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Effects of varied dietary lipid sources tested in tilapia study

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Deficiency of essential fatty acids leads to decreased immune responses



The study appeared to indicate that omega-6 fatty acids have a better growth-promoting effect than omega-3 in Nile tilapia.

Dietary lipids are an important source of highly digestible energy and the only source of essential fatty acids required for normal growth and development of fish. They are also carriers and assist in the absorption of fat-soluble nutrients such as sterols and vitamins A, D, E and K. In addition, dietary lipids serve as a source of phospholipids and participate in the synthesis of hormones, prostaglandin and other metabolically active compounds.

There is evidence that dietary lipids and their constituent fatty acids influence immune response and disease resistance in fish. A deficiency or excess of omega-3 fatty acids can suppress immune function and increase the susceptibility of fish to infectious pathogens.

Feed study

The authors recently conducted a study to evaluate the effects of different lipid sources on the growth performance, whole body proximate composition, immune response and resistance of Nile tilapia (*Oreochromis niloticus*) to *Streptococcus iniae* infection.

A casein gelatin-based diet with 34 percent protein was supplemented with corn oil, beef tallow, fish oil, linseed oil or combinations of fish oil, corn oil and beef tallow; or linseed oil, corn oil and tallow at a level of 7 percent. Twice daily for 12 weeks, each diet was fed to tilapia of 6.5 grams average weight stocked at 35 fish per aquarium in four replicate aquariums. The aquariums used flow-through dechlorinated city water heated to 27 to 28 degrees-C and continuous air stone aeration. Photoperiod was kept on a 12 hours light, 12 hours dark schedule.

Fish in each aquarium were group weighed and counted at two-week intervals. At the end of week 12, blood samples from four fish per aquarium were collected for measurement of hematology. Another group of four fish per aquarium was also bled to determine immune responses.

Fifteen fish per aquarium were challenged by intraperitoneal injection with 0.1 ml of 5×10^6 colony-forming units/ml of *S. iniae*, with mortality recorded daily for 14 days. On day 15, blood samples from the surviving fish were collected to determine antibody levels.

Growth performance

The average final weight gain, dry matter feed intake, feed efficiency, protein efficiency, apparent protein utilization and survival rate are given in Table 1. Fish fed diets containing corn oil; fish oil; corn and fish oils plus tallow; and linseed and corn oils plus tallow had similar growth patterns throughout the feeding period. Fish fed diets with only linseed oil or beef tallow grew more slowly.

Lim, Growth performance and survival of Nile tilapia, Table 1

	Dietary Sources of Lipid Corn Oil	Dietary Sources of Lipid Beef Tallow	Dietary Sources of Lipid Fish Oil	Dietary Sources of Lipid Linseed Oil	Dietary Sources of Lipid Beef Tallow	Dietary Sources of Lipid Corn Oil, Beef Tallow
Weight gain (g)	29.5 ± 4.1 ^a	11.2 ± 2.2 ^b	27.2 ± 2.3 ^a	26.6 ± 1.4 ^a	31.6 ± 0.4 ^a	34.6 ± 3.1 ^a
Feed intake (g)	27.8 ± 2.7 ^a	12.9 ± 1.6 ^c	24.3 ± 1.8 ^{ab}	22.2 ± 1.1 ^b	29.4 ± 0.7 ^a	29.6 ± 1.8 ^a
Feed efficiency ratio	1.1 ± 0.1 ^b	0.9 ± 0.1 ^c	1.1 ± 0.0 ^{ab}	1.2 ± 0.0 ^a	1.1 ± 0.0 ^{ab}	1.2 ± 0.0 ^{ab}

Protein efficiency ratio	3.1 ± 0.2 ^a	2.5 ± 0.2 ^b	3.3 ± 0.1 ^a	3.5 ± 0.1 ^a	3.2 ± 0.1 ^a	3.4 ± 0.1 ^a
Apparent protein utilization	47.8 ± 2.3 ^a	37.8 ± 3.2 ^b	51.0 ± 1.4 ^a	53.4 ± 2.3 ^a	48.9 ± 0.7 ^a	52.6 ± 1.8 ^a
Survival (%)	97.1 ± 2.0 ^a	88.6 ± 3.5 ^b	93.6 ± 3.0 ^{ab}	99.3 ± 0.7 ^a	97.1 ± 2.9 ^a	99.3 ± 0.7 ^a

Table 1. Growth performance and survival of Nile tilapia fed diets containing various sources of lipid. Means (± S.E.) with different letters in same row are significantly different ($P < 0.05$).

By week 6, the weight gain of these two groups of fish was significantly ($P < 0.05$) lower than those of the other test groups. Thereafter, growth of fish fed the tallow-supplemented diet remained consistently poorer, while fish fed the linseed oil-supplemented diet, although still inferior, followed the same trend as those of the other fish.

The mean final weight gain of fish fed the tallow diet was significantly ($P < 0.05$) lower than those of fish fed the other diets. No significant difference in weight gain was found among the fish fed the other test diets.

Feed intake was a reflection of weight gain, with fish fed the tallow-supplemented diet having significantly lower intake than those fed the other diets. The feed intake of fish that received the linseed oil diet did not differ from that of fish fed the fish oil-supplemented diet but was significantly lower than for those fed the remaining diets.

Feed efficiency was significantly lowest for fish fed the tallow-supplemented diet. Although the feed-conversion ratio for the diet with added corn oil was lower than that for the diet with linseed oil, these values were not significantly different from those of the other diets.

The protein efficiency ratio and apparent protein utilization were significantly lowest for the beef tallow diet but statistically similar for the other diets. Survival was lowest for fish fed the diet with tallow, but this was not significantly lower than that of those fed the fish oil diet. There was no significant difference in survival among the remaining fish groups.

No significant ($P < 0.05$) difference was observed among the moisture and lipid contents of fish receiving various dietary lipid sources (Table 2). Crude protein content was significantly lowest and ash content highest for fish fed the diet with beef tallow, but the values of these parameters did not differ among fish fed the other diets.

Lim, Composition of Nile tilapia fed diets, Table 2

Whole-Body Proximate Composition (% wet weight)	Dietary Sources of Lipid Corn Oil	Dietary Sources of Lipid Beef Tallow	Dietary Sources of Lipid Fish Oil	Dietary Sources of Lipid Linseed Oil	Dietary Sources of Lipid Fish Oil, Corn Oil, Beef Tallow	Dietary Sources of Lipid Fish Oil, Corn Oil, Beef Tallow
Moisture	70.6 ± 0.6 ^a	70.9 ± 0.8 ^a	70.4 ± 0.3 ^a	70.9 ± 0.2 ^a	70.5 ± 0.6 ^a	70.5 ± 0.4 ^a
Protein	15.3 ± 0.1 ^a	14.6 ± 0.3 ^b	15.3 ± 0.2 ^a	15.2 ± 0.2 ^a	15.3 ± 0.1 ^a	15.3 ± 0.1 ^a
Lipid	8.5 ± 0.4 ^a	8.5 ± 0.5 ^a	8.7 ± 0.3 ^a	7.8 ± 0.1 ^a	8.8 ± 0.3 ^a	8.8 ± 0.2 ^a
Ash	3.2 ± 0.1 ^b	3.6 ± 0.1 ^a	3.2 ± 0.1 ^b	3.2 ± 0.1 ^b	3.2 ± 0.1 ^b	3.3 ± 0.1 ^b

Table 2. Composition of Nile tilapia fed diets containing various sources of lipid. Values are means of two pooled samples of 4 fish/tank and 4 tanks/treatment.

Immune response, *S. iniae* challenge

Counts of red and white blood cells were significantly highest in fish fed the fish oil diet. These values did not differ significantly in fish fed the other dietary lipids. The sources of dietary lipid had no effect on hemoglobin and hematocrit. Serum protein, lysozyme activity and natural hemolytic complement activity were significantly lowest in fish fed the diet with beef tallow. The values of these parameters did not significantly differ among fish fed other diets.

Prechallenge antibody testing indicated that fish were serologically negative for *S. iniae*. Postchallenge antibody titers were not influenced by the varied dietary source of lipid.

The daily mortality of the tilapia following challenge with *S. iniae* is presented in Fig. 1. Cumulative mortality at day 15 for the fish fed the tallow diet was significantly lower than those obtained in the groups fed the corn oil or fish oil/corn oil/beef tallow diets, but these values did not significantly differ from those of the other treatments.

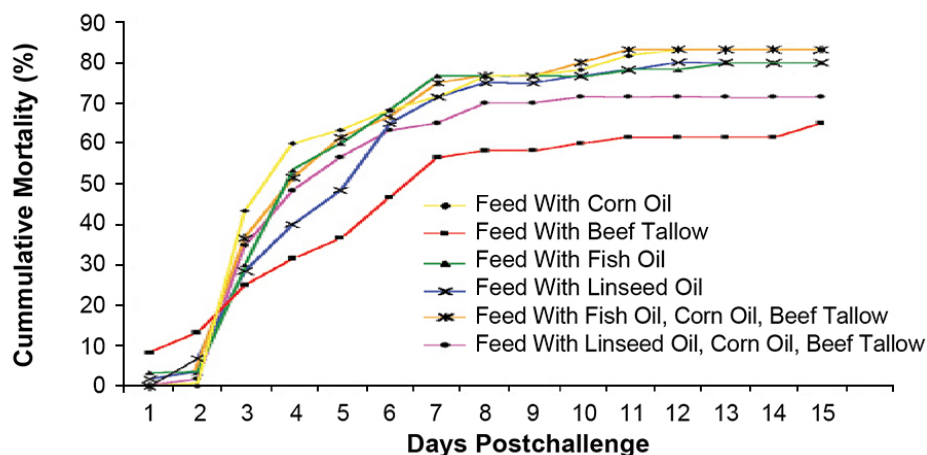


Fig. 1: Daily mortality of Nile tilapia challenged with *S. iniae* for 15 days. Values are means of 4 replicates/treatment. Values at day 15 postchallenge with different letters are significantly different ($P < 0.05$).

Dietary requirements

The study appeared to indicate that Nile tilapia have dietary requirements for both omega-6 and omega-3 fatty acids. Fish fed the diet with beef tallow, which contained low levels of omega-6 and omega-3 (0.31 and 0.26 percent, respectively) exhibited poor growth performance. High dietary levels of either omega-6 or omega-3 may spare the requirement of the other, but omega-6 appeared to have a better growth-promoting effect than omega-3. Excessive levels of omega-3 highly unsaturated fatty acids in the diet with fish oil may lead to abnormally high red and white blood cell counts, and excessive mucus production.

Deficiency of essential fatty acids leads to decreased immune responses. However, this did not translate into reduced resistance of fish against *S. iniae* challenge.

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