Avitech
Knowledge | Nutrition | Innovation

Technical Bulletin

JULY, 2018

Role of Nutrition in improving immunity

The environmental conditions in which animal species are raised to increase productivity are far from optimal. There has been a lot of interest in the role of nutrition in managing the immune systems of animals in order to enhance productivity. This concept becomes more crucial in the production of animals without growth promoting antibiotics,

The necessity to combat anti microbial resistant bacteria is an issue of high priority for public health and agriculture globally. It is possible to derive preventive and even curative solutions from diets.

IMMUNITY: A basic understanding

1.1 The immune system

The immune response is an essential defense mechanism of an animal. There are two types of immune response which are identified as (a) Innate immune response and (b) Adaptive immune response.

1.1.1 Innate immunity

The innate immune response is a non–specific response that occurs very rapidly leading to an inflammatory process (Oswald, 2013). It is intended to exclude or eliminate pathogens *(Korver, 2012)*.

The body has many lines of defense such as the skin and mucosal surfaces. Epithelial cells are the primary barrier against the infectious and non-infectious challenges *(Korver, 2012)*.

If these protective systems fail, then pathogen-associated molecular pattern (PAMP) are recognized by the system through toll-like receptors (TLR) and pattern recognition receptors (PRR) *(Kogut, 2009)*. The early responses are directed towards containment of the pathogens. Various activation cascades finally lead to inflammation and clearance of the pathogens *(Kogut, 2009)*.

This innate response does not exhibit memory unlike the adaptive immune response.

This inflammatory response can be costly from a nutritional standpoint. It can lead to a diversion of nutrient away from growth and towards the inflammatory response (*Yang et al.*, mentioned by *Korver, 2012*). It also increases the metabolic rate (fever) and/or reduces the feed intake. It also generates an activity of the liver to produce the so-called Acute Phase Proteins which are there to protect the host against microbial growth. Morbidity, anorexia and fever can also be observed in such situations *(Klasing, 2007)*.

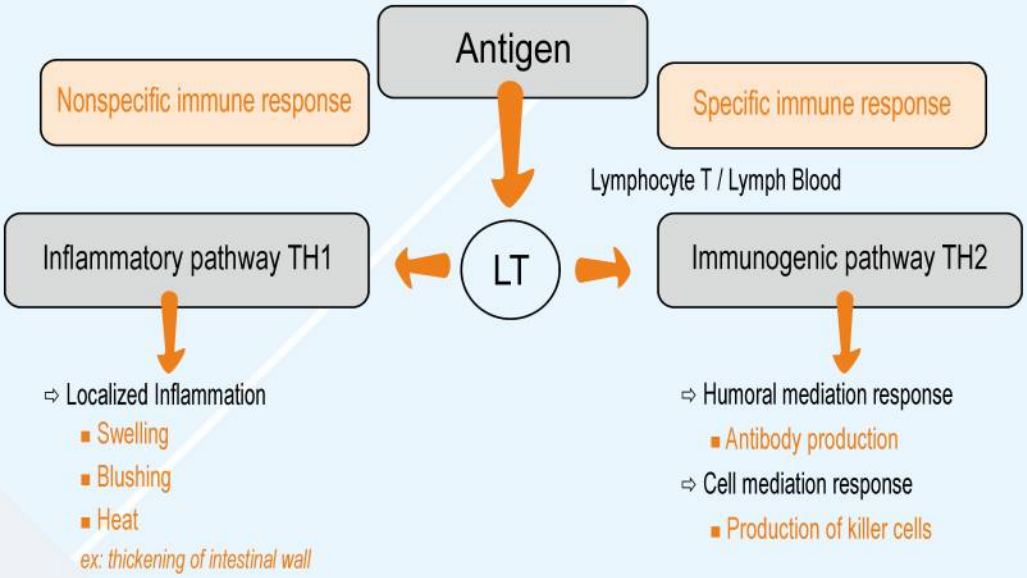
1.1.2 Adaptive immunity

This component of the immunity involves a specific response following an exposure to an antigen. Lymphocytes B will produce antibodies to this antigen and T cells will actively eliminate invading pathogens. The so-called T Helpers cells are here to direct the immune response *(Korver, 2009)*;

Adaptative immunity is activated more slowly and is dependent on the innate immune system for initial pathogen recognition. Expansion of B cells and T cells are driven by the first signals launched by the innate system with specificity for the ongoing challenge *(Kogut, 2017)*.

The production of "memory" B cells and T cells will provide lifelong specific protection

Summary:



1.2 Effects of selection on immune function

The genetic selection of animals for rapid growth has changed the way in which they respond to infectious challenge. Modern broilers, for instance, appear to have lesser innate immune response (less fever after a challenge). Their genetic makeup allows them to grow rapidly with low feed conversion rate by minimizing the diversion of nutrients to inflammatory response and other systemic response.

Modern commercially bred turkeys are more susceptible to disease challenge than the wild-type turkeys (*Genovese et al.*, 2006 quoted by *Korver, 2012*).

The selection for production performance characteristics tend to result in decreased immune function.

