Commentary

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# The Role of Nutrition for the Growth and Health of Animals

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## Description

Feeding is vital for animal growth and the maintenance of health. However, the underlying mechanisms that mediate dietary performance have long been a so-called black box. It is only during recent years that studies have demonstrated that nutrients act as signals that can be sensed by cells and organisms and that play vital roles in gene expression and metabolism. Multiple signaling pathways have been identified as being responsible for the sensing of discrete nutrients. While successes have been achieved in the exploitation of nutrient-sensing signals in drug discovery and disease control, applications based on the sensing and metabolic control of major nutrients (proteins, lipids, carbohydrates) in aquaculture and land-farmed animals remain in their infancy. We thus provide a tentative perspective on future research topics and applications of nutrient sensing in animal nutrition.

## Tuberous Sclerosis Complex

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.

Mechanistic target of rapamycin signaling has become known as the major signaling hub for sensing the availability of nutrients, especially amino acids, and regulating the balance of anabolism versus catabolism in cells. mTOR complex 1 (mTORC1) comprises serine/threonine kinase mTOR, raptor (a regulatory protein associated with mTOR), Dishevelled, Egl-10 and Pleckstrin (DEP) domain-containing mTOR-interacting protein (DEPTOR), and mLST8 (mammalian lethal with Sec13 protein 8) [9]. Among the many downstream effectors of mTORC1, 4E-Binding Protein 1 (4EBP1) and the p70 ribosomal S6 Kinases (S6K) are the fundamental players in Messenger RNA (mRNA) translation, protein synthesis, and cell proliferation regulation. Small Guanosine Triphosphatase (GTPases), such as Rag and Rheb (Ras homolog enriched in brain), are crucial for transducing nutritional input and mTORC1 activation. mTORC1 receives signals from growth factors that involve signaling cascades consisting of cell surface receptors, akt, Tuberous Sclerosis Complex (TSC), and Rheb interactions with mTORC1. The activation of mTORC1 by Rheb also requires the lysosome localization of mTORC1 and is mediated by the Rag GTPases heterodimers of RagA/B bound to RagC/D. The GTP-loaded Rag GTPases recruit mTORC1 to the surface of lysosomes when nutrients especially amino acids are available.

The present study aimed to evaluate the potential of yellow mealworms reared using local agricultural by-products as an alternative feed for monogastric and ruminant animals. The mealworms were raised on oat-based and wheat-based by-products, and their nutritional properties and in vitro digestibility were evaluated, simulating the digestive system of both monogastric and ruminant animals. Furthermore, the gut microbiome of mealworm larvae was studied. Crude fat and most minerals were higher in larvae fed WB than those fed OB, reflecting the nutritional profiles of the substrates. Larvae and pupae generally shared a common nutritional profile: Lower contents of crude fiber, crude protein, and total amino acids, and higher crude fat, total fatty acids, and gross energy levels compared to adults.

## Soy Bean Meal

Total essential and non-essential amino acid contents in larvae and pupae were similar to those of a commercial Soy Bean Meal (SBM). The dry matter and protein digestibility of larvae and pupae were similar to SBM and significantly higher (30%) than the values for adults for both monogastrics and ruminants. Firmicutes and proteobacteria were the most abundant gut microbial phyla in larvae, and the gut micro biome revealed remarkable plasticity in response to altered nutritional status, such as starvation. A new insight into the nutrition of mealworm's metamorphic stages fed on agricultural by-products and how feeding modulates the larval gut micro biome provides an innovative approach to exploit mealworms as a sustainable and alternative animal feed source in the future.

The world's human population is growing rapidly, and ensuring food security is a global concern. The livestock sector

plays a vital role in agricultural food production, contributing 15% of total food energy and 31% of dietary protein globally. Due to increased calorie intake and the nutritional shift toward animal-based products worldwide, it is anticipated that future demands for livestock-based products will increase even further, particularly in low- and middle-income countries. Such increased demands for livestock products can be fulfilled through the identification and utilization of alternative animal feeding resources, as they play a crucial role in establishing a sustainable livestock sector in the future. In recent years, different insect species have been identified as promising alternative and more sustainable feed ingredients for livestock due to their capability to convert waste or by-products into biomass rich in protein and other valuable nutrients.

Among insects, the yellow mealworm has been identified as one of the few candidate species with the potential for large-scale commercial production. Mealworms can potentially be grown under a variety of agricultural and other low-quality organic substrates and can be utilized as alternative nutrient sources for livestock, mainly mono gastric animals. In Nordic countries, self-sufficiency for domestic animal feed resources is relatively low. Thus, the local production and utilization of new feed ingredients, such as mealworms, would contribute to an increased domestic supply of raw ingredients for feed industries in the region. This requires knowledge of whether locally available bio resources, such as agricultural by-products from the Nordics, can be efficiently utilized to produce mealworm biomass of high nutritional quality for production animals.