Research Update 1989

CATFISH

FIRST IN RESEARCH UPDATE SERIES ON CATFISH

This is the first catfish research report published in a new publication series, entitled "Research Update," inaugurated in 1989 by the Alabama Agricultural Experiment Station. The new series is meant to promote timely reporting of research results dealing with a specific crop or commodity, with distribution to all producers of that particular commodity. In this case, the target audience is all Alabama catfish producers.

Other information about catfish production and latest recommendations are available from each county Extension Service office in Alabama.

Channel X Blue Hybrid Catfish Show Production Advantages

Twenty-eight interspecific hybrids from seven species of catfish have been produced and evaluated for growth rate. Channel catfish female X blue catfish male hybrids showed superior growth in the pond environment in AAES research. This hybrid had an average increase in body weight of 20 percent above that of channel catfish. Furthermore, the feed conversion of channel X blue hybrids was 11-14 percent more efficient than that of channel catfish. These growth and efficiency advantages could make a big difference in profitability of production, but the hybrid also exhibited other desirable traits in AAES tests.

Culture of the channel X blue hybrid could reduce losses of catfish due to oxygen depletion because this catfish proved resistant to critically low oxygen levels. When 90 percent of a channel catfish population succumbed to low dissolved oxygen, only 50 percent of the hybrids died. When 50 percent of a channel catfish population expired from deficiency of dissolved oxygen, only 10 percent of the hybrids died.

Channel X blue hybrid fingerlings were also more resistant to columnaris than channel catfish. However, there was no increased resistance to channel catfish virus injected into the test fish.

Fishing success in fee-fishing catfish ponds could be improved by stocking the channel catfish X blue catfish hybrid. These hybrids were more catchable by hook and line than their parent species, which did not differ. The channel X blue was also much easier to catch by seining than channel catfish.

The average dressout percentage for the channel X blue hybrid was higher, 64.5, than for the channel catfish, 61.2. The higher dressout percentage of the channel X blue hybrid may be related to its deep body conformation and small head.

The hybridization rate between the parent species has been variable, 0-100 percent in pens and 30 percent

ALABAMA AGRICULTURAL EXPERIMENT STATION AUBURN UNIVERSITY
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in ponds. This remains the major obstacle to the commercial production of channel X blue hybrid fingerlings. The use of crossbred channel catfish females increased the hybridization rate with blue catfish. Hatchability of hybrid eggs and viability of hybrid fry are as high as those of parental species.

Recent research has focused on overcoming these obstacles to hybridization. Various ovulating agents and inhibitors, such as human chorionic gonadotropin, carp pituitary extract, luteinizing hormone releasing hormone (LHRH), and pimozide, have been evaluated. LHRH in combination with pimozide resulted in the highest hybridization rates.

Several strains of blue catfish and channel catfish have been examined for their propensity for hybridization. Significant strain effects for hybridization rate and performance of the resulting hybrid were observed. Hopefully, this beneficial hybrid will soon be ready for utilization by commercial catfish farms.

