THAD COCHRAN

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THAD COCHRAN NATIONAL WARMWATER AQUACULTURE CENTER
127 Experiment Station Road
P.O. Box 197
Stoneville, MS 38776-0197
Phone: (662) 686-3242 FAX: (662) 686-3320
www.msstate.edu/dept/tcnwac

Use of Corn Gluten Feed in Catfish Feeds

Ed Robinson and Menghe Li

Summary: *Corn gluten feed (CGF) is a byproduct of wet milling corn that typically contains about 21% crude protein and is generally competitively priced. Based on its nutritional and physical characteristics, it appears to be a suitable feedstuff for use in catfish feeds. Research has demonstrated that channel catfish can efficiently utilize CGF at levels up to 50% of the diet without adverse effects on palatability, weight gain, and feed conversion. In addition, body composition data indicate that CGF may be beneficial in reducing fattiness of channel catfish and improving carcass yield by reducing the energy content of the diet.*

Hopefully this article will clear up some of the confusion that seems to surround the use of corn gluten feed (CGF) as a feedstuff in catfish feeds, particularly in regard to the quality of diets containing CGF. Even though catfish feeds have historically been based on soybean meal and corn, other feedstuffs can be used without negatively impacting weight gain and feed conversion if they are used properly. In fact, alternative feedstuffs must be used if feed cost is to be reduced. First and foremost, regardless of what alternative protein/energy source may be proposed for use in catfish feeds, the resulting feed must be balanced in respect to nutrient and energy requirements. That is, the feed must meet the nutrient and energy needs of the catfish and it must be in a form that is palatable and digestible. The point is that when new feedstuffs are used in a catfish feed they are not just included without regard to their nutrient and energy contributions to the overall nutritional needs of the fish, and what they may lack in that regard is accounted for by adding other feedstuffs or ingredients to ensure that no deficiencies exist in the final feed. The impact of including a new feedstuff in a feed on pellet quality, palatability, and digestibility is also considered. Taking all these factors into account, there are numerous feedstuffs and feed ingredients that are perfectly acceptable for use in catfish feeds including CGF.

Corn gluten feed is a byproduct of refining corn by the wet milling process that separates the corn kernel into

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Use of Corn Gluten Feed in Catfish Feeds
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starch, oil, bran, and protein. It typically contains about 21% crude protein, 2% fat, 10% fiber, and 8% ash and it is usually competitively priced relative to other feedstuffs. Corn gluten feed should not be confused with corn gluten meal (CGM), which is also a byproduct of the wet milling process. Corn gluten meal contains over twice the protein of CGF, but it also contains a high level of the yellow pigments (lutein and zeathanxin) that may impart a yellow coloration to channel catfish flesh when fed for an extended period of time. Thus CGM is not recommended for use in catfish feeds. In contrast, CGF contains a low level of yellow pigments and can be included at relatively high levels in catfish feeds without imparting yellow pigmentation to edible flesh. Traditionally CGF has been used as an ingredient in livestock and pet foods, and it has been used effectively in tilapia and catfish feeds.

The use of CGF in catfish feeds is based on a study that was conducted at Stoneville in which three 32%-protein diets containing 0%, 25%, or 50% CGF were tested. Corn gluten feed replaced corn and part of the soybean meal. Channel catfish fingerlings (average weight: 120 pounds/1000) were fed all they would eat once daily for a 147-day growing period. No differences were observed in feed consumption, weight gain, feed conversion ratio, survival, or fillet protein concentration among fish fed the test diets. The fish gained on average about one pound and feed conversion ratio was about 1.7 for all groups. Fish fed diets containing 25% and 50% CGF exhibited a lower level of visceral fat and a higher carcass yield than fish fed the control diet without CGF. The diet containing 50% CGF resulted in a lower level of fillet fat and a higher level of moisture than the control diet. These differences can be attributed to the fact that CGF contains less energy than corn. There were no visible differences in the coloration of skin or fillet of channel catfish fed diets with and without CGF.

In conclusion, research has demonstrated that channel catfish can efficiently utilize CGF at levels up to 50% of the diet without adverse effects on palatability, weight gain, or feed efficiency. In addition, CGF may be beneficial in reducing fattiness of channel catfish and improving carcass yield by reducing the digestible energy to protein ratio of the diet. Corn gluten feed is a good feedstuff for use in catfish feeds, and because of its lower energy content relative to corn its use in catfish feeds can actually improve feed quality rather than decrease feed quality as some have suggested. In addition, it is presently priced favorably which allows for considerable cost savings.

