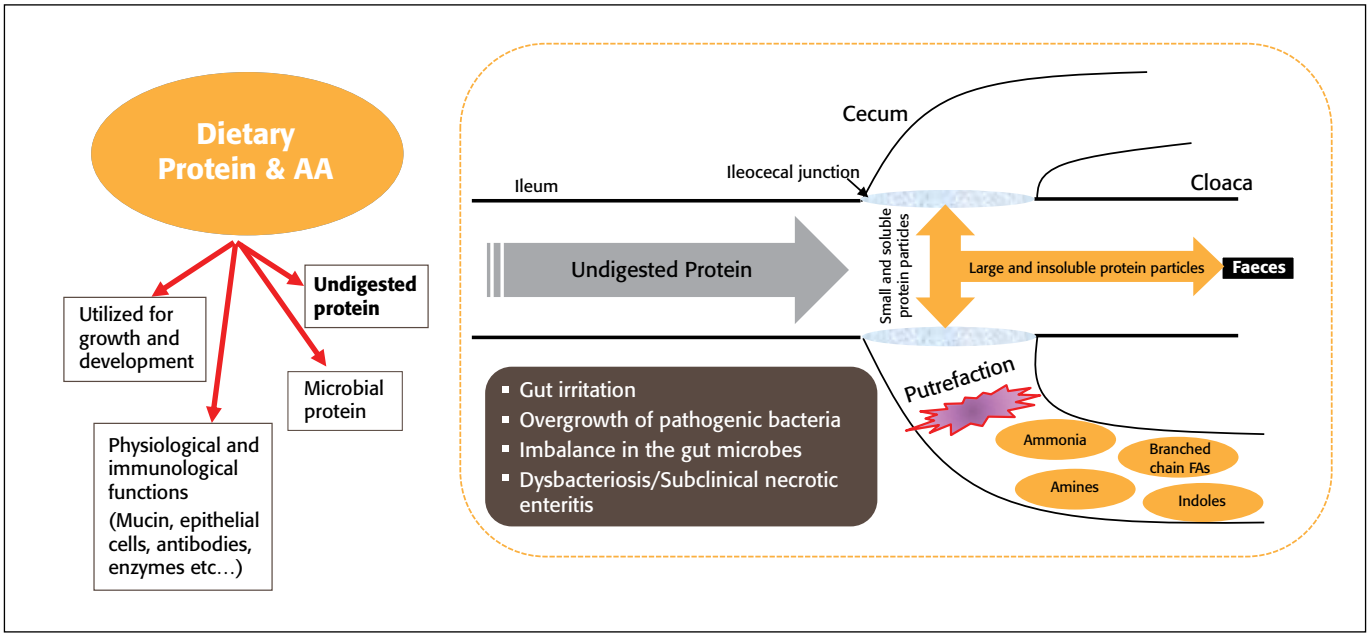


**Table 2: Recommendations for standardized ileal digestible amino acids for laying hens. AminoHen, %of diet & daily amino acid intake/mg.**

| | Lys | Met | Met+Cys | Thr | Trp | Arg | Ile | Val |
|---|---|---|---|---|---|---|---|---|
| Ratio to Lys | 100 | 50 | 91 | 70 | 21 | 104 | 80 | 88 |
| Intake, mg/d dig AA | 831 | 415 | 756 | 582 | 174 | 864 | 665 | 731 |

healthy gut is developed. A healthy gut can be defined as a steady state where the microbiome and the intestinal tract exist in symbiotic equilibrium and where the welfare and performance of the animal is not constrained by intestinal dysfunction. Not only is the gut the major organ for nutrient digestion and absorption, it also works as the first protective mechanism to exogenous pathogens which can colonize and/or enter the host cell tissues.