Rex A. Dunham and R. O. Smitherman

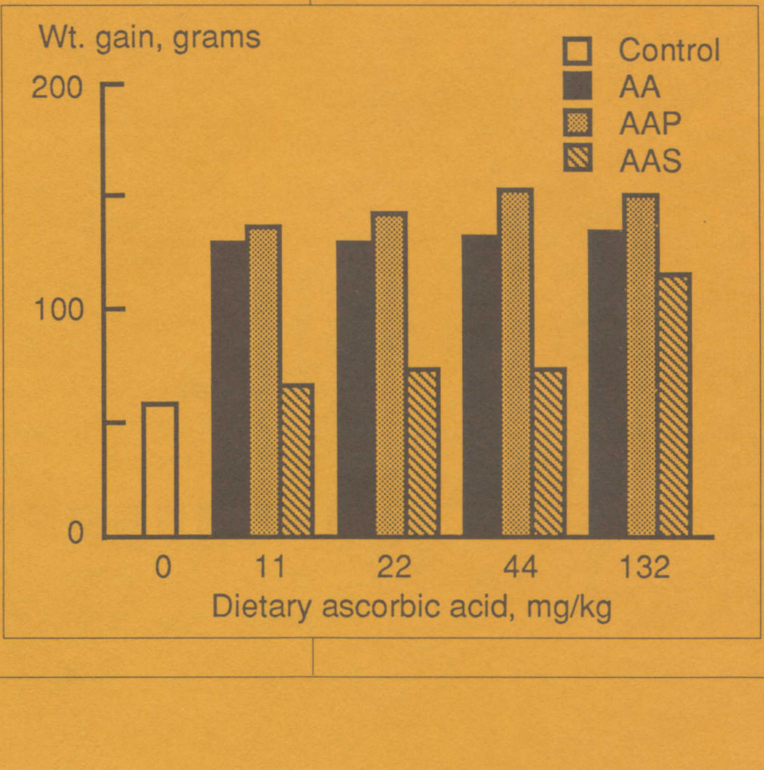
New Vitamin C Source for Fish Feeds

While most animals don't require vitamin C in their diet, fish are extremely sensitive to a deficiency. Without vitamin C, fish show reduced growth rate, physical deformities (crooked backs, etc.), slow wound healing, and reduced resistance to infections, environmental contaminants (nitrites, chlorinated hydrocarbons, etc.), and other stresses.

L-ascorbic acid is the vitamin C source used in commercial fish feeds, but there is a serious problem with this compound. It is sensitive to oxidation, and heat and moisture in feed processing destroy 40 to 60 percent of the amount put into the feed. Also, its half-life (time required for 50 percent to be lost) in fish feeds during storage is less than 90 days. Because of the large losses of ascorbic acid during processing and storage, new sources of vitamin C are needed for use in aquaculture feeds.

Phosphate and sulfate derivatives of ascorbic acid, which are relatively stable against oxidative deterioration, were examined in AAES research as potential sources of vitamin C for fish feeds. Ascorbic acid phosphate (AAP) and ascorbic acid sulfate (AAS) were compared with L-ascorbic acid (AA) for vitamin C activity for channel catfish. Each source of vitamin C was fed at four levels in purified diets under controlled environmental conditions.

As shown by the graph, fish fed no ascorbic acid (control) grew poorly. Those fed ascorbic acid sulfate also grew poorly and although growth improved as the dietary level increased, it never reached the growth rate of the fish fed L-ascorbic acid. Growth rate of fish fed ascorbic acid phosphate was equal to that of the fish fed L-ascorbic acid. This was true even at the lowest level fed, which is near the lower limit of the channel catfish's vitamin C requirement.



There were no deformities in the fish fed any of the dietary levels of L-ascorbic acid or ascorbic acid phosphate; however, over 50 percent of fish fed the control diet or diets containing 44 milligrams per kilogram[1] (mg/kg) or less of ascorbic acid sulfate had crooked backs. Only the highest dose of ascorbic acid sulfate (132 mg/kg) prevented deformities. The results show that ascorbic acid phosphate is equal to L-ascorbic acid in meeting the vitamin C requirements of channel catfish, but ascorbic acid sulfate has less vitamin C activity than the other compounds.

During extrusion processing of catfish feed, only 10 to 20 percent of ascorbic acid phosphate was lost, while 50 to 60 percent of L-ascorbic acid was lost. Because of increased stability during processing and high vitamin C activity, ascorbic acid phosphate will likely be a major source of vitamin C in aquaculture feeds in the future. This will allow more precise supplementation of fish feeds with vitamin C, providing a cost savings and increased assurance that the feed is sufficient in vitamin C.

[1] 1,000 milligrams = 1 gram = 1/28 ounce; 1 kilogram = 2.2 pounds.