A Liquid Oxygen Calculator for Fasted Channel Catfish

Phillip Pearson[1], Rachel Beecham[2], and Doug Minchew
[1] USDA Agricultural Research Service, [2] Mississippi Valley State University

A liquid oxygen (LOX) calculator has been developed by scientists at Mississippi State University, Mississippi Valley State University, and the USDA Agricultural Research Service. The LOX Calculator uses results of scientific experiments on catfish respiration to estimate oxygen (O_2) requirements for fasted channel catfish confined in grading nets or live haul tanks. Entry of ten variables provides estimates of O_2 consumption with respect to time and biomass, the liquid oxygen equivalent of the volume, liquid oxygen expense, and the ratio of liquid oxygen expense to revenue.

The LOX Calculator can be used to determine if a diffused oxygen aeration system can provide adequate O_2 during a catastrophic low dissolved oxygen event. Live haulers can use the LOX Calculator to find out if they carry enough liquid oxygen to keep fish alive if they experience a delay due to a break down or wait at a processing plant. The liquid oxygen expense as a percent of gross revenue is also provided.

For example, a producer invests $12,000 in a LOX storage container and a trailer-mounted diffused oxygen aeration system having a LOX capacity of 135 gallons, a maximum O_2 flow rate of 1,000 SCF per hour, and diffusers with an oxygen transfer efficiency of 10%. He estimates that 25,000 pounds of fasted channel catfish (1.5 pound average weight) are in an 8 X 50-foot grading net. The catch will be held for 12 hours in 80° F water 4 feet deep.

Based on information in the LOX Calculator Results, he decides that his diffused oxygen aeration system has

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Use of Non-fat Dry Milk in Catfish Feeds

Ed Robinson and Menghe Li

Non-fat dry milk (NFDM) is a nutrient-dense product derived by the removal of water from defatted milk. NFDM typically contains 34-37% crude protein, 0.6-1.25% crude fat, and 50-52% lactose. The protein is of high quality, containing considerable quantities of essential amino acids and is highly palatable and digestible to many animals. Though NFDM is an excellent nutrient source, its use is limited in certain animals because of its high lactose content.

A typical soy-based catfish diet was used as the control diet to which varying levels of NFDM was substituted for soybean meal (on a protein basis) resulting in five diets containing 0, 5, 10, 15, and 20% NFDM. All diets met or exceeded nutrient requirements for catfish and were manufactured as extruded floating pellets. All dietary ingredients with the exception of the NFDM were from commercial sources.

Channel catfish (mean weight: 167 pounds/1000) were stocked into 25, 1/10-acre ponds at a rate of 6,000 fish/acre. Five replicate ponds were used for each treatment. Fish were fed the experimental diets once daily to apparent satiation for 158 days.

At the end of the study, 30 fish ranging in sizes from about 1.0 to 1.5 pounds were taken from each pond to determine processing yield. Visceral fat content and yields of carcasses and shank fillets were determined as percentages. After the fish were sampled for processing, all fish were harvested, counted, and weighed.

There were no differences in feed consumption, feed conversion, weight gain, or survival of fish regardless of dietary treatment (Table 1). These data demonstrate that NFDM is palatable to catfish and provided for excellent growth. Visceral fat decreased in fish as the level of NFDM increased in the diet, but carcass and fillet yields were unaffected. The decrease in visceral fat is likely due to a reduction in the digestible energy levels in diets containing NFDM. Even though lactose was apparently not utilized by the fish, no noticeable adverse effects were observed as a result of the increasing levels of the sugar in the diet, which can cause gastric distress in some animals. There were no differences in the proximate composition of catfish fillets fed the various diets. However, there was a trend that as the NFDM level increased fillet fat generally decreased.

In conclusion, it appears that NFDM can be included in catfish diets at relatively high levels without adversely affecting fish performance. However, these data should be considered as preliminary since they are based on a single study.

Table 1. Means of production and processing characteristics, and fillet nutrient composition of channel catfish fed diets containing various levels of non-fat dry milk for one growing season in ponds. Means in each row followed by different letters were statistically different at the 5% probability level.

