On the Estimation of the Digestible Nutrient Contents of Finished Feeds

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A very large proportion of the aquaculture feed manufacturers are now formulating their feeds on a digestible nutrient basis. This progressive move from formulating on a "total nutrient" basis to formulating on digestible nutrients is praiseworthy since it is providing a more rational basis for the production of cost-effective diets adequately meeting the nutrient requirements of animals.

Every year, an increasing amount of information of the digestibility of nutrients of different ingredients is becoming available. This information is informally compiled in a number of reference documents and increasingly used by commercial feed formulators. The question arises as to how reliable is the available information and how it is best used. In a context of very high feed commodities prices, the impact of overestimating or underestimating digestible nutrient contents of feed ingredients can translate into significant economical impacts. For example, variations as low as two or three percentage points in the digestibility of protein or lipid sources can translate into variations of as much as $10 to 30 per tonne of feed produced, clearly not something negligible.

For years, the debate around estimates of apparent digestibility was on methodological issues (e.g., feces collection methods) and perhaps more important issues have been neglected. I wish to briefly highlight two of these issues in this column.

Ingredients, such as poultry by-products meal, feather meals, meat and bone meals, and DDGS are increasingly used in commercial aquaculture feed formulations. A substantial amount of information of the apparent digestibility of protein, amino acids and energy of these ingredients is available in the reference literature. However, these ingredients are produced using a wide variety of equipment and processing and drying conditions. Consequently, significant differences may exist in the apparent digestibility of nutrients amongst lots (batches) of these ingredients. Very little work has been done to meaningfully characterize the variability of the digestibility and nutritive value of different lots of the same ingredient. This is a major issue for feed manufacturers since these ingredients are frequently sourced from several different suppliers (brokers) and these suppliers, in turn, frequently source these ingredients from different manufacturing facilities.

Another important issue is the way by which the digestible nutrient contents of finished feeds can be computed. In feed formulation, the nutrient contributions of different ingredients are used to predict the concentration of nutrient (or energy) in the finished feed. The contribution of nutrients of different ingredient is thus assumed to be additive. It is common for nutritionists to assume that the digestible nutrients and energy contents of feeds can also be calculated as the sum of digestible nutrient and energy contributions of different feed ingredients (calculated from the quotient of incorporation level in the feed, the apparent digestibility coefficient (ADC) and the nutrient content of the ingredient). While practical and generally effective, an increasing amount of evidence suggests that this type of approach may not be suitable for several types of nutrients.

A series of publications from the University of Guelph (Hua and Bureau. 2006. Aquaculture, 254: 455-465; Hua and Bureau. 2009. Aquaculture, 294: 282-287; Hua and Bureau. 2009. Aquaculture, 286: 271-276; Hua and Bureau 2010. Aquaculture, 308: 152-158) showed that the digestible phosphorus (P), starch and lipid contents of finished feeds could not be computed from the sum of expected digestible nutrient contributions of the different ingredients. This research indicated that the forms under which these nutrients were supplied (or found in the finished feeds), the levels and interactions between different forms of the nutrients, and the effect of some exogenous factors (e.g., water temperature, % gelatinization) had to be taken into account to accurately predict the digestible nutrient contents of finished feeds.

Fortunately, this research also showed that multiple regression equations provided a simple and practical approach of addressing this challenge. Equations where thus developed for predicting the digestible P, starch and lipid content of feeds manufactured using a wide array of feed ingredients. Unfortunately, most least-cost feed formulation software are not currently designed to carry out an optimization (least-costing) of the digestible P, starch and lipid contents of feeds on the basis of these equations. However, these simple equations can be programmed into most feed formulation software and the effects of changes in feed formulation on the digestible P, starch and lipid contents of the finished feeds be easily computed.

These issues should be on the radar screen of feed manufacturers and more systematic and commercially relevant work needs to be done by fish nutrition researchers on the important topic of estimating the digestible nutrient contents of feeds.

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