

Benefits of Nucleotide Supplementation in Poultry

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Abstract: Nucleotides are semi-essential nutrients: under conditions of rapid growth, stress and disease the own synthesis capacity of animals is not sufficient. Supplementation of animal feed with nucleotides improves animal productivity with respect to average daily gain and feed conversion ratio. This effect is especially pronounced in young chickens as nucleotides enhance the immune system resulting in increased numbers of immune cells and antibodies, reducing the impact of pathogenic infections. Consequently, dietary nucleotides provide a valuable tool to the poultry producer as an alternative to antibiotics.

Keywords: Nucleotides, Poultry, Antibiotic replacement

Introduction

Bacterial infections are an important problem for both health and productivity of poultry. Traditionally, antibiotics were used sub-therapeutically by the poultry industry to reduce the impact of bacterial infections. However, there are increasing consumer concerns about drug residues in meat products and the rise of antibiotic resistance of pathogenic bacteria. As a result, many countries have banned the inclusion of antibiotics in livestock diets as a routine means of growth promotion. Consequently, there is an increasing demand for alternatives to antibiotics (Swiatkiewicz *et al.*, 2013). Nucleotides play a major role in almost every biological process. They are the building blocks of DNA and RNA and play a central role in cellular metabolism, i.e. as energy

carriers (i.e. ATP), in cell signaling (i.e. cAMP) and are a building block for important cofactors (i.e. NAD⁺). Although cells can synthesize nucleotides themselves, they are considered semi-essential nutrients as under certain conditions the own synthesis capacity of animals is too low (Rutz *et al.*, 2008; Sauer *et al.*, 2011). Moreover, the most commonly used feed ingredients contain relatively low amounts of nucleotides (Sauer *et al.*, 2011). After decades of studies, the health benefits of nucleotides have in the meantime been well established in humans (Grimble & Westwood, 2001), and they have therefore been added to human infant formulas for decades (Boza & Martinez-Augustin, 2002). An increasing body of evidence demonstrates similar benefits in poultry (Rutz *et al.*, 2008).

Immune modulation: stronger and faster response against pathogens

Maintaining a good immune status helps the animal to protect itself against pathogens. Nucleotides have been shown to enhance the immune system after dietary supplementation (Boza & Martinez-Augustin, 2002). Also in poultry, dietary supplementation with nucleotides has been shown to improve the immune system of broilers by increasing the production of leukocytes and macrophages (Dil & Qureshi, 2002). Under stress conditions, bird mortality was reduced by approximately 30% upon nucleotide feeding (Rutz *et al.*, 2008). Frankic *et al.* (2006) showed that feeding nucleotides to mycotoxin-challenged chickens repaired DNA damage in immune cells, that are highly sensitive to mycotoxin action.

Increasing rate of antibody formation after vaccination

Poultry vaccines are an important component of poultry disease prevention and control. Dietary yeast nucleotides triggered a faster and stronger antibody response to routine vaccines in chickens. Chickens fed nucleotides reached the level of effective protection 1 week before the control group (Wu *et al.*, 2018).

Enhancing growth, development and integrity of the Gut

Young chickens have an immature digestive system. The involvement of dietary nucleotides in intestinal growth and maturation of poultry has been well documented (Rutz *et al.*, 2008). Wu *et al.* (2018) demonstrated that nucleotides supplementation resulted in a healthier gut flora, as demonstrated by higher concentrations of lactic acid bacteria and a more diverse intestinal microbiota. Moreover, chickens fed nucleotides had a healthier gut indicated by increased villus height and villus height to crypt depth intestinal villi (Jung & Batal, 2012; Wu *et al.*, 2108).

Boosting animal performance

Supplementation of diets with nucleotides has been demonstrated to improve growth performance in poultry. The availability of nucleotides might be rate-limiting in rapidly dividing tissues, like in young chickens. Exogenous added nucleotides do not only overcome this bottleneck, but also reduce the energy requirement of the animal, as *de novo* synthesis of nucleotides is an energy demanding process. Yeast nucleotides added to bird feed lead to higher body weight, higher daily body weight gains, and better feed conversion ratios (Esteve-Garcia *et al.*, 2007; Jung & Batal, 2012; Wang *et al.*, 2009). Improvements in weight gain were especially noticed when nucleotides were fed the first 3 weeks of life, indicating optimal early development of the birds will support performance later on (Esteve-Garcia *et al.*, 2007; Rutz *et al.*, 2008). Jung & Batal (2012) also showed that nucleotides had an added beneficial effect on animal growth when birds were exposed to stress conditions such as high stocking density or dirty litters. Additionally, nucleotide supplementation improved egg production, egg fertility and egg hatchability (Bonato *et al.*, 2014). Overall, the number of live chickens was 6% higher in the group fed nucleotides (Bonato *et al.*, 2014). Birds that were fed nucleotides had a larger body weight and consequently a higher carcass yield including drumstick, thigh, wing and breast weights (Rutz *et al.*, 2008).

Improved meat quality

When chicken were fed nucleotides, their meat was tenderer and redder in color which is more appealing to the consumer (Chiofalo *et al.*, 2011; Zhang *et al.*, 2008). Moreover, the meat had improved nutritional characteristics as it contained more iron, more lipids with higher unsaturation degrees which have beneficial health effects in humans (Chiofalo *et al.*, 2006; Chiofalo *et al.*, 2011).

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