R. T. Lovell

AAES Catfish Study Explains Winter-Kill

"Winter-kill" is a major cause of losses of commercially reared catfish. The name implies a causative relationship with the winter months; however, there may be a number of factors involved, including the lower temperatures and subsequent effect on the immune system of fish with inability to fight off invading pathogens. One manifestation of winter-kill is dark coloration and fungus infections of the fish's skin.

An AAES study that examined skin of infected fish gave an insight into how the mucus of the skin was produced and the nature of fungus infections. Goblet cells, which produce the mucus, are located at the surface and mid layers of the epidermis with openings distributed on the surface of the epidermis. The goblet cells produce mucin, which is released from the cells in tiny droplets. The mucin combines with water to form mucus. This mucus is a first line of defense against invading pathogens.

Light and electron microscopy were used to study fungus infections of catfish skin. Infected skin lacked the mucus layer that was normally present on the skin of healthy fish. Most of the epidermal cells in fungalions were necrotic. In some lesions the epidermis was completely lost and the dermis layer was exposed. Two species of *Saprolegnia* (water mold) were involved in the lesions and both penetrated the dermis layer. Pigment cells were decomposed and the pigment was scattered among the cell debris, which may account for the dark coloration associated with winter-kill.

In addition to the fungus infection, loss of the mucus layer and epidermis of catfish may result in a loss of body fluids. The inability to regulate osmotic pressure within the body may be the primary cause of the extensive mortalities associated with winter-kill.

W. A. Rogers and Dehai Xu

Omega-3 Fatty Acids in Catfish Increased by Diet Manipulation

There is convincing evidence that omega-3 polyunsaturated fatty acids (n-3 PUFA) in fish oils reduce risk of heart disease in humans by lowering cholesterol levels and prolonging clotting time of the blood. Marine fish have traditionally been associated with oils high in the n-3 PUFA. Cultured fish fed grain-soybean meal based feeds, however, have a fatty acid composition that is much lower in n-3 PUFA's than sea-caught fish; in fact, the fatty acid profile of farm-raised catfish is similar to that of grain-fed farm animals.

Because the fatty acid composition of fat in animals is influenced by the diet, a study was conducted to determine if the amount of n-3 PUFA's in catfish could be changed by manipulating the diet.

Four test diets were fed to channel catfish in 0.1-acre earthen ponds for a 12-week summer period. The control diet was a practical type catfish feed containing 50 percent soybean meal, 40 percent corn, 8 percent fish meal, and 2 percent vitamins and minerals. Three percentages of menhaden fish oil, 2, 4, and 6, were added to the basal diet replacing corn. Menhaden oil is high in n-3 PUFA, containing approximately 15 percent. At the end of the feeding period, the fish were analyzed for fatty acid composition and evaluated for taste and potential oxidative flavor deterioration in frozen storage.

Comparisons of catfish from the four test feeds with sea-caught salmon are given in the table. Cultured catfish fed a commercial type (control) feed contained much less n-3 PUFA than sea-caught salmon. However, adding 2 to 6 percent fish oil to a catfish feed increased the n-3 PUFA content to 38, 56, and 67 percent of that of wild salmon. This indicates that n-3 PUFA in cultured catfish can be significantly increased by dietary manipulation. Although n-3 PUFA content was increased, n-6 PUFA content was not reduced as much. The n-3/n-6 ratio in the catfish was increased to only 36 percent of that in the salmon.

Taste tests revealed that the catfish fed menhaden oil had a "fishy" flavor which intensified with amount of fish oil in the feed. This was considered undesirable for the normally mild-flavored cultured catfish. Fat content in the flesh of the catfish ranged from 6.6 percent in the control fish to 12.1 percent in the fish fed 6 percent fish oil. Iodine number, which indicates amount of unsaturation of fat, increased from 85 for the control fish to 103 for those fed 6 percent fish oil. The increase in body fat and fat unsaturation may increase the susceptibility of the fish to oxidative rancidity in frozen storage.

