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Aquafeeds

Microdiets for red drum larvae

1 April 2002

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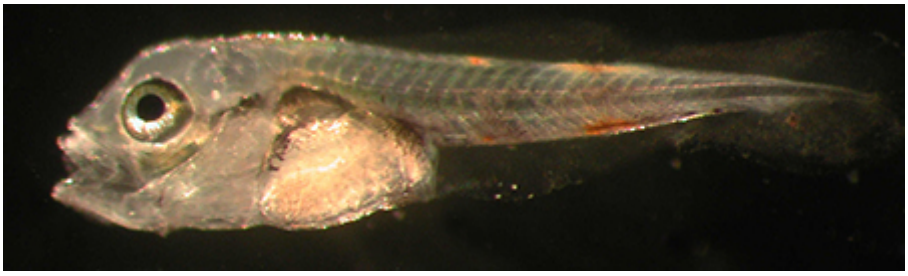
Do they need live prey?



Red drum can be weaned to dry diets earlier than many species.

The most common and successful feeding approach to raising a variety of marine fish larvae under culture conditions involves zooplankton such as rotifers (*Brachionus* sp.), followed by artemia. However, feeding live prey is generally considered labor-intensive, expensive, and of inconsistent nutritional quality. In addition, live food is difficult to maintain under culture conditions.

Formulated microdiets, which are easier to maintain and have a lower production cost than live prey, offer an alternative food source. Although the use of microdiets from first feeding has been generally unsuccessful, red drum larvae have been produced under culture conditions without zooplankton.

Previous studies

In general, studies have indicated that marine fish larvae reared with microdiets have lower growth and survival rates than those reared on live prey. This may be attributed to the poor development of the digestive system and limited digestive enzyme activity of the animals.

Exogenous enzymes

It has been suggested that larvae can utilize exogenous enzymes from live prey to aid in digestion or activate the zymogens (inactive enzymes) present in the gut, thus increasing digestion and growth rates. However, the mechanism through which exogenous enzymes act is not clearly understood.

Moreover, several authors have reported a lack of significant differences in the digestive enzyme activity of fish larvae reared on live prey and those that received formulated microdiets. These results suggest the low growth rates associated with microdiet utilization from the onset of first feeding might not be attributable to enzymatic deficiency.

Research at UTMSI

Successful weaning of red drum larvae to a microdiet has been achieved at the University of Texas at Austin's Marine Science Institute in Port Aransas, Texas, USA. In a standard protocol, live prey is used in conjunction with a microdiet for the first five days of exogenous feeding, and the microdiet alone thereafter. Although red drum can be weaned onto a dry microdiet earlier than many other species, they still require live food for proper development.

Multidisciplinary approach

In an attempt to eliminate the need for zooplankton in the rearing of red drum, a multidisciplinary approach evaluated the utilization of microdiets by first-feeding larvae. Additionally, the digestive enzymes present throughout development were identified and characterized. These results were subsequently used to develop *in vitro* assays for measuring protein digestibility and ingredient-mediated enzyme inhibition.

Microdiet development

Adequate protein sources were selected, and diet composition was tailored to the nutritional requirements and digestive capacity of the red drum larvae. Based on previous work and other published data, the authors developed four microdiets (Table 1). These included intact protein sources, as well as a balanced fatty-acid profile.

Lazo, Composition of experimental diets with varied levels of fish protein, Table 1

Ingredient	15% FPH	20% FPH	25% FPH	30% FPH
Casein	9.0	9.0	9.0	9.0
Menhaden Fishmeal	40.0	35.0	30.0	25.0
Hake protein hydrolysate	15.0	20.0	25.0	30.0
Yeast	5.0	5.0	5.0	5.0
Fish oil	8.0	8.0	8.0	8.0

Aqualip 95 (phospholipids)	3.0	3.0	3.0	3.0
Aquagrow (DHA:EPA:AA)	8.5	8.5	8.5	8.5
Vitamin and mineral premix	9.5	9.5	9.5	9.5
Attractants	2.0	2.0	2.0	2.0

Table 1. Composition of experimental diets with varied levels of fish protein hydrolizate (FPH – g/100 g dry weight.)

The diets were isonitrogenous (54 percent protein) and isoenergetic (21 kilojoules per gram), and contained 15, 20, 25 or 30 percent levels of fish protein hydrolysate. A commercial diet from Japan was used as a control.

Feeding trials

The feeding trail had three replicate tanks per diet. Rotifers were provided in addition to the microdiets for only the first three days following initiation of exogenous feeding.

Microdiet performance was evaluated by determining growth and survival. Additionally, at the end of the experiment, larvae were subjected to a commonly used challenge salinity test to evaluate their physiological condition.

Growth and survival

In the feeding trials, significant differences ($P < 0.05$) in growth were observed between the experimental diets and the control, except for the diet containing 15 percent fish protein hydrolysate (Table 2). No significant differences in survival or the challenge salinity test were observed among dietary treatments. Although not significant, there was a trend toward reduced growth with increasing dietary content of fish protein hydrolysate.

Lazo, Performance of red drum larvae fed experimental diets, Table 2

Test Diet	Final Std. Length[1]	Survival (%)	Condition Index[2]
Control	5.84 (0.39)	10.40 (3.09)	22.11 (01.64)
15% FPH	4.88 (0.21)	18.45 (9.32)	27.56 (13.84)
20% FPH	4.61 (0.12)	10.52 (4.19)	38.67 (12.23)
25% FPH	4.39 (0.06)	16.23 (6.44)	27.89 (10.88)
30% FPH	4.53 (0.10)	10.90 (4.32)	39.89 (16.69)

[1]Means of three replicates. [2] Lower numbers indicate better physiological condition.

Table 2. Performance of red drum larvae fed experimental diets.

Algal addition experiments

In previous experiments, the presence of algae in rearing tanks improved the performance of microdiets in the rearing of red drum larvae. To identify the mechanisms by which algae affected growth and survival, the influence of algae on digestive enzyme activity and ingestion rates was evaluated. Higher digestive enzyme activities were documented for larvae fed a microdiet in the presence of algae.

Ingestion measurement

A new technique based on the fluorescent labeling of protein sources in the diet measured the ingestion rates of the microdiets after rearing larvae in the presence or absence of *Isochrysis galbana*. The food ingestion of the larvae was sampled over a four-hour period on days 3, 4, 6, and 8 after hatching.

Due to high variability, there was no consistent trend in the average quantity of diet ingested by red drum reared with or without algae. However, on any given day after hatching examined (except day 6), the apparent total amount of diet ingested was significantly higher in the presence of algae. This was particularly the case three days after hatching.

Conclusion

Results from this U.S. study of red drum larvae point to a shift from the current paradigm for larval feeds, which proposes an insufficiency in digestive enzymes during early development as an explanation for the inability to satisfactorily raise marine fish larvae on microdiets alone. Evidence continues to accumulate for the further development of diets that can be adequately ingested, properly induce the secretion of digestive enzymes, and present nutrients in a digestible form.

(Editor's Note: This article was originally published in the April 2002 print edition of the Global Aquaculture Advocate*.)*

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