AQUA FOCUS

Feed deprivation increases the susceptibility of channel catfish to columnaris disease

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KEY POINTS

- **Two studies in channel catfish were conducted to evaluate the effect of withholding feed and its influence on columnaris disease, which is caused by *F. columnare*.**
- **After exposure to *F. columnare*, mortality was significantly higher in fish that were not fed for 7 or more days compared to fish that were fed.**
- **Juvenile channel catfish should be fed to satiation at least once every other day to improve resistance to columnaris disease.**

Introduction

Columnaris disease (Figure 1) caused by *Flavobacterium columnare* is a major disease in warm and cold water species of fish. In the U.S. channel catfish industry, it is considered among the top two bacterial pathogens, along with enteric septicemia of catfish (ESC). Oftentimes, columnaris and ESC (which is caused by *Edwardsiella ictaluri)* are seen concurrently on the same farm.

One strategy for managing ESC is withholding feed during initial stages of the disease. Fish congregate when they feed, which is believed to enhance transmission of *E. ictaluri*. Feed withholding has been practiced by producers to minimize the severity of ESC outbreaks and decrease death loss. However, feed withholding results in lost feeding days and, ultimately, in decreased growth.

FIGURE 1: Channel catfish fingerlings showing depigmentation of the skin, especially in the caudal (tail) region, typical of columnaris disease.

There is limited information on the practice of withholding feed and its influence on columnaris disease in channel catfish. In other animal species, however, it is well known that proper nutrition results in improved animal vigor, performance and disease resistance.

Studies on restricted feeding

Two studies have been conducted at the United States Department of Agriculture-Agricultural Research Service, Aquatic Animal Health Research Laboratory, to evaluate the effects of restricted feeding on the innate (natural) resistance to columnaris disease.

The first study was designed to determine the effect of short-term feed deprivation on innate resistance following challenge with *F. columnare*. The second study evaluated the effect of longer periods of feed deprivation on innate resistance and also established parameters that could be used to indicate feed deprivation in channel catfish.

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...food deprivation was associated with significantly higher mortality from columnaris disease compared to fish that were fed.

STUDY ONE

Two groups of channel catfish weighing 16 and 22 g, respectively, were used. The experiments were conducted in a temperature-controlled laboratory using flow-through 110-L aquaria. The fish were stocked at a rate of 20 fish per aquarium.

Fish in the two weight categories were randomly assigned to one of the following feeding schedules.

16-gram fish:

- *Not fed for 10 days before challenge*
- *Fed twice daily to satiation for 10 days*

22-gram fish:

- *Not fed for 3 days before challenge and for 10 days after challenge*
- *Not fed for 7 days before challenge and for 10 days after challenge*
- *Fed twice daily to satiation for 3 days before and for 10 days after challenge*
- *Fed twice daily to satiation for 7 days before challenge and for 10 days after challenge*

Fish from each feeding group were then challenged with *F. columnare* by intramuscular injection or they served as controls and were challenged with phosphate buffer saline.

Water flow in the aquaria was 0.6 L/min and photoperiod was maintained at 12:12 h light:dark. Water temperature averaged 26° C to 27° C (78.8° F to 80.6° F) and mean dissolved oxygen was 5 to 6 mg/L.

RESULTS / STUDY ONE

All fish — 100% — that were not fed for 10 days died following challenge, whereas mortality among fish maintained on feed for 10 days was 11.7% after challenge.

Results of the 3- and 7-day feed deprivation study in the 22-gram fish are presented in Table 1. Note that among fish deprived of food that were not challenged with *F. columnare*, none died.

Mortality from columnaris disease in 22-gram fish was significantly higher in fish that were not fed for 7 days (70%) then challenged with *F. columnare* compared to fish not fed for 3 days (11.7%) or 3- and 7-day fed fish (18.3 and 11.7%, respectively).

STUDY TWO

A similar experiment was conducted with fish averaging 36 g that were stocked at 40 fish per aquarium (triplicate aquaria per treatment). In addition, fish were examined for weight changes and physiological condition.