Hence, when the gut function is impacted by pathogens, there is not only an immunological response but also a change in passage rate, digestion, mucin secretion, and an increase in turnover rates of the intestinal epithelium. As a result of reduced feed intake, there is a higher maintenance nutritional requirement, with diversion of nutrients to bolster the immune system. Energy and nutrients expended to mount a strong enough immune response to defeat disease, as a consequence of a disturbed microbial ecosystem, reduce absorption and digestion of nutrients (increased FCR), overstimulating the immune system as a consequence trigger enteritis and noticeably performance losses.

## Managing gut health through nutrition

### *Crude fiber*

Crude fiber has been regarded as an inert nutrient in monogastric animals. However, this is not the case, as it can have roles in improving gut health, enhancing nutrient digestion and modulating behavior. A minimum constraint should be established, for instance 5% in diets for laying hens. Besides the fiber content in the diet, there are benefits for the digestive system of birds when coarse particles are fed. Flocks fed with larger particles will developed larger and more muscular gizzards and longer intestinal tracts. Coarser feed particles require more time in the gizzard to grind feed into smaller particles, before they can enter into small intestine. Increased retention time stimulates pH drop, which has a bacteriocidal effect. Larger feed particles have a longer transit time through the gut, which improve the length of microvilli and increase the absorptive surface area in the intestine, and thereby positively affects digestibility and nutrient absorption.

### *Feed particle size*

Layers have a preference for larger particles, and the preference grows stronger with age. Therefore, hen behavior also benefits, not only due to birds having to spend more time eating, but also because they have less time for vices such as feather pecking/cannibalism. Feeds containing high levels of powdery raw materials should be avoided, as they may lead to production losses (Table 1). Birds find it more difficult to consume fine grist; and, once consumed, they have a direct outflow through gizzard without utilization. Hence a feed of larger grist size is very desirable. An addition of 2% oil also assists in achieving a homogenous feed with optimal particle distribution.

## Dietary "protein" has significant effect on the gut health

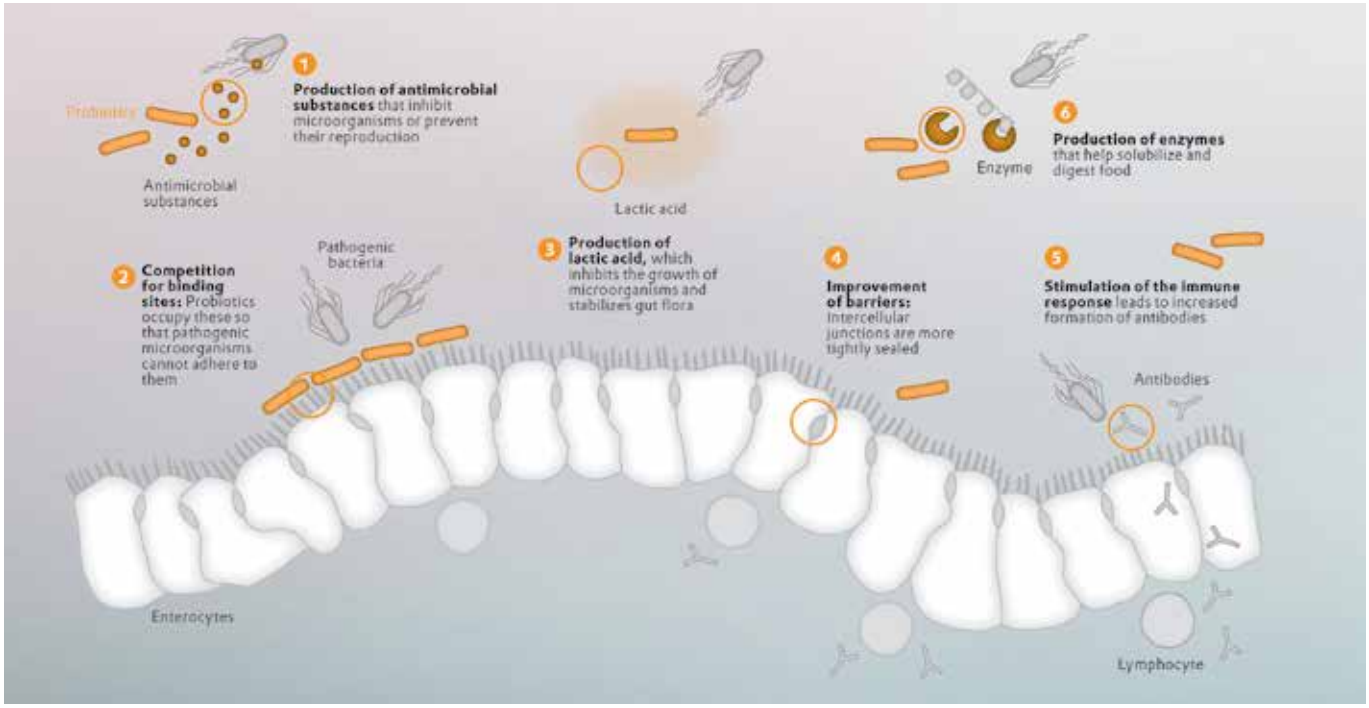
The primary role of amino acids from feed for animals is for growth and development of organs and tissues, mainly to serve as building blocks in protein synthesis. However, amino acids are also essential in many metabolic pathways to regulate physiological functions and modulate response in the body's immune system; mucin, epithelial cells, antibodies, enzymes, hormones, etc.