	Non-fat dry milk (%)				
	0	**5**	**10**	**15**	**20**
Feed consumption (pound/fish)	2.27	2.27	2.38	2.28	2.23
Weight gain[1] (pound/fish)	1.19	1.23	1.29	1.25	1.17
Feed conversion (feed/gain)	1.91	1.85	1.85	1.84	1.91
Survival (%)	95.0	91.6	90.5	93.4	93.7
Visceral fat (%)	3.76 a	3.29 ab	3.31 ab	3.12 b	2.88 b
Carcass yield[2] (%)	66.0	67.4	67.1	65.7	66.3
Fillet yield (%)	35.8	36.7	36.4	35.1	35.7
Fillet protein (%)	17.1	16.9	16.4	17.1	17.2
Fillet fat (%)	6.88	7.07	6.50	5.82	6.03

[1] Average initial fish weight was 167 pounds/1000 fish.
[2] Yield of dressed carcasses without head and viscera, but with skin.

Tolerance of Channel Catfish Fry to Abrupt pH Shifts

Chuck Mischke and David Wise

It is common to have high unaccounted mortality when fry are stocked into nursery ponds; survival from fry to fingerlings varies from 0 to 100%. The first 30 days of pond production is very important to overall survival of fry. Because of the small size of fry, mortalities are difficult to detect, and most unaccounted mortalities probably occur during this time.

Unaccounted mortalities during the early stages of pond culture seriously compromise production efficiency. The extent of these early mortalities is not known until harvest, and if mortalities are high, the result is wasted pond space over an entire growing season.

Although we have been improving pond fertilization practices to enhance natural food productivity in nursery ponds, survival remains variable. Because fry survival cannot be completely attributable to fertilization practices and zooplankton abundance, there may be issues with handling and stocking methods currently used.

Most farmers in Mississippi follow the recommendation to temper fish at less than 1º F per minute if water temperatures between the hatchery and pond differ by more than 5º F and will routinely check temperatures when stocking fry. However, the effect of abrupt pH changes on fry is not known.

The pH range of 6.5-9.0 is commonly cited as the optimum for growth and health of most freshwater aquatic animals, and most waters used for aquaculture have pH values within this range, so direct toxic effects from extremes of pH are seldom encountered. It is assumed that pH problems *per se* are uncommon in channel catfish ponds in the Mississippi delta, because the pH range usually does not rise much above 9.0, and the most important practical aspect of pH in catfish farming is its effect on the ionization of ammonia.

However, when stocking fish, fish are transferred relatively quickly from one water to another. Hatchery water pH may be 7.5 and pond water may be 9.0 – even though both pH values are within the optimal range for catfish culture, it is not known if fry can handle an immediate change of 1.5 pH units. Even though the pH of the water may be within the range considered optimal, abrupt changes may cause death. We conducted studies to determine the tolerance of channel catfish fry to pH changes. The tests were set up as a short-term (24 hours) acute toxicity test, and the 24-hour LC10, LC50, and LC90 values were determined.

In the first study, catfish fry showed a high tolerance for decreasing pH values, but a relatively low tolerance for increased pH values (Fig. 1). With a beginning pH of 8.2, fry tolerated an abrupt decrease of 4 pH units before mortalities were observed. However, a relatively small increase of less than 1 pH unit caused significant mortalities.

This shows that increasing pH should be more of a concern than decreasing pH, at least for the short term. Unfortunately, pond waters are commonly higher in pH than hatchery waters because of photosynthetic activity. Increased ammonia levels would exacerbate the problem. We attribute the mortality in this study directly to pH, but with significant ammonia levels in ponds, ammonia toxicity would lower the tolerable pH shift for the fry.

Because it appears that increasing pH levels are of most concern, the second

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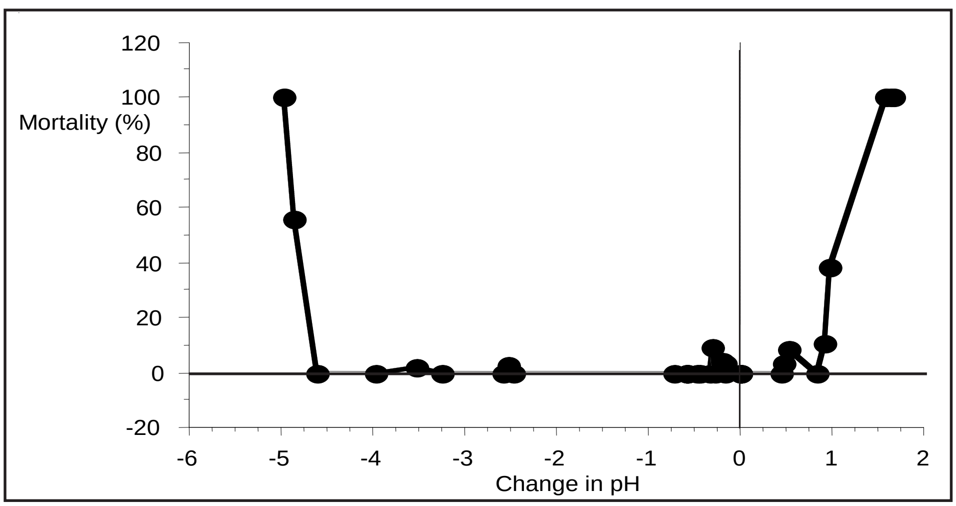