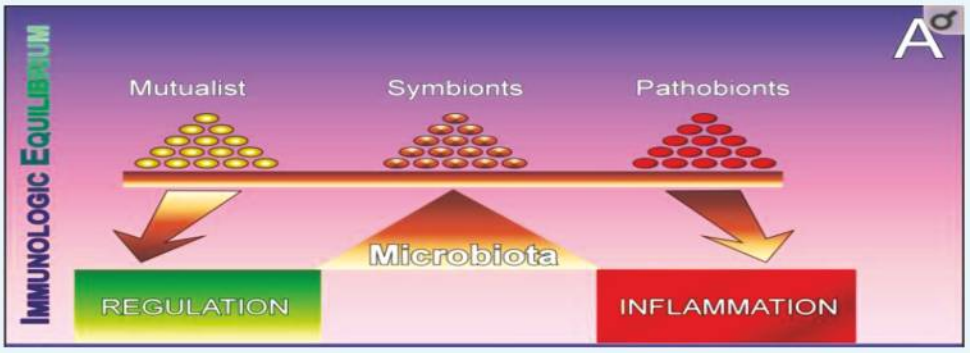
1.3 Diets and Microbiome interaction: Its influence on immune response

A network of interactions characterize the interdependence between the innate immune system and the microbiota. The two systems affect one another to bring about whole-organism physiology *(Thaiss, 2016)*

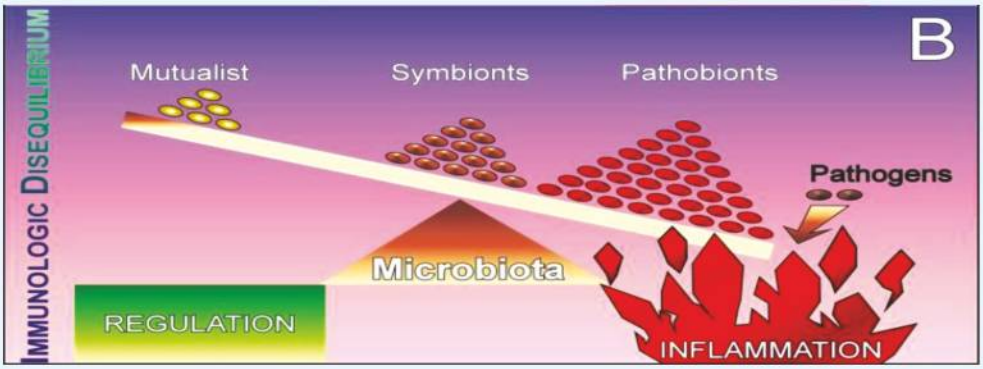
The gastrointestinal tract is the primary site of interaction between the host immune system and microorganisms, both symbiotic and pathogenic.

Recent evidences support the idea that disturbances in the bacterial microbiota result in immunological dysregulation as inflammatory disease.*(Round and Mazmanian, 2009)*

Germ-free animals have numerous immunological defects that may lead to disease, which implies there is



A healthy microbiota contains a balanced population of bacteria.



During dysbiosis, there is a change in the composition of the microbiota. The result is non-specific inflammation.

a role for the microbiota in actively supporting health. The adaptive immune system is influenced by intestinal microbial colonization.

The microbiotia, as a "second brain" is a regulator of the immune response *(Kogut, 2017)*.

The composition of the gut microbiome is affected by variations in the diet. Therefore, diets and commensal microbiota have an influence on the host immune response.

1.4 Feed-induced inflammation

Some constituents of common diet can induce immune response. Insoluble Mannans are not digestible by the poultry and are found to stimulate innate response.

The presence of this Non Starch Polysaccharides (NSP) can eventually lead to a demand for extra energy and protein. The usage of exogenous enzymes such as Beta-glucanase, Xylanase, Protease and Hemicellulase is appropriate and effective..

NUTRITION – IMMUNITY interactions

2.1 Nutrient Modulate Immune systems

Many nutrients are capable of modulating the immune system *(Korver, 2012)*. Immune functions are influenced by diet composition, feed and energy intake. Deficiencies of nutrients, such as protein, lysine, arginine and phosphorus can reduce immune response *(Korver, 2012)*.

2.2 Disturbances of proteic metabolism

During the acute phase of an inflammation a large part of the protein synthesis is dedicated to the production of acute phase protein. *(Reeds and Jahoor (2001)* evaluated that it could represent upto 25% of the total synthesis. Preferential breakdown of skeletal muscle supports energy demand. In fact, the profile of these acute phase proteins is different from those of the muscle. Consequently, during stress, birds will have specific requirements as far as amino acids are concerned.

Tryptophan and Arginine levels in the diets can modulate the systemic immune response against Gumboro disease *(Emadi et al., 2011)*. It is also true for the sulfur amino-acid *(Jankowski, 2014)* and threonine *(Amadori et al., 2009)*

As a result challenged birds will have a different protein demand as opposed to non-challenged birds.