Comparison of Polyunsaturated Fatty Acid (PUFA) Contents of Catfish Fed Various Supplements of Menhaden Fish Oil and of Sea-caught Salmon

PUFA	Catfish				Salmon
	Control feed	Fish oil, 2%	Fish oil, 4%	Fish oil, 6%	
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Total	17.0	19.0	20.5	21.5	21
n-3	3.0	5.7	8.4	10.1	15
n-6	12.3	10.4	9.8	9.0	5
n-3/n-6 ratio	.2	.5	.9	1.1	3.0

Although n-3 content of farm-raised catfish can be increased by adding fish oil to feeds, the adverse effect on sensory quality of the fish makes this questionable at present. More information is needed, such as the amount of n-3 PUFA that must be consumed by various individuals to significantly reduce the risk of heart disease, before considering a feeding program to increase n-3 PUFA in catfish.

R. T. Lovell

Nighttime Pond Aeration Boosts Catfish Production

An AAES experiment compared the effects of emergency aeration and nighttime aeration on water quality and fish production. Results showed a considerable advantage in both production and efficiency with nighttime aeration. The bottom line was about double the return over emergency aeration management.

Six ponds were stocked with 4,000 channel catfish per acre and fed a commercial feed. A maximum feeding rate of 47 pounds per day was attained on July 21 and continued until fish were harvested October 24. Emergency aeration was used a few times in three ponds when dissolved oxygen concentrations were low. In the other three ponds, aeration was applied from midnight until 6 a.m. every night between May 30 and October 12. The aeration rate was equivalent to 1.5 horsepower per acre of aeration with a highly efficient, floating, electric paddlewheel aerator. Aerators were turned on and off by timers.

Dissolved oxygen concentrations in the early morning were much higher in the ponds with nightly aeration than in the ponds with emergency aeration only. The average dissolved oxygen concentration at 6 a.m. for all dates was 2.8 p.p.m. in emergency-aerated ponds and 4.5 p.p.m. in nightly aerated ponds.

Fish production data are summarized in the table. Harvest weight of fish in ponds with nighttime aeration averaged about 1,000 pounds per acre more than in ponds with emergency aeration. The stocking and feeding rates were identical for the two treatments. Greater production in ponds with nighttime aeration resulted from a better feed conversion ratio in these ponds (1.32 vs. 1.75). Better feed conversion in ponds with nighttime aeration resulted from higher dissolved oxygen concentrations between midnight and dawn. An economic analysis of the data gave net returns to land, management, and equity capital of $696 per acre for ponds with nighttime aeration and $363 per acre for ponds with emergency aeration only.

C. E. Boyd

Effects of Nighttime Aeration of Ponds on Catfish Performance

Variable	Nighttime aeration	Emergency aeration
Fish stocked/acre, no.	4,000	4,000
Fish harvested/acre, no.	3,939	3,808
Harvest weight/acre, lb.	4,288	3,258
Average weight/fish, lb.	1.09	0.86
Feed applied/acre, lb.	5,550	5,550
Feed conversion ratio[1]	1.32	1.75

[1] Pounds of feed per pound of fish production.

Gypsum Improves Water Quality for Catfish Farming

Ponds in certain areas of the catfish-farming region of west-central Alabama have high concentrations of total alkalinity and dissolved phosphate but low concentrations of calcium and total hardness. For example, a water sample from a well used to fill catfish ponds near Boligee had a total alkalinity of 189 p.p.m., a total hardness of 3 p.p.m., 1 p.p.m. calcium, and 0.7 p.p.m. dissolved phosphate. Excessive phytoplankton often develops in such ponds and dangerously high pH may result. Performance of eggs and larvae may not be good in catfish hatcheries supplied with water of low calcium concentration.

Such water quality problems may be solved by use of agricultural gypsum, AAES research results reveal. Gypsum treatment to increase total hardness to roughly the same concentration as total alkalinity lowered phosphate concentrations and reduced phytoplankton blooms and high pH in ponds which naturally had low hardness but high alkalinity. A gypsum concentration of 2 p.p.m. was necessary to increase total hardness by 1 p.p.m. Gypsum treatment also proved useful to increase calcium concentrations in water supplies for hatcheries.