Figure 1. Effects of pH change on fry survival. Graph represents survival after 24 hours with a starting hatchery pH of 8.2.

study was conducted to concentrate on the effects of increasing pH on survival. The LC10, LC50, and LC90 values were calculated (Table 1). At a 0.7 pH unit increase, mortality of 10% occurred, and a 1.4 pH unit increase caused 50% mortality.

Although most water used for catfish culture is well buffered, pond pH still fluctuates significantly in these fertilized ponds. Based on the results of this study, attention to pH is important, and fry should be tempered if the pond pH is more than 0.5 units higher than the hatchery water pH. Stocking in the morning may be helpful with ponds that have large fluctuations in pH. By monitoring pond pH at stocking, some of the variability in fry survival may be eliminated.

Table 1. Estimated pH change (increase) without acclimation that will kill 10, 50, or 90% of 8 day post hatch channel catfish fry.

Lethal Concentration	Estimate	95% CI
LC10	0.7	0.58 – 0.80
LC50	1.4	1.38 – 1.50
LC90	2.2	2.08 – 2.30

Karmex® and Direx® Products Receive Section 24(c) Registration

Jimmy Avery

In January 2008, DuPont™ and the Catfish Farmers Registration Corporation entered into an agreement that allows for a FIFRA Section 24(c) Special Local Needs registration for "qualified farmers" to purchase and use Karmex® DF, Karmex® XP, or Direx® 4L to control macroalgae responsible for production of off-flavor compounds in commercially operated catfish ponds in Alabama, Arkansas, Mississippi, Louisiana, and Texas and commercially operated freshwater ponds for hybrid striped bass production in Texas. Farmers may qualify under this agreement if: 1) they have a current Private Applicator Certificate, 2) have signed and submitted an *Acknowledgment and Release* form, and 3) are a member of Catfish Farmers of America.

If you plan to purchase any of these products during 2008 and have not received an application packet, contact your state Extension Aquaculture Specialist, state agriculture regulatory agency, or the Catfish Farmers association in your state. They should be able to provide you with the *Acknowledgment and Release* form and the state-appropriate *Supplemental Labels*.

You will be asked to provide your Private Applicator Certificate number on the *Acknowledgment and Release* form. If your Certificate has expired, contact your local Extension Service office concerning the next available training. These trainings are typically held during the spring in county Extension Service offices across the state. If you have missed the training in your local office, ask about available trainings in adjacent counties.

There is a question on the form concerning the quantity of Karmex® DF, Karmex® XP, or Direx® 4L purchased. Since you are filling out this form prior to actually purchasing any product, you will need to estimate the amount of product you will purchase during the 2008 calendar year. This estimate should be based on the application rate as stated on the *Supplemental Labels* and prior use experience. It is important that this estimate be as accurate as possible since the combined estimated usage for the five states will be reported at the end of the 2008 calendar year.

Once you have completed the *Acknowledgment and Release* form, return it to the address below. Ms. Bridges will be able to confirm your membership status with Catfish Farmers of America.

Catfish Farmers Registration Corp.
1100 Hwy 82 E., Suite 202
Indianola, MS 38751
Attn: Sissy Bridges

2007 Aquatic Diagnostic Laboratory Summary Report

Lester Khoo, Pat Gaunt, and Michael Mauel

The Aquatic Diagnostic Laboratory is dedicated to the success of Mississippi's commercial catfish industry through service, research, and teaching. Our staff and fish health professionals strive to support the industry's efforts to produce a high quality, economical, and profitable product. Our goals are derived from the needs of the industry and aimed at developing management strategies for controlling the impact of diseases that effect profitability. These goals can only be accomplished through mutual respect, cooperation, and the maintenance of a close supportive relationship with our clients.