Nonetheless, a proportion of amino acids and non-amino acid nitrogen offered through the feed are not well digested in the digestive tract, generating substrates for microbes and toxins for the animal. This material can thus insult the ileum, causing overgrowth of pathogenic bacteria, imbalance in the gut ecosystem, gut irritation, dysbacteriosis and in some cases subclinical necrotic enteritis. Large and insoluble protein particles which are not assimilated by the animal, go to the large intestine, leaving the digestive system through the feces. However, small/soluble protein particles pass through the ileocecal junction into the caecum, where their breakdown (putrefaction) take place and ammonia, amines, indoles and branched chain fatty acids are produced. These compounds can be toxic and problematic (Figure 1).

Excess of "crude protein" not only increases production cost, it also generates health problems in the bird. However, reduction of crude protein (total nitrogen) in feed must be accompanied by balancing amino acid profile and supply according to the requirements of the birds. Precise (amino acid) nutrition implies raw material (amino acid) knowledge, digestibility, awareness of poor processing of protein sources, and the use available pure amino acids. This approach can then meet the demand of maintenance, health challenges and egg production without excess of nitrogen. The correct balance of digestible amino acids – also called: "Ideal Amino Acid Profile" - is shown Table 2.

Supporting the above mentioned, is a study of the effects of dietary protein source and level on intestinal populations of *Clostridium perfringens* in broiler chickens. Two studies demonstrated that the level of dietary crude protein (230 and 400 g/kg) and protein source (soy protein concentrate or low-temperature-dried fishmeal) of diets affected the growth of *Clostridium perfringens* populations in the lower intestinal of broiler chickens. A significant interaction between protein source and level was observed where the number of *C. perfringens* present in

**Figure 2. Schematic representation of some important modes of action of probiotics.**




the ileum and cecum increased as the level of crude protein in the diets increased in the birds fed fishmeal-based diets, ($p < 0.05$), but not in the birds fed soy protein concentrate based diets. This suggests that the level of crude protein, protein source, and amino acid content of diets might all be predisposing factors to outbreaks of clinical necrotic enteritis.

## Path forward to tackle gut health challenges

Among the various classes of products used probiotics are becoming increasingly successful because of their wider mechanisms of action. The FAO and World Health Organization (WHO) defined probiotics as "live micro-organisms which when administered in adequate amounts confer a health benefit on the host." As the demand for growth rate and feed efficiency of the modern poultry increases, the birds' nutritional and healthy status provided through "gut health" need to be managed efficiently. Probiotics can alter the dynamics of the gut microflora and, thus, improve animal performance through the combination of different mechanisms of actions. Spore-forming *Bacillus* based probiotics are tolerant to heat, pressure, and harsh pH environments, and, therefore, can survive feed processing and digestion in the stomach.

