Perspective

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Journal of Animal Research and Nutrition

2022
Vol.7 No.10:048

Animal Feed Production in Livestock and Poultry

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Received date: September 11, 2022, Manuscript No. IPJARN-22-14985; **Editor assigned date:** September 13, 2022, PreQC No. IPJARN-22-14985 (PQ); **Reviewed date:** September 24, 2022, QC No. IPJARN-22-14985; **Revised date:** October 04, 2022, Manuscript No. IPJARN-22-14985 (R); **Published date:** October 11, 2022, DOI: 10.36648/2572-5459.7.10.048

Citation: Goud D (2022) Animal Feed Production in Livestock and Poultry. J Anim Res Nutr Vol. 7 No10: 048

Description

In contrast to inorganic Se, the absorption of Selenomethionine (SeMet) and selenocysteine is mediated by an amino acid uptake mechanism. SeMet is likely transformed into the intermediate product Sec through the transsulfuration pathway and then subsequently decomposed into H2Se or undergoes transamination to demethylate into H2Se. Recently, a possible mechanism for the conversion of nano-Se to selenite has been proposed, suggesting that gut microbes convert nano-Se into selenite, Se-phosphate, or H2Se, leading to the synthesis of selenoproteins.

Metabolic Pathways

As the branch point of 2 metabolic pathways, H2Se is ultimately converted into selenophosphate to supply Se in an active form for the synthesis of selenoproteins. On the other hand, some SeMet is incorporated into selenoenzymes or in place of Met to participate in the synthesis of selenoproteins, thereby increasing the total Se content in body tissues. Thus, differences in the degrees of improvement of livestock products and human health with the use of different Se sources may be clarified by determining their probable metabolic pathways and absorption processes. Based on these contrasting roles, we further discuss the effect of Se on the quality of livestock and poultry meat, providing a reference for research on biological Se enrichment technology and the development of Se-rich products. In this sense, several recent studies have obtained promising results for Polyunsaturated Fatty Acid (PUFA) concentrations in response to organic Se, indirectly indicating the effect of Se on preventing meat from undergoing lipid oxidation and protecting PUFAs. The essential role of omega-3 (n-3) fatty acids in preventing cardio-metabolic and inflammatory diseases is well known. PUFAs derived from animal foods, rather than purified dietary supplements, are combined with antioxidant nutrients such as Se and glutathione, further synergizing with long-chain n-3 fatty acids and inducing them to play an active role in protection. Accordingly, optimizing the Se content and the ratio of n-3 and n-6 fatty acids in livestock products has been considered a new target for increasing the intake of Se and long-chain n-3 fatty acids in humans.

Muscle Nutritional Component

The bimolecular interactions between myoglobin and other factors, such as lipid oxidation, are widely accepted to jointly govern meat color, and the autoxidation of myoglobin is the main reason for deviations from bright cherry-red to brown. Additionally, several studies have shown an underlying relationship between a change in meat color, lipid oxidation, and protein oxidation; the oxidation reactions occurring in the lipids and proteins are transferred to the myoglobin fraction, thereby affecting fresh meat color. In this case, strategies for supplementing Se to enhance the activity of antioxidant selenoproteins such as GPx and thioredoxin would be useful in preserving the color of fresh meat by disrupting the co-oxidation reactions of myoglobin, lipids, and proteins as well as promoting myoglobin synthesis. The degradation of cytoskeletal proteins may lead to swelling of muscle cells to retain the water discharged from myofibrils. The activation of calcium-activated neutral proteases (calpains) produces a rapid fragmentation of intermediate protein filaments in meat, thereby preventing the shrinking of the whole muscle cell membrane. However, calpains are highly susceptible to oxidation and pH because of the histidine and SH containing cysteine residues present in their active sites. Meanwhile, a low pH inhibits the ability of muscle protein to bind water and reduces negative electrostatic repulsion between muscle filaments, resulting in the dehydration and contraction of myofibrils. Moreover, lipid peroxidation induced by free radicals attacks polyunsaturated fatty acids in muscle, destroying the integrity of the muscle cell membrane, which is one of the leading causes of seepage of intracellular fluids. An increase in the meat antioxidant capacity caused by Se, namely, increased synthesis and activity of GPx, reduces calpain oxidation and membrane damage, thereby helping to modify drip loss, whereas other evidence has highlighted the antioxidant capacity of activated calpains in enhancing muscle water-holding capacity by increasing pH and rapidly degrading inter-muscular proteins.

With the increasing demand for healthy food, increasing interest in safe and high-quality animal products with longer shelf lives has been observed. It is an essential trace element for both human and livestock health that is necessary for numerous metabolic processes, such as antioxidant defense capacity, immune function, and reproductive function, thereby effectively reducing the risk of many diseases. Conversely, the results derived from clinical studies suggest that the enrichment of animal derived foods with Se *via* supplementation of animal feed may be an effective method for addressing Se deficiencies and simultaneously providing some protection against cancer. Therefore, Se-enriched food, which provides organic forms of Se with the highest bioavailability in ready-to-use products to supplement micronutrient deficiencies and maintain the metabolic balance of organisms, has attracted extensive attention. In pork, the increased Se content without a reduction in production performance indicates it's comparatively low toxicity and the commercial opportunities for using organic Se at high doses to produce Se-enriched pork. Similarly, beef is considered a potential major source of dietary Se with the inclusion of Se in cattle feed. Therefore, the addition of Se to cattle feed should be further investigated.

Se additives in animal feed are divided into 2 main forms: Organic Se and inorganic Se. The general consensus is that organic Se, in the form of both selenoamino acids and Se-Enriched Yeast (SY), is more effective than inorganic Se at increasing growth performance, antioxidant status, and tissue Se concentration, as well as in improving the meat quality of livestock, mainly due to its higher bioavailability and tissue retention. After slaughter, the collapse of the endogenous antioxidant system and the biochemical changes that occur during the conversion of muscle to meat are considered responsible for deteriorating meat quality. These alterations remarkably influence the physical and chemical properties of proteins, including solubility, water-holding capacity, and meat tenderness. In addition, protein oxidation decreases the bioavailability of amino acid residues, thus negatively affecting the nutritional values of meat proteins. Lipid peroxidation is suggested to be responsible for the destruction of cell membrane integrity and pigment reduction systems, resulting in a reduced muscle water-holding capacity and meat discoloration along with an off-flavor. Furthermore, increasing evidence indicates that the interactions between protein and lipid oxidation concomitantly lead to further oxidation.