Diagnostics

In 2007, the Aquatic Diagnostic Laboratory (ADL) at Stoneville received a total of 999 fish diagnostic cases submitted by farmers and 145 research submissions (Table 1). These cases were received from 97 different farms. This is an 18% increase in the number of submissions over the 845 cases in 2006. There were 1,117 water quality samples that were analyzed representing a 17% increase over the 954 samples received in 2006.

Individual case submissions represent a composite sample of fish collected from a single pond. The numbers reported are derived solely from submissions processed by the ADL and do not necessarily reflect actual disease incidence in the field. Routine diagnostic procedures include evaluation of gill clips and skin scrapes for parasites, external and internal examination for signs of disease, bacterial and viral cultures, histopathology, and water quality evaluation. The ADL works closely with MAFES fish health professionals to offer treatment recommendations, monitor disease trends, provide surveillance for new and emerging diseases, provide field service investigation, and maintain a database of epidemiologic information on diseases of catfish. The ADL supports the research efforts of other NWAC units, including MAFES, MSU-Extension Service, College of Veterinary Medicine, and USDA/ARS Catfish Genetics Research Unit. Furthermore, the laboratory provides an outlet for the dissemination of information gained from research efforts back to producers.

Bacterial diseases again dominated the number of cases submitted. Columnaris as a single disease accounted for 102 cases but in combination of multiple diseases was seen in 429 submissions, a 3% increase from the previous year. There were 124 cases of Enteric Septicemia of Catfish (ESC) by itself and in combination with other diseases was seen in 375 submissions, a 9% increase. The continued increase in the last couple of years may be attributable to the recent introduction of the antibiotic, florfenicol, which is labeled for the control of ESC and also has a conditional approval by the FDA for use in control of Columnaris disease. It is dispensed by a Veterinary Feed Directive order from a licensed veterinarian and producers are encouraged to submit fish immediately if they suspect disease is occurring in a pond, and if they intend to use *any* medicated feed. The seasonal incidence of these diseases together with Saprolegnia and Proliferative Gill Disease (PGD) is presented in Table 2.

Proliferative gill disease remained the most commonly diagnosed parasitic disease at 18.4% (approximately the same as in the previous years). The other parasitic diseases *Ichthyophthirius multifiliis* (Ich) was only 0.6% which was about the same as in 2006 (0.8%), while *Bolbophorus* trematode cases comprised 1.5% of cases submitted, which was a slight increase from the previous year (0.7%). Farmers are encouraged to continue surveillance efforts and to control ram's horn snails (intermediate host of the parasite) with lime or copper sulfate, particularly if pelicans are visiting their ponds. *Bolbophorus* trematodes are capable of killing fingerlings and increasing susceptibility to ESC, as well as decreasing feed consumption in larger fish.

Saprolegnia was seen in 8% of the cases (approximately the same in 2006 – 8.4%). The number of channel catfish virus (CCV) disease cases decreased again to 2.0% from 9.2% in 2005 and 5.9% in 2006. Anemia cases increased to 10.7% of the cases and Visceral Toxicosis of Catfish (VTC) was 1.3% of cases submitted.

We are here to serve the industry and encourage producers to continue to take advantage of the diagnostic services offered.

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Research Highlights

The antibiotic florfenicol (Aquaflor®) has been granted conditional approval for use in catfish to control mortality associated with Columnaris. The drug's sponsor, Schering–Plough Animal Health, has funded new studies to evaluate the effectiveness of florfenicol against columnaris infections. The results of these trials will be submitted to the FDA as a component of the drug approval application process against this disease agent.

The faculty at the ADL are involved in these studies as well as other studies to increase our understanding of both *Edwardisellia ictaluri* and *Flavobacterium columnare* in the pond environment. Hopefully, this will allow for predicting outbreaks and better management schemes for these diseases.

Since the discovery of the association of botulinum type E toxin with VTC, research has continued on this disease, and we would like to continue to encourage farmers to bring suspect VTC fish to the Aquatic Diagnostic Laboratory. Ongoing VTC research requires a supply of blood from affected fish and bringing in fish would be a tremendous aid. It will also give us a better idea of the incidence of the disease and allow us to collect pond information that might help in elucidating the source of the toxin.

Molecular methods have been developed to ascertain the concentration of *Henneguya ictaluri* in pond water. This relatively quick method may be used a management tool to ascertain if it is safe to stock fish in the pond.