2.3 Oxidative stress

To clear the pathogens invasion, some of the host cells produce pro-oxidant elements. An inflammatory condition can impair the balance between this production and the anti-oxidant status of the tissues and cause an oxidative stress. Supplementing the feed with antioxidants in such situations becomes important.

NUTRITION: As Immune Modulator

The challenge that a nutritionist faces is to choose amongst various raw materials and feed additives that are required as per the nutrient specifications of various animal species. Addition of more than what is required does not bring about a corresponding benefit.

Following is the review of important ingredients.

3.1 Immunomodulation ingredients

3.1.1 Role of essentials oils

Essential oils (EO) are widely used as alternative to antibiotic growth promoter. They are known for their anti-bacterial properties, and like antibiotics, EO also show anti-inflammatory and anti-oxidant properties. Many studies demonstrate the immunomodulatory effects of natural and herbal products *(Lillehoj and Lee, 2012)*.

Dietary feeding of cinnamaldehyde along with carvacrol and capsicum showed synergistic enhancement of innate immunity against intestinal parasitic and bacterial infections.

3.1.2 Direct Fed-Microbia

Probiotics are "live microorganisms that can influence the profile of the microbiota, modulate the inflammatory response and improve the nonspecific intestinal barrier" *(Lillehoj and Lee, 2012)*.

The live microorganisms that are commonly included in feeds are Bacillus, Bifidobacterium, Enterococcus, Lactobacillus, Lactococcus, Streptococcus, Saccharomyces cerevisiae and Aspergillus oryzae. Many studies demonstrate the role of such ingredients in immunomodulation.

Bacillus subtilis is one of the most common probiotics used in poultry as the spores of B. subtilis are heat-resistant and can tolerate multiple environmental stressors.

Supplementation with Bacillus subtilis-based probiotic reduces heat stress-related behaviors and inflammatory response in broiler chickens *(Wang, 2018)*

3.1.3 Poly Unsaturated Fatty Acids – PUFA

Omega-3 polyunsaturated fatty acids are well recognized to reduce the growth- suppressive impacts of inflammation *(Korver, 1998)*. From a metabolic standpoint, Omega 3 PUFA is good for the immune system.

Eicosapentaenoic Acid (EPA), docosahexaenoic Acid (DHA) and ᾱ-linolenic Acid (ALA) are also beneficial for the immune system

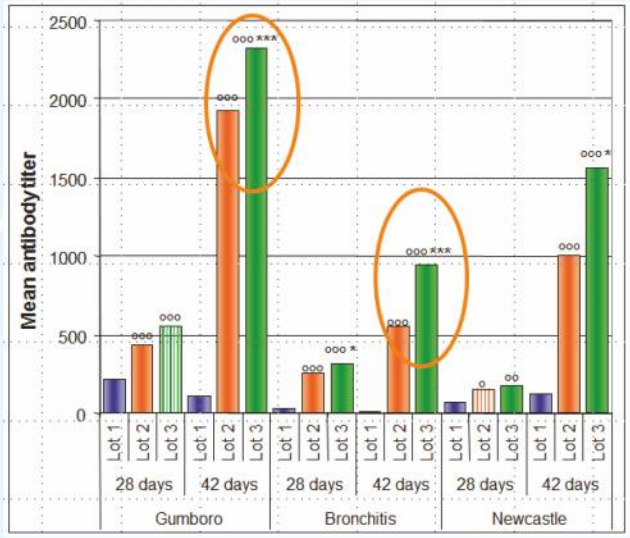
The chain length is important. The longer the chain, the better is the immunity.

The use of oils enriched in PUFA is certainly an option that a nutritionist needs to consider when formulating feeds for animal species under challenging conditions.

3.2 Nutrition and vaccination

Nutrition can bring "boost effects" on the immune-stimulation following a vaccination. In a trial, Broilers were fed with a diet supplemented with a phytogenic solution (*Techna*, non-published data, 2007). Post vaccination, antibodies titer was monitored. Seroconversion was boosted for Gumboro, Infectious Bronchitis and Newcastle valences for supplemented birds.

Flock 1	Non Vaccinated
Flock 2	Vaccine alone
Flock 3	Vaccine + IMUNEO®



Conclusion

The immune system of an animal is highly complex and a robust immune system is the key to optimal health and performance.

The immune-nutrition approach is a proven strategy to improve immunity. However, this subject still requires a lot of research to identify all the links between Nutrition, Pathology and Immunity. There definitely exists a cost for immunity which effects performance parameters of animals.

A better comprehension of how nutrients modulate the immune response give nutritionists the ability to formulate diets to improve immunity and overall health.

About the author: **Antoinne Rousseau** is an international poultry expert spanning a career of almost 30 years in various capacities. With a technical background in animal husbandry, nutrition and production control, he now serves as an advisor to the President of Techna Group, France for the Poultry sector.

AVITECH NUTRITION PVT. LTD.
(ISO 9001, ISO 22000 and GMP certified)
GP-37, Sector 18, HSIIDC, Gurugram, Haryana-122015
Email: marketing@avitechnutrition.com
Website: www.avitechnutrition.com