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Opinion

Impact of coccidiosis and enteritis on poultry energetics and feed energy value

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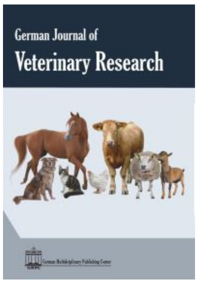

Abstract

Diet energy density is a major factor in broiler production costs, but metabolizable energy system has limitations in accurately predicting broiler performance due to its low sensitivity to actual metabolism. The productive energy (i.e., Arkansas Net Energy) system, which measures productive energy, provides a more accurate assessment of energy utilization, particularly under conditions affected by gut health, like enteritis and coccidiosis. This article highlights opportunities for assessing the effects of enteritis and coccidiosis on poultry energetics, evaluating dietary interventions on gut health, improving precision nutrition, and supporting One Health strategies in antibiotic-free production systems.

Keywords: Enteritis, Coccidiosis, Energy, Productive energy, Feed additives, Precision nutrition

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Introduction

Feed costs account for approximately 65% of total broiler production costs, with the energy density of the feed representing the most considerable portion of the formula cost. For the last six decades, metabolizable energy (ME) has been the standard method to quantify the energy value of the feed and to formulate poultry diets (Lopez and Leeson, 2008). However, ME has been shown to be weakly correlated with performance (Hill and Anderson, 1958) and to be primarily influenced by nutrient digestibility (Wu et al., 2020). As a result, the sensitivity of ME to actual bird metabolism is limited (Sibbald et al., 1960), making it unsuccessful in predicting the feed intake and growth rate of broilers, particularly under commercial conditions (van der Klis and Jansman, 2019).

Enteritis, often resulting from bacterial infections and dietary anti-nutritional factors, and coccidiosis, caused by *Eimeria* spp, disrupt digestive processes and impair nutrient absorption, greatly impacting broiler performance and health (Martinez, 2022). However, their effects are associated with inflammatory processes that reduce feed intake (Lu et al., 2014; Martinez et al., 2023a). These conditions can shift the growth curve and delay the age at which birds reach market weight (Martinez et al., 2023a, b). For broilers to produce meat, they need to gain body protein, which results from a positive balance between body protein synthesis and breakdown rates as constituents of protein turnover (Maharjan et al., 2020). The inflammatory response triggers an increase in the body protein breakdown rate (i.e., catabolism; Klasing and Austic, 1984) and reduces the synthesis rate of muscle protein to support the production of acute-phase proteins (Peinado-Izaguerri et al., 2024), leading to decreased body protein accretion. Indeed, both enteritis (Pastorelli et al., 2012) and coccidiosis (Moraes et al., 2019) have been reported to affect body weight gain by increasing the maintenance expenditure of nutrients.

Despite the lack of sensitivity of ME to actual metabolism, the impact of coccidiosis on broiler diet ME has been reported (Teeter et al., 2008a, b). However, an energy system responsive to actual metabolism and protein accretion is needed to accurately assess the full impact of intestinal health on poultry energetics.

Quantifying the influence of gut health on poultry energetics

Recently, a new energy system (Arkansas Net Energy; Hilton, 2020) has been developed to more accurately account for the energy use by production birds. Such a system is defined as productive energy (PE) (Maharjan et al., 2021b) as it accounts for the energy the birds use to produce meat, in the case of broilers and turkeys, or eggs, for broiler breeders and commercial layers. In the case of broilers, this PE system is based on direct measurements of body energy retention (net energy for gain; NEg) and the maintenance energy expenditure (i.e., fasting heat production = net energy for maintenance; NEm). NEg is determined with Dual-Energy X-ray absorptiometry (DEXA) and NEm via indirect calorimetry chambers, both expressed per unit of feed intake. Additionally, DEXA determinations of broiler processing weights, i.e., breast, tenderloins, wings, and leg quarters (Martinez et al., 2022a, b, c), allow dynamic economic evaluations. Since PE measures the actual energy output (PE = NEm + NEm), it is sensitive to factors influencing digestion, absorption, actual bird metabolism, protein accretion, and overall performance (Suesuttajit et al., 2022).

The relevance of an energy system sensitive to changes in body composition and heat production has been reported. A recent meta-analysis reported that changes in body composition are associated with variations in the conformation of the broiler carcass (i.e., breast-to-leg ratio), which influences its market value (Martinez et al., 2022d). Moreover, body composition has been shown to influence heat production, associated with changes in protein turnover (Martinez et al., 2022e). Notably, higher body protein gain correlates with improved growth rates and lower feed conversion ratio (Maharjan et al., 2020, 2021a). Therefore, the high sensitivity of PE to performance (Suesuttajit et al., 2022) is well justified.

Conclusion

Since ME lacks sensitivity to actual metabolism, it underestimates the impact of enteritis and coccidiosis on energy metabolism. Consequently, the effects of coccidiosis on energy metabolism are likely more significant than previously reported. PE offers a more accurate approach to assessing the impact of gut health and dietary interventions on energy metabolism and their economic implications. PE research will allow industry nutritionists and veterinarians to develop management strategies toward precision nutrition, adapt production practices to varying conditions (Riboty et al., 2024a, b), and implement more dynamic metaphylactic-type feed additive interventions (Martinez et al., 2020) in antibiotic-free production considering environmental conditions and field risk factors. This approach would help minimize the likelihood of clinical or subclinical enteric processes, ultimately supporting One Health initiatives.

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