Researchers Look to Amaranth Leaf as Fishmeal Alternative

As aquaculture continues to expand, more high quality feed is required to sustain the industry, but this is putting further strain on limited available ingredients such as fishmeal.

The amaranth leaf has been drawing increasing attention for its nutritional content. In addition to growing quickly and being inexpensive to produce, it's also resistant to conditions such as heat and drought. The leaves contain 17.5-30.3 per cent dry matter as protein of which 5 per cent is lysine, while significant levels of Vitamins A and C are also present. Other major elements in the leaves include sodium (to maintain extracellular fluid balance), potassium (for haemoglobin functioning and maintaining electrolyte balance and normal cellular function), magnesium (for enzyme action, muscular contraction, nerve transmission and bone health) and phosphorus (to regulate acid-base balance and form bone and cells).

Recently, the amaranth leaf was the focus of a study by an international research team of scientists in the US and Kenya. The team, led by Professor Ngugi, included Dr Elijah Oyoo of Karatina University, Professor Julius Manyala of the University of Eldoret and Professor Kevin Fitzsimmons of the University of Arizona, USA.

The study analysed the growth performance, nutrient utilization, carcass proximate composition and digestibility of Nile tilapia (Oreochromis niloticus) that were given protein concentrates from the amaranth leaf.

"Aquaculture in Kenya is still practised mostly by small-scale farmers at extensive and semi-intensive levels," explained Professor Ngugi.

"Farmers at the semi-intensive levels must rely on expensive, imported fish feed so we thought it would be appropriate to evaluate alternative cheaper protein sources. We started with Atyid shrimp (Caridina nilotica) in our trials but because of limited distribution, turned to other options. The amaranth leaf, hydrolysates from the leaves and concentrates showed good protein content, and this formed the basis of our research."

In the study, Nile tilapia fingerlings were fed 4 times a day at 2.5 per cent body weight for 160 days.

Trial diets were prepared, in which 100 per cent, 75 per cent, 50 per cent 40 per cent, 20 per cent and 0 per cent of fishmeal protein respectively was replaced by protein concentrates from the amaranth leaf. The diets were also formulated with locally available feed ingredients such as wheat bran, perch oil, cassava and mineral and vitamin premix. The fingerlings were evaluated for performance, nutrient use, body composition, survival, and nutrient digestibility, while feed conversion ratio (FCR) and specific growth rate (SGR) were also calculated.

"We hypothesized that alternatives that produce significantly similar growth rates to fishmeal would be suitable for aquaculture because they cost less than fishmeal," said Professor Ngugi.

"But we didn't know the exact inclusion level of alternatives like plant ingredients in diets that would not produce lower yields than fishmeal."

Although the fishmeal-based diets had a higher profile of various essential amino acids, phenylalanine and tryptophan levels were lower compared to the amaranth leaf. Growth performance was generally unaffected by amaranth leaf replacements with no significant differences in terms of SGR, mean weight gain and weight gain between diets of 100 per cent fishmeal and those containing 75 per cent, 50 per cent, 40 per cent and 20 per cent of fishmeal respectively. However, the diet containing 100 per cent amaranth leaf protein concentrates produced a lower final weight, weight gain and FCR, and the highest survival rate was observed in fingerlings given 100 per cent fishmeal. Daily feed intake rose with increasing fishmeal substitution, and there were also significant differences in nutrient utilization parameters.

The study concluded that up to 80 per cent of fishmeal could be replaced with amaranth leaf protein concentrates without compromising growth performance and nutrient utilization, but differences between the two were observed. For example, the essential amino acid composition of both was similar except for histidine, leucine, lysine and methionine levels, which were lower in the amaranth leaf. This was presumed to be more limiting for fish growth performance, especially low lysine levels.

Anti-nutritional factors such as phytates and oxalates were also observed in the amaranth leaf, with some remaining bound to certain proteins in the diets, rendering them inaccessible to digestive enzymes and thus reducing protein digestibility. This may also have impaired the absorption of some essential amino acids in the amaranth leaf diets, depressing fish growth as a result. Phytate may also have been responsible for reduced growth in fingerlings that were given higher levels of amaranth leaf.

"The amaranth leaf still comes with many challenges," Professor Ngugi explained. "It does have potential, for example it can help increase the concentration of essential amino acids, but there are other issues to address such as processing. Many farmers are not aware of the processing technology required to make feed from it."

Professor Ngugi and his colleagues believe their research will make a difference to aquaculture. "Over 50 per cent of operating costs tends to be feed," he said. "While protein ingredients make up 60-70 per cent of feed costs. One of the reasons why protein costs are so high is because fishmeal and other animal or plant-based protein ingredients are expensive. Finding cheaper alternatives will help formulate less expensive feeds. In addition, farmers can learn and adopt the required technology to manufacture such feeds and operate at lower costs."

Professor Ngugi and his team are evaluating more components of the amaranth leaf, its protein concentrates and hydrolysates, as well as other animal-based ingredients such as freshwater shrimp (Caridina niloticus) and plants regarded as weeds in their region. They hope that in future, more alternatives will enable farmers to formulate their own feed at a lower cost.

"We are currently working with researchers from the University of Arizona and the University of Eldoret on the technical aspects of amaranth leaf research, " he said. "We have received funding from the Aquafish Innovation Lab project (the USAID-funded Aquafish Collaborative Research Support Programme) to promote cheaper and affordable alternative protein feed ingredients for fish farmers, and research projects are available to our graduate students. We are also open to other project proposals from researchers covering the same theme as us."

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