Gypsum can be used to remove suspended clay particles from "muddy" ponds. Treatment rates of 250 to 500 p.p.m. of gypsum often reduced turbidity of pond water to less than one-fourth of original turbidity. Gypsum was less effective and slightly more expensive than alum for removing turbidity from pond water. However, it is safer to use than alum because it will not depress pH and it also has a lower residual action than alum.

Gypsum is fairly soluble in water, but best results came from a slurry made of 1 part gypsum to 10 parts water splashed or pumped over pond surfaces. Gypsum is not a "cure-all," but it did improve the specific water quality problems mentioned. Although it contains calcium, gypsum is not a substitute for agricultural limestone because it will not neutralize acidity.

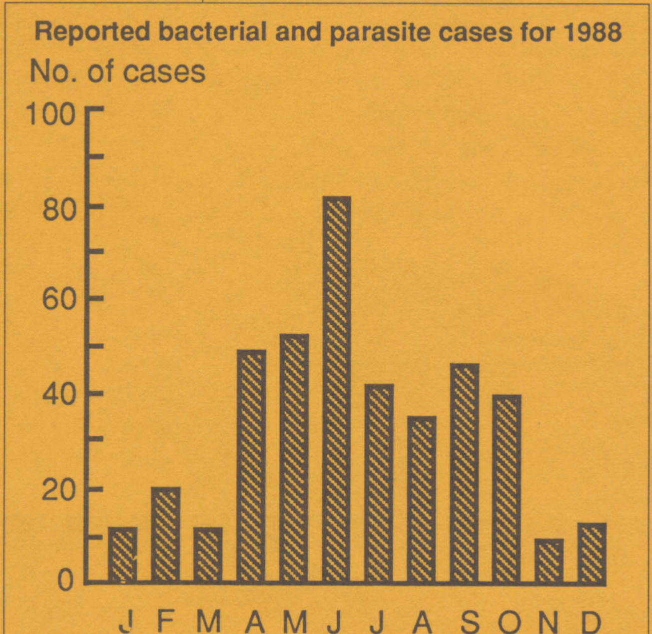
C. E. Boyd

Disease Outbreaks Show Seasonal Nature

Infectious disease outbreaks are related to the presence of pathogenic organisms and a susceptible host, and are usually related to some stressful condition. Many disease-causing organisms are common in ponds. Several diseases affect channel catfish and may cause high mortalities.

The seasonality of disease development was established by evaluation of cases received by the Southeastern Cooperative Fish Disease Laboratory at Auburn. As illustrated by the graph for the 1988 calendar year, the greatest number of cases occurred in June, but there were large numbers of cases from April through October. Major bacterial and parasitic diseases identified are described here:

Motile aeromonas septicemia (MNS), a bacterial disease caused by *Aeromonas hydrophila* affects channel catfish and other warmwater species. The optimum temperature for MNS is 68 to 86°F, and outbreaks usually occur when water temperatures are in this range.



Columnaris disease is caused by the bacterium *Flexibacter columnaris*, and its optimum temperature range is also 68 to 86°F. This disease occurs in spring, summer, and fall.

Edwardsiellosis, caused by *Edwardsiella tarda*, and enteric septicemia of catfish, caused by *Edwardsiella ictaluri*, occur when temperatures are 86° and 72-82°F, respectively.

Among the parasitic infections, *Ichthyopthirius multifiliis*, commonly called "ich," is considered a "cool water" pathogen and occurs in spring when temperatures range from 68 to 76°F. Anchor worm (*Lernaea elegans*) is common during warmer temperatures of late spring through summer.

Viral diseases also occur in a specific temperature range. Channel catfish virus disease affects catfish fry and fingerlings and is most devastating in summer when water temperatures average 82°F. High nitrite levels may be detected in culture ponds in spring and fall. This causes a condition called methemoglobinemia, or "brown blood" disease, and may predispose fish to bacterial infections.

