Commentary

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Biotechnological Techniques in Animal Nutrition

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Description

Nutrition is vital for the growth and health of animals. Nutrients especially macronutrients, including amino acids, fatty acids, and carbohydrates provide energy and basic building blocks that are needed for homeostasis and biomass accretion. Traditionally, nutrition science has focused on the physiological processes of digestion, absorption, transport, and metabolism. However, starting in the beginning of this century, a great deal of attention has focused on how cells and organisms sense and metabolically respond to nutritional status through what is known as nutrient sensing a topic that has become a hot spot in the biological sciences. Numerous studies have demonstrated that nutrient sensing plays critical roles in the regulation of food intake, energy expenditure, hormone secretion, and metabolic processes in humans and other animals.

It is plausible that changes in tissue inositol phosphates accompany changes in myo-inositol status. The measurement of endogenous inositol phosphates in animal tissues and the establishment of their relationship with myo-inositol are problematic without recourse to metabolic labeling with radioactive precursors. A method using post-column complication of inositol phosphate with ferric ion in per-chloric acid and UV detection at 290 nm is widely used for measurement of inositol phosphates in seeds, grains and beans and digestive tract chymus. In the following trial, this method was used to measure inositol phosphates in chicken erythrocytes and a HPLC method is described for measurement of myo-inositol therein. The objective of the following study was to determine whether super dosing of phytase liberated myo-inositol from phytate, which can then be taken up by the blood plasma to support Ins P5 production in chicken erythrocytes to enhance oxygen availability and help alleviate WB myopathy.

Regulation of Nutrient

Nutrient-sensing signaling pathways receive external nutrients and environmental inputs to regulate biomass accretion and health. Dysregulated sensing signals have been shown to be involved in pathological processes such as cancer, cardiovascular diseases, and neuro-degenerations. Digestive enzymes, endocrine peptides, and hormones are responsive to food ingestion. The hypothalamus has been demonstrated to be a signaling integratory center for nutrient sensing and regulating appetite through anorexigenic and orexigenic neuropeptides. Nutrient sensing in the central nervous system coordinates with that in the periphery to modulate metabolism in organs through secreted neuropeptides and hormones. Compared with terrestrial animals, fish require a high level of dietary protein, optimally from fishmeal, which is a limited natural resource that is unsustainable for the development of aquaculture. We also found that targeting the nutrient-sensing pathway by simply increasing feeding frequency could fine-tune postprandial responses and improve fish growth by 7.68% and protein retention by 4.01% in turbot. Replacing fishmeal with plant proteins in aqua feeds has been a long-term goal, and a great deal of effort has been made in this endeavor. Regardless of the trend of reduced fishmeal inclusion in fish diets, however, it is generally acknowledged that the performance of fishmeal is superior to that of other protein sources.

There are features of nutrient-sensing molecules that render them potentially useful as biomarkers: Their activities are responsive to nutritional status in a dose dependent manner and they are vital for organ specific functions, including muscle protein deposition and immune responses, which can be measured and employed as surrogate outcomes. A great deal of effort is needed to screen and select potential candidates as useful biomarkers for the indication of the nutritional and health status of farmed animals. We have seen rapid development of the integration of bio-sensing technologies with the Internet of things paradigm to promote rapid, on-farm, and real-time monitoring of the health and welfare of farmed animals, especially cattle. Conceptual sensors have also been developed to monitor nutritional status in animals. Nevertheless, it is still necessary to tailor technologies efficiently and accurately for particular physiological purposes and species-specific traits. Such data should be valuable for future precision animal farming.

Nutrient Sensing

Most nutrient-sensing molecules and functions for amino acids, lipids, and carbohydrates are well conserved in farmed animals such as pigs. Nutrient sensing in the intestine plays a fundamental role in signaling the nutritional status to the central nervous system and regulating feeding behavior in pigs.

Nutrient sensing has received a considerable amount of attention in aquaculture species in recent years and has been comprehensively reviewed elsewhere. Fish share the main regulatory networks of growth, feeding, and metabolism with other vertebrates. Nutrient-sensing signaling pathways, including Peroxisome Proliferators Activated Receptors (PPARs) are also highly conserved in fish. This finding suggests that the self-protective mechanism of fish in response to high energy intake has not been well established from an evolutionary perspective. Nutrient sensing after meals is present in multiple tissues in fish, such as the intestine, liver, pancreas, muscle, and brain (hypothalamus). Nutrient-sensing systems may detect nutrients either directly or indirectly by sensing some derived metabolite that reflects nutrient abundance.

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Numerous studies have unequivocally demonstrated that nutrient sensing plays major roles in the regulation of metabolism and diseases. There have been extensive applications of nutrient sensing in clinics. For example, various forms of fasting, protein restriction, and specific reductions in the levels of essential amino acids such as met and the branched chain amino acids are practiced in order to selectively impact signaling to promote healthy longevity.