We are also continuing research into anemia that appears to be increasing in incidence and occurring over a broader range of temperatures. Since the successful initial trials using parenteral iron, there has been yet another separate trial looking at both parentral and limited enteral iron supplementation. The former method yielded similar results to the earlier trials but the enteral route yielded mixed results.

Table 1. Trends in disease diagnosis as a percentage of diagnostic case submission over time.

Disease	Average	2007	2006	2005	2004	2003	2002	2001	2000	1999
Columnaris	45.5%	37.5	68.4	49.4	40.9	44.7	44.5	37.2	42.6	45.5
ESC	37.7%	32.8	56.5	31.1	30.8	34.7	39.8	36.4	33.5	41.2
PGD	18.1%	18.4	17.8	8.4	10.7	10.8	16.3	20.1	29.8	30.0
Saprolegnia	7.7%	8.0	8.4	4.0	3.7	5.3	10.1	10.4	10.5	8.7
CCV	6.0%	2.0	5.9	9.1	10.8	8.9	5.8	7.3	2.3	1.8
Anemia	5.1%	10.7	4.9	4.6	2.1	5.2	5.3	5.0	4.9	2.8
Ich	1.7%	0.6	0.8	1.3	5.0	0.5	2.2	1.8	2.7	0.7
Bolbophorus	2.6%	1.5	0.7	3.4	2.6	1.1	2.0	4.4	5.6	1.5
VTC	1.9%	1.3	3.1	0.9	3.2	3.7	2.0	2.5	-	-
No Pathogens	17.2%	17.1	20.3	12.8	20.8	18.3	16.2	19.2	15.0	15.2
Number of Cases	1,228	1,144	845	607	778	832	1,057	1,602	2,189	2,007

Table 2. Seasonal incidence of major catfish diseases in 2007.

Disease	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
Columnaris	1	2	42	84	50	16	65	18	100	35	6	10	**429**
Saprolegnia	3	21	32	20	1	0	0	0	0	1	2	11	**91**
PGD	1	4	35	94	36	8	3	9	9	5	0	6	**210**
ESC	0	0	6	21	60	28	84	21	100	50	1	4	**375**
Anemia	0	1	1	4	8	29	16	10	23	21	5	4	**122**
Water Temp (F)	50	50	65	67	65	79	86	86	88	80	68	56	

U.S. Farm-raised Catfish Industry Suffering More Than Other U.S. Livestock Industries

Terry Hanson

The recent NWAC Newsletter entitled "Feed Price Risk Management Considerations for Catfish Producers" (March 2008) focused on how U.S. grain markets have affected catfish feed prices. Other U.S. livestock industries are being adversely affected as well, but not to the extent that the U.S. farm-raised catfish industry will be affected. In this article, we look at why the collateral effects of ethanol policy and other recent grain market shocks have impacted the U.S. farm-raised catfish industry much more severely than other U.S. livestock industries.

Feed cost as a percent of total variable production costs is greater for catfish production than for other U.S. livestock industries (Figure 1). The percent of variable costs that feed represents for catfish production has risen from 43% in 2000 to 52% in 2007 compared to an increase of 22% to 35% for hogs and 15% to 21% for finishing beef for the same time period. (Poultry production costs could not be obtained due to the industry's vertical integration and proprietary nature).

Clearly, as corn and soybeans are major components of these livestock's feed ration, increased grain prices have impacted the channel catfish industry more than it has the beef and hog industries.

The percent of livestock imports as a percentage of total livestock sales in the U.S. is greater for catfish than any other livestock (Figure 2). The percent of U.S. catfish sales accounted for by imported frozen catfish fillets has increased from 4% in 2000 to 36% in 2007. Comparatively, the beef industry has had a narrow range of 7% to 9% of U.S. beef sales coming from overseas for this same period; the hog industry has had a decrease from 5% to 4% during this time period; and less than 0.00001% of poultry products sold in the U.S. comes from overseas. Thus, the trend of catfish imports into the U.S. is clearly increasing quickly in comparison to the rates of imports for other U.S. livestock industries.

What does increasing the share of U.S. catfish sales from imports mean to the U.S. catfish industry? To pass on the increase in catfish production costs due to feed price increases would raise the price of the catfish product in the market place, and allow constant priced imported catfish to become relatively less expensive. The result would be a further eroding of sthe U.S. catfish industry's market share in the U.S. In comparison, other U.S. livestock industries and supply chains can pass a greater proportion of the increased feed price on as there is much less imported product waiting to take market share away through importation of a relatively less expensive beef, hog, or poultry product.