Y. J. Brady

Poor Pond Environment Promotes Catfish Diseases

Many of the common infectious diseases of catfish are closely related to physical and chemical features of the pond. Bacteria and parasites that cause catfish diseases are usually present in the water, mud, or fish in the pond. Typically, however, a disease outbreak does not occur unless something happens to trigger the disease. Moving catfish to a different pond is an example of a common "trigger" event that can result in a disease outbreak.

Nitrite is a natural product that occurs in fish ponds because of the bacterial metabolism of ammonia excreted from fish. Nitrite toxicity causes a disease which can be easily diagnosed by the brown color of the blood in affected fish, but the toxicity of nitrite varies depending on characteristics of the water, such as pH, salinity, and temperature. In AAES laboratory experiments, catfish exposed to nitrite at a concentration of 6 milligrams per liter (mg/l) were killed with a lower dose of *Aeromonas hydrophila* than that required to kill control fish. *Flexibacter columnaris* infections occurred spontaneously in catfish exposed to 5 mg/l nitrite for 7 days, while none of the control fish became infected. These results indicate that sublethal concentrations of nitrite can cause increased susceptibility to bacterial diseases.

Perhaps the most common environmental problem leading to diseases of catfish is low dissolved oxygen (DO) concentrations. Unless adequate supplemental aeration is available, low DO will often result in the sudden death of most catfish in an intensively managed pond. This is why most catfish farmers using high stocking rates have aerators available. A lesser known problem caused by low DO is the greater chance that bacterial diseases will occur if DO becomes low. Laboratory experiments at Auburn in which catfish were exposed to low concentrations of dissolved oxygen have demonstrated that bacterial infections in catfish are triggered by low DO. The same result was evident from monitoring of fish in ponds after DO depletions. Even if the DO concentration is not low enough to cause fish deaths, the low DO can cause catfish to be weakened and become infected by the bacteria during the period of low DO.

Perhaps the overwhelming factor influencing bacterial diseases of catfish is water temperature. Catfish have a body temperature that is the same as the water temperature, so they are greatly influenced by temperature. In the spring, bacterial infections are more common than at other times, at least partly because winter temperatures slow the immune system of the fish. During the summer, diseases develop faster than at other times of the year because the metabolic rate of both fish and pathogens is increased. Consequently, rapid diagnosis and timely corrective measures are important because of the rapid progression of diseases.

John M. Grizzle

Vaccination Offers Encouragement for Control of Enteric Septicemia

During the last 10 years, enteric septicemia (ESC) has become the most serious infectious disease problem in cultured channel catfish. Also known as "hole-in-the-head," ESC is caused by the bacterium *Edwardsiella ictaluri*. In recent years, ESC has been diagnosed in over 30 percent of all catfish disease cases. It is estimated that the disease costs catfish farmers millions of dollars each year.

Research at the AAES has emphasized control of ESC by vaccination. Results show that channel catfish exposed to the killed bacterium for 1 to 2 minutes in a bath will develop immunity. Channel catfish were vaccinated (immersed) in late October and stocked into 22-square-foot net pens in a pond for overwintering. The level of antibody, a measure of immunity, was determined at 30-day intervals. It was found to increase throughout the winter and decline in the spring. A natural exposure of the vaccinated fish in May following primary vaccination served as a booster vaccination and increased the immune response fourfold.

Although an ESC vaccine is not yet available for catfish growers to use, results are encouraging and indicate that such a vaccine can be used as a disease management tool.

John A. Plumb

Support Catfish Research

Funds appropriated by the Alabama Legislature provide the major financial support for Alabama Agricultural Experiment Station research. Hatch funds from the U.S. Government also represent an important funding source. Since these funds are limited, however, many areas of research would go unsupported except for financial support from various' granting agencies, commodity groups, and other friends of the Experiment Station. Contributions of these supporters to the AAES programs of research are acknowledged with gratitude.

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