Probiotics are beneficial in preventing and controlling enteric pathogens and/or improving animal performance. Probiotics can modulate the dynamics of the gut microflora through the combination of different mechanisms of actions (Figure 2). These include:

- Inhibition of enteric pathogen colonization through competitive exclusion. This is accomplished by physical obstruction of attachment sites, or competition for essential nutrients.
- Production of secondary metabolites and lactic acid that help in inhibiting pathogens.
- Production of certain enzymes (e.g., proteases, xylanases, cellulases) that aid in nutrient digestibility.
- Alteration of cell to cell signaling in pathogenic bacteria.
- Production of short-chain fatty acids (SCFAs), and reduction of the pH in the intestinal environment.
- Improvement of the gut barrier function and enhancement of immune regulation and host response.

## Holistic solution –nutritional knowledge + proven feed additives

- Healthy sustainable nutrition combines modern nutritional concepts with new science-proven feed additives to form a holistic solution
- Competence to design pathogen specific solutions, e.g. probiotics
- Research on *in vivo* and *in vitro* models enable fast development
- Understanding the mode of action
- Scientifically proven performance

## Funtional feed additives – a sustainable arsenal

It is clear that there are costs involved in mounting and maintaining an immune response. However, we have a diverse arsenal of weapons and tactics at our disposal to support a well-functioning, but energetically efficient immunological military force. For animal husbandry this arsenal includes many aspects including management, nutrition, feed additives and pharmaceuticals. Of course, in the decision making process it should be understood that each changing aspect also comes with costs.

Changing management practices may involve updating physical structures and systems within a production facility and retraining staff. Nutrition strategies involved in health may reduce efficiency of animal protein deposition and/or increase the cost of feed. Non-nutritive additives, like probiotics, likewise increase overall feed cost. Immune modulatory feed additives may unnecessary reallocate energy resources to the immune mechanisms even in times of peace, where no pathogen challenge exists.

Prophylactic in-feed antibiotics (where not already banned by governments) disrupt the normal physiological and immunological development of animals and increase resistance in bacterial population, which may pose a real threat to future treatment of disease in both animals and humans. Pharmaceuticals not only add to production cost, but are administered upon signs of clinical infection and therefore production losses due to disease that have already been incurred. Vaccines are not available for all potential diseases and stressors that may negatively impact animal welfare and performance. Clearly, there is no one solution that applies to all species, diseases or producer's needs. With new products and strategies continually being developed, each individual producer must be able to critically compare all available options.

The selection of a suitable feed additive should include a cost to benefit analysis that includes not just the cost of the additive itself, but weights any losses to performance that may be caused by immune stimulation to any losses that could otherwise be incurred by the health issues they aim to prevent. In addition to the many options available to improve animal health there are numerous stakeholders involved in the decision making process such as government regulatory agencies, feed producers, livestock managers and consumers. This makes the selection of strategies to balance the cost of disease and cost of treatment or prevention exponentially more complicated. While understanding the intricacies of the immune system may appear to confuse an already complex equation of cost analysis and welfare outcomes, a basic understanding of the mechanism involved within the animal in maintaining healthful homeostasis is a vital part of the evaluation.

## Conclusions

- Flocks fed with larger particles and high fiber content will develop larger and more muscular gizzards and longer intestinal tracts.
- Feeding high crude protein (high nitrogen) diets have a negative impact on gut health.
- Feeding low crude protein (low nitrogen) diets balanced for digestible amino acids have positive advantage of reducing nitrogen excretion.
- Feeding functional feed additives (e.g., probiotics) helps to maintain gut health by modulating gut microbiota and reducing pathogenic bacteria (e.g. *Clostridium perfringens, Enterococcus and E. coli*)
- Therefore, combination of low protein diets together with probiotics might help to increase health status, maintain performance and contribute towards sustainable production. AP

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