INTESTINAL HEALTH AND COGNITIVE FUNCTION: A CONCERN FOR FARM ANIMAL WELFARE?

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While it is difficult to define “animal welfare” precisely, it is widely accepted to encompass both physical and mental health states.1 Welfare includes many of the elements that contribute to an animal’s quality of life, including its ability to cope with the environment in which it lives. An animal is considered to be in a good state of welfare if it is healthy, comfortable, well-nourished, safe, able to express innate behavior, and not suffering from unpleasant states such as pain, fear and distress.2

Welfare of animals raised for food must include disease prevention and appropriate veterinary treatment, shelter, management and nutrition, humane handling and humane slaughter or killing. There is a critical and indispensable relationship between animal welfare and animal health. Farm animal welfare is of major concern to producers and consumers alike, and the gastrointestinal tract (GIT) can be a major player given its dominant role in animal's physiological and emotional state. The GIT represents the largest surface of exposure to, and input from, the external environment for the animal. The intestinal mucosal surfaces not only play an essential role in nutrient absorption to fuel growth and productivity but also act as a selective barrier to protect the host animal from the external insults. There are indispensable physical, chemical, immunological and microbiological components to this mucosal selective barrier.3 One in particular is the intestinal microbiome (complex communities of bacteria, protozoa, fungi, yeasts, bacteriophages and viruses) that, when mature and healthy, helps with digestion, fights off infections and helps boost the immune system. The fact that less than one percent of the microbiome can be identified by culture methods underscores the tremendous complexity and diversity of the intestinal microbiome.4

Intestinal Integrity critical to health and productivity

Structurally, post-hatch development of the intestine is fairly rapid in poultry compared to other animals.5-8 However, the establishment of a balanced microbiome is far from complete in young chickens (e.g., broilers) and highly influenced by stressors such as the diet and feed form, exposure to infectious agents (bacterial, viral and zoo-parasitic), environmental conditions, handling, immunization and stocking densities.9-11 Reducing and/or eliminating stress and distress in intensive poultry production systems is essential for animal health and welfare, as well as for productivity. Stress triggers physiologically complex and metabolically costly inflammatory and immune responses (both innate and adaptive) with potentially negative welfare consequences.
Diet and the intestinal microbiome connected to animal behavior

There is increasing evidence that diet, the intestinal microbiome and animal behavior are interconnected. The intestinal-mental link appears to be bidirectional; just as negative emotional states (anxiety or stress) influence the intestinal function, the intestine can also communicate its state of health or imbalance to the central nervous system (CNS). It is well documented that changes in feed ingredients or in feed composition can readily alter a bird's behavior, although such modifications without impairment of health likely represents adaptation by the animal to changes in nutrient accessibility and content.

Intestinal dysbiosis (inability to establish and/or maintain a healthy microbiome) can impact animal welfare directly through injury to the intestinal mucosal barrier, thereby inducing subclinical or clinical enteritis and diuresis (diarrhea or flushing) in chickens. Diarrhea, flushing or feed passage increase litter moisture and accentuate ammonia production, which in turn can trigger contact dermatitis as well as ocular and respiratory stress in confined rearing environments. All of these conditions can lead to welfare issues in extensive production systems.

Intestinal dysbiosis can also result in the production of excess and/or toxic metabolites, some of which can serve as signals of stress that alter animal behavior and welfare indirectly. For example, the accumulation of microbial by-products, such as propionate and D-lactate or production of endotoxins by the commensal bacteria, have been shown to cause anxiety, aggression and cognitive dysfunction in laboratory animals and humans.

The release of chemical messengers (cytokines and C-reactive proteins, etc.) during intestinal dysbiosis, inflammation, oxidative stress and altered mucosal permeability is communicated to the CNS through the nervous system. Inflammation also causes changes in the metabolism of neurotransmitters in the CNS.

For example, the amino acid tryptophan can be shunted towards the production of anxiety-provoking chemicals, such as quinolinate, rather than the production of serotonin and melatonin. Interestingly, restoring the normal intestinal barrier improves these emotional symptoms.

So far, the research on GIT and brain connection in poultry has been limited to assessing behavioral responses of birds to feeds and feeding programs. Any link(s) to animal welfare has been indirect at best. However, new research on brain health, cognitive function and social behavior of domesticated chickens indicates striking similarities in certain regions of the CNS of primates and chickens. If chickens can display emotions comparable to those of primates, then one can speculate that the intestine is also likely to influence the mental state of poultry.

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The intestine-mental health link must be considered within the context of complex interaction of genetics, dietary and environmental factors, as well as the microbial challenge normally present in animal production facilities. Broiler chickens are marketed at very young ages (28 to 66 days of age), well before the establishment of the balanced and stable microbiome commonly present in adult birds. Early and frequent shifts in the intestinal microbiome can increase the susceptibility of broiler chickens to intestinal dysbiosis and subsequently to intestinal disease.

Manage health risks with targeted, supervised interventions

Poultry and other farm animals live in large numbers and in close association with each other, and must coexist with bacteria, viruses and parasites from their surroundings. The exposure to vectors (e.g., flies, rodents, etc.) within their environment is a fact of life. Hence, there is a significant health risk from potentially infectious agents in the environment. Animal housing, flock management, feeding and health programs have evolved to reduce this health risk not only to animals but also to humans.

At times, targeted medical interventions are necessary to protect the health and welfare of poultry and to assure food safety. Health programs may require targeted applications of various antimicrobials, vaccines or antibiotics specifically developed for farm animals and poultry. These interventions, when implemented judiciously and under the supervision of veterinarians, have been extremely successful in stabilizing the microbiome or treating intestinal disease in broilers. Sanitation and biosecurity alone are not adequate to achieve predictable and sustainable health and welfare outcomes.

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Recent trends to replace some of these proven interventions (e.g., antibiotics) with probiotics, prebiotics, enzymes, organic acids or herb extracts have yet to be proven consistently effective.30 Yes, there can be negative outcomes from irresponsible use of antimicrobials or antibiotics, but that is not how these products are intended nor used by the industry. Judicious use under the oversight of a veterinarian is essential, as these antimicrobials are not a panacea or quick bandage to management problems. In the meantime, the welfare of broiler chickens may be compromised, whether directly or indirectly, with the indiscriminate elimination of targeted interventions in broiler production.