An Investigation into the Protein Requirement of a Marine Prawn *Fenneropenaeus indicus* (H. Milne Edwards).

by

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Abstract

The white prawn, *Fenneropenaeus indicus* (H. Milne Edwards) (Perez-Farfante & Kensley 1997), is a species native to east-southeast Africa. Until 2004 South Africa boasted a small yet viable prawn industry which, during its prime, produced an annual harvest of approximately 130 mt of cultured *F. indicus*. At times pond yields surpassed total yearly trawls of wild stocks caught offshore, but due to high running costs the farms were forced to close. Renewed interest by investors to revive and expand the industry using large scale farming techniques is presently being addressed. However, there remains concern about the high costs incurred in manufacturing feeds since, in both natural and prepared diets, protein is the main and most expensive nutrient. To date, diets formulated for *F. indicus* have a protein content of approximately 33 - 43 %. To assess if protein requirement changes with age the survival, nutritional indices, body composition gains and growth response in approximately 2, 7 and 14 g prawns fed diets with protein concentrations ranging between ~ 5 to 50 % during 35 day growth trials, was investigated. Results indicated that dietary protein significantly influenced growth and nutritional indices and that the protein requirement for 2, 7 and 14 g prawns was 34, 35 and 41 % of the diet, expressed on a dry matter basis, respectively. Moreover the quantitative aspect of protein utilization (g nutrient/unit of mass gain) was examined by implementing the Reading model, primarily used to establish the optimal requirement of essential amino acids in laying hens based on economical terms. Results indicated that the optimum dose increased with age with protein requirements of 18, 46 and 152 mg/day recorded for 2, 7 and 14 g prawns.

In formulated diets fish meal, although the most suitable source of protein with a digestibility coefficient in excess of 90 %, remains the most expensive ingredient and due to fishing pressures may become scarce in the future. Alternative and less expensive sources of plant proteins *viz.* wheat gluten, sunflower oilcake, brewers yeast and soybean meal together with a slightly more expensive animal protein, casein, were investigated and found to have digestibility coefficients of 97, 96, 95, 88 and 90 %, respectively.

Moreover, a model used to describe growth in pigs and poultry was adapted to describe and predict growth in *F. indicus*. The model describes the potential rate of increase of body protein using the Gompertz equation, which estimates body protein mass at a point in time (P_t) from the mature body protein mass (P_m), the degree of maturity at birth μ where $\mu = P_t / P_m$ and from the rate of maturation (β), which is a Gompertz constant. In addition the potential rate of increase in mass of each body component *viz.* flesh and exoskeleton and their respective chemical fractions, expressed as a function of the current protein mass, may be calculated using allometry. Body mass of the animal at any given point in time is then determined by adding the mass of each component and their associated fractions.

In this study the procedures used to establish the relevant parameters of the Gompertz growth equation (*i.e.* β, P_m) under assumed non-limiting conditions involved the measurement and comparison of the growth of prawns reared in a laboratory system and in a growout pond for ~ 400 days. Based on a series of mixed samples of pond-reared male and female prawns, the inherent growth parameters of the species, when reared at 19 – 27 °C and in 21 – 27 ‰, were as follows: P_m of 6541.00 mg, β of 0.014 per day, maximum rate of protein deposition of 32.68 mg/day, and lipid:protein, ash:protein, water:protein, carbohydrate:protein at maturity equal to 0.03, 0.02, 3.30 and 0.06, respectively.

Animals require dietary energy for maintenance and growth. In order to establish the metabolic rate of fasting *F. indicus* the oxygen consumption of 5, 7 and 14 g prawns at temperatures of 20, 25, 30 °C and salinities of 15, 25 and 35 ‰ was measured. In addition the percentage increase in metabolism caused by the specific dynamic action (SDA) for the same size animals fed diets of 21, 31 and 41 % crude protein was measured. Salinity had no significant effect on respiration rates but metabolic rates were affected significantly by temperature. Oxygen consumption (mg. $hour^{-1}$) as a function of live mass of fasting animals at 20, 25 and 30 °C was described by $0.194\, M^{0.783}$, $0.243\, M^{0.810}$ and $0.341\, M^{0.854}$, respectively, at 15 - 35 ‰. Despite SDA contributing to an increase above pre-feeding levels of about 9, 10 and 13 % for prawns fed diets containing 21, 31 and 41 % crude protein respectively, no significant differences in respiration rates between animals fed the different diets were found. Oxygen consumption of fasting prawns, together with a conversion rate of 20 kJ/ℓ O_2 respired, provided a means of calculating the minimum digestible energy required by the species at the above-mentioned environmental parameters. For example, an individual of 14 g at 20 °C is predicted to have a maintenance requirement for energy (HE_f) of $[0.194\times(14)^{0.782}] \times 20 = 0.031$ kJ /hour × 0.744 kJ/day.

Emmans (1984) and Oldman and Emmans (1990) have shown that an estimate of metabolizable energy (ME) is not an accurate means of describing energy yields of feedstuff since the heat increment of feeding is not accounted for. A solution known as the effective energy system, proposed by Emmans (1984; 1994) and Emmans and Fisher (1986), takes these deficiencies into account and was used here in place of the ME system when calculating dietary energy content and prawn requirement. The daily energy requirement (EERQ) of prawns may be predicted using: $EERQ = HE_f + 47\ PR + 56\ LR + 17\ CR$ (kJ/day) where PR, LR and CR are the retention of body protein, lipid and carbohydrate, respectively. The desired feed intake (DFI) is calculated as $DFI = EERQ \div EEC$. Using these same principals the desired protein intake based on the amino acid requirements for maintenance and growth was established.

This study indicated that, with estimates of potential growth rate, fasting metabolic rates and changes in body composition, the nutrient requirements of *F. indicus* could be predicted. With this knowledge, especially for protein and energy, producers can make better decisions that will ultimately lead to increased production and a decrease in costs.