Methionine's Role in Animal Nutrition Extends 'Beyond Building Blocks' for Protein

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18 January 2017- The Advancia Seminar seeks to advance understanding and promote sharing of knowledge concerning sulfur amino acid metabolism. In its most recent incarnation, researchers focused on the role of these substances in oxidative stress signaling, the immune system, gene expression, and even oxidation and meat quality. Indeed, as argued by Dr. Sophie Tesseraud of the Poultry Research Unit at INRA Tours, methionine in particular can now be seen as more than a simple "building block" for protein; the additive has the potential to affect numerous physiological systems.

To learn more about these effects, Feedinfo News Service spoke to Dr. Tesseraud and Dr. Pierre-André Geraert, Director of Innovation and Marketing at Adisseo, organisers of the Advancia summit, who believe that a more sophisticated conception of methionine supplementation is on its way in.

Dr. Pierre-André Geraert
Director of Innovation and Marketing
Adisseo

[Feedinfo News Service] Dr. Geraert, the focus of the most recent Advancia seminar was on sulfur amino acids in particular. What advantage do sulfur amino acids have compared with other amino acids when it comes to benefits such as improved immune response and antioxidative properties?

[Dr. Pierre-André Geraert] Sulfur amino acids are rather peculiar in their roles. Indeed methionine is the 1st AA or the 1st genetic codon read during protein synthesis, and thus appears even more than essential. Cysteine is the basis of the di-sulfur bridge and is thus important in constitution and maintenance of the global structures of the proteins. Moreover, cysteine is also one of the component of the tripeptide glutathione involved in the antioxidant mechanisms in all animal species. And finally methionine being a precursor of cysteine is often the key source of cysteine. Regarding the immune response, methionine is involved not only in the synthesis of the proteins involved in the immunity and in the inflammation response but also in the cellular signaling cascade activating those mechanisms. All those potentials demonstrate the value of methionine and the difficulty to find alternatives.

[Feedinfo News Service] Dr. Tesseraud, you argue in favor of understanding sulfur amino acid (SAA) provision in terms of the tissue-specific responses. Can you briefly explain what that means? How does

that perspective differ from the current paradigm for amino acid provision?

[Dr. Sophie Tesseraud] Optimizing SAA provision involves considering the different roles of these amino acids, which depends on the tissues considered. For example, the comparison of dietary methionine restriction on lipid metabolism in different tissues (i.e. adipose tissue and liver) and animal models (pigs, rodents and/or chickens) indicate tissue- and species-specific responses. SAA metabolism in the intestine regulates gut growth and intestinal function, including the digestion, absorption and metabolism of nutrients, the immune surveillance of the intestinal epithelial layer and regulation of the mucosal response to foreign antigens. Taken into account such differences in tissue responses and functions is essential to improve the nutrition and health status of animals. A major challenge for future experiments is thus to improve the integration of the various roles of SAA at the whole-body level for rational use in nutrition.

[Feedinfo News Service] What is the link between methionine deficiency and oxidative stress? What kind of impacts could this have on animal performance (or meat quality)?

[Dr. Sophie Tesseraud] Methionine is an essential amino acid and its provision at insufficient levels in the diet leads to reduced protein synthesis and impaired animal performance. Methionine participates in synthesis of other SAA, notably cysteine. Cysteine is required for the synthesis of glutathione and taurine, which are essential compounds for host defense against oxidative stress. SAA are therefore implicated in the control of oxidative status through their essential anti-oxidant potential, with consequences on metabolism, physiological responses and health of animals. SAA provision has also been reported to modify meat susceptibility to oxidation. According to the methionine source provided in the diet (DL-Met or hydroxy-methionine), oxidative stress and lipid peroxidation will be greater or less significant, which may provide a promising implication for nutritional strategies to improve animal management and meat quality.

Dr. Sophie Tesseraud
Poultry Research Unit
INRA, Tours

[Feedinfo News Service] Methionine is also understood to affect the immune system, is that correct? How does it have such effects? For what animal species has this been demonstrated?

[Dr. Sophie Tesseraud] Methionine is recognized to affect the immune system in mammals as in fish and birds. The underlying mechanisms are numerous: major contribution to the synthesis of proteins of the immune system, role of precursor of polyamines involved for

example in lymphocyte proliferation and differentiation, regulator of key metabolic pathways as a precursor of components such as glutathione, taurine, H2S and sulfates, protecting cells from oxidative stress during the inflammatory process and acting on cellular signaling with consequences on gene expression, etc.

[Feedinfo News Service] Are there any other effects of methionine that are perhaps underappreciated?

[Dr. Sophie Tesseraud] Methionine is a source of the methyl groups needed for all biological methylation reactions, including methylation of DNA and histones, a process that influences chromatin structure and gene expression. Therefore, this amino acid may have important implications for perinatal programming of metabolism, growth and health through epigenetic mechanisms. Interestingly, these effects appear to be obtained with modest early dietary intervention (changes within physiological ranges), indicating the importance of adequate dietary methyl group supply for metabolic programming and the need to define the level of intake.

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Dr. Pierre-André Geraert

[Feedinfo News Service] Dr. Geraert, how does our evolving understanding of these advantages change the use of dietary amino acids? For example, are different inclusion levels (or ratios among the various amino acids) required in order to fully benefit from these advantages?

[Dr. Pierre-André Geraert] The research into roles of amino acids beyond building blocks, such as threonine and the sanitary status, methionine and its antioxidant benefit, tryptophan and its appetite potential and much more, have created an interest in the technical community to reconsider the use of amino acids. However, we are still far from adjusting the dietary amino acid supply and balance according to specific health, environmental preservation or product quality targets. Animal growth is still often considered by most feed formulators as the only criterion for the evaluation of the requirement. But recent practical feed formulations have demonstrated the value to feeding the animals even for a short period to benefit from those potentials, thus challenging our amino acid recommendations.

[Feedinfo News Service] One of the themes of this year's Advancia seminar was that dietary amino acids have a wide variety of advantages when used in animal feed, beyond simply serving as "building blocks". How widely do you think this message has been understood by the industry at large?

[Dr. Pierre-André Geraert] The industry often considers amino acids only for the protein deposition. But recent works and publications have started to create interest among nutritionists. Both the sharing of these new data, and communication on their economic benefits still need to be better promoted to fully value the benefits of amino acids. However, some end users, feed millers or integrators have recently demonstrated the value potential of increasing the supply of methionine for a few days to a week prior to slaughter, to increase protein deposition and meat quality. Reinforcing the antioxidant defenses by combining the methionine source and other antioxidant solutions will surely be the optimal cost-effective option to benefit the users.

[Feedinfo News Service] As we increase our knowledge of the effects of amino acids on animal physiology and health, how do such findings affect Adisseo's commercial strategy for amino acids?

[Dr. Pierre-André Geraert] Currently, feed formulation takes into account the animal's basic need for amino acids, as well as the digestible amino acid content of feedstuffs. However, the knowledge on new potential benefits or roles beyond the building blocks is clearly challenging our way of formulating diets on amino acids. Oxidative stress situations such as heat stress, weaning, reproductive status or dietary imbalance need extra amounts of sulfur amino acids to support the genetic potential of our modern animals. Supplementing high amounts of sulfur amino acids, even for a short pre-slaughter period, has also demonstrated technical and economic benefits.

Adisseo will increasingly look at the full potential of amino acids, which means proposing recommendations taking into account the objectives of the end-users, its customers. Amino acids, and particularly sulfur amino acids, will have to be considered more as specialty additives than just as amino acid sources for protein deposition and muscle growth. Moreover, when considering the source of methionine, OH-methionine has even stronger antioxidant properties than methionine, thus suggesting the need to refine not only the dietary supplementation level but also the source when considering specific benefits such as the antioxidant potential.

[Feedinfo News Service] Dr. Tesseraud, do you believe there remains much to be discovered in terms of the effects of amino acids on animal physiology and health? What are some of the most pressing questions going forward?

[Dr. Sophie Tesseraud] A large number of studies have been devoted to exploring the key roles of SAA, but further experiments are still necessary to obtain direct evidence regarding some of their effects on nutrient metabolism, cell functions and physiological responses in animals. Authors often focus on particular points and the difficulty is to integrate all the data available to propose recommendations. A major challenge for future studies will be to improve the integration of data without oversimplification, while taking into account the findings/concepts which are generalizable or dependent on a particular condition such as the physiological (e.g. perinatal nutrition) or physiopathological conditions (disease, environmental stress).