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## Feeding Fish Without Fishmeal: Earthworm Meal as Alternative Animal Protein Source in Rural Areas

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### Abstract

Fishmeal is a limited resource and restricts the development of aquaculture especially in rural areas which have no established markets to supply suitable feed resources. Previous studies have shown that a traditional integrated farmer household in northern Vietnam with in average one cattle and one buffalo can produce 11.1 (min)–33.1 (max) kg of dry earthworms per year. The aim of this study was to evaluate whether earthworm meal can fully replace fishmeal in supplemental feeds and what the feed conversion of such feed is.

In northern Vietnam, a trial was carried out with common carp in net cages (total 32 nets, 1.5 × 1.5 × 2 m) lasting for three months. Three iso-nitrogenous (16 % crude plant protein, 11 % crude animal protein) and iso-lipidic (10 % crude lipid) feeds were tested. Carp were fed either 10 g kg<sup>-0.8</sup> of feed at a stocking rate of 5 fish per cage or 20 g kg<sup>-0.8</sup> at a stocking of 10 fish per cage. In the feeds A, B and C, fishmeal protein was replaced by 0 %, 50 % and 100 % earthworm protein.

The stepwise replacement of fishmeal by earthworm meal in feeds at lower feeding levels resulted in relatively higher specific growth rates of 0.10±0.15 (A), 0.17±0.19 (B) and 0.22±0.16 (C), while the higher feeding rate accounted for 0.24±0.25 (A), 0.32±0.24 (B) and 0.42±0.27 (C). Lower feeding levels had relatively lower feed conversion rates of 1.4±0.6 (A), 1.2±0.5 (B) and 0.9±0.0 (C) than higher feeding rates which reached 1.5±0.3 (A), 1.5±0.6 (B) and 0.9±0.2 (C).

It was shown that earthworms are suitable as sole animal protein source in plant-based supplemental feeds for common carp under semi-intensive pond management. At an inclusion rate of 20 % of earthworm and financial input of 0.3 € kg<sup>-1</sup> feed, a household could produce 56(min)–165(max) of feed. As the FCR in this experiment was 0.9, the potential additional fish yield would be 50–149 kg of common carp with a net profit of 83–249 € year<sup>-1</sup> and household (average income of 156 € per capita and year). Consequently, earthworms as a feed ingredient for common carp may open the possibility for farmers in rural areas to engage in semi-intensive aquaculture.

**Keywords:** Common carp, earthworm, fishmeal replacement