The three feeding regimens in Study 2 were used for 4 weeks before and for 2 weeks after challenge with *F. columnare* and were as follows:

STUDY ONE RESULTS **22-gram fish**

Feeding Regimen	Mean Cumulative Mortality (%)
Control (challenged with saline, not *F. columnare*)	
Non-fed, 3-day	0.0[c]
Non-fed, 7-day	0.0[c]
Fed, 3-day	0.0[c]
Fed, 7-day	0.0[c]
Challenged with *F. columnare*	
Non-fed, 3-day	11.7[b,c]
Non-fed, 7-day	70.0[a]
Fed, 3-day	18.3[b]
Fed, 7-day	11.7[b,c]

TABLE 1: Mortality in 22-gram catfish deprived of food for 7 days then challenged with *F. columnare*.

Note: Means with different superscript letters are significantly different ($P < 0.05$).

It is generally believed that poor nutrition results in decreased health and immunity.

36-gram fish:

- *No feeding for the duration of the study*
- *Feeding once every other day*
- *Feeding to apparent satiation once daily*

RESULTS / STUDY TWO

Significant changes occurred in the organ weight to body weight ratio and in physiological parameters, which were measured after 2 and 4 weeks of feed deprivation (Table 2).

Gut and hepatosomatic indices decreased in the non-fed fish at both 2 and 4 weeks. Blood glucose (39.5 and 40.3 mg/dL, weeks 2 and 4, respectively) and liver glycogen (1.7 and 1.8 mg/g, weeks 2 and 4, respectively) also significantly decreased in this group. Blood glucose and liver glycogen levels below 46 mg/dL and 2 mg/g, respectively, are indicative of feed deprivation in channel catfish. In contrast, values for these parameters remained relatively stable in fish that were fed daily or fed every other day (Table 2).

Results in the 36-gram fish were similar to the results in smaller fish: food deprivation was associated with decreased fish condition and increased mortality compared to fish that were fed. Cumulative mortality in the non-fed group was 78.3% (Table 2). Mortality in fish fed daily or fed every other day was only 0.0 and 1.7%, respectively.

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STUDY TWO RESULTS **36-gram fish**

Feeding Regimen	Gut Index (gut weight/ weight of fish x 100)		Hepatosomatic Index (liver weight/weight of fish x 100)		Liver Glycogen (mg/g)		Blood Glucose (mg/dL)		Cumulative Mortality (%)
	Week 2	Week 4	Week 2	Week 4	Week 2	Week 4	Week 2	Week 4	Week 6
Fed daily	3.9[a]	3.9[a]	1.3[a]	1.5[a]	46.5[a]	52.6[a]	67.5[a]	92.4[a]	0.0[a]
Fed every other day	3.9[a]	3.7[a]	1.3[a]	1.1[a,b]	45.1[a]	51.5[a]	82.8[a]	85.5[a]	1.7[a]
Not fed	2.7[b]	2.5[b]	0.6[b]	0.7[b]	1.7[b]	1.8[b]	39.5[b]	40.3[b]	78.3[b]

TABLE 2: Physiological results and mortality in 36-gram fish that received different feeding regimens.

Note: Means with different superscript letters are significantly different ($P < 0.05$).

Our study results also suggest that juvenile channel catfish should be fed to apparent satiation at least once every other day...

Summary

Results of these studies suggest that channel catfish that are not fed for 7 days or more in an environment where natural food is absent have an altered innate resistance to *F. columnare*, characterized by increased mortality upon exposure to this pathogen.

It is generally believed that poor nutrition results in decreased health and immunity. In catfish and other animals, immune cell (macrophage) function becomes impaired following periods of restricted feeding. Starvation has been characterized as a form of chronic stress that may lead to immunosuppression.

Although we did not measure stress parameters in our studies, fish that were not fed were shown to be highly susceptible to disease. This may indicate that one or more nutrients essential for maintenance of optimum immune function are lacking in feed-deprived catfish.

Our study results also suggest that juvenile channel catfish should be fed to apparent satiation at least once every other day to maintain weight, normal physiological parameters and proper immune function and to improve resistance to columnaris disease.

Klesius, P., Lim C. and Shoemaker C. 1999. Effect of feed deprivation on innate resistance and antibody response to *Flavobacterium columnare* in channel catfish, *Ictalurus punctatus*. *Bulletin European Association of Fish Pathologists* 19(4):156-158.

Shoemaker C., Klesius P., Lim C. and Yildirim M. 2003. Feed deprivation of channel catfish, *Ictalurus punctatus*, (Rafinesque), influenced organosomatic indices, chemical composition and susceptibility to *Flavobacterium columnare*. *Journal of Fish Diseases* 26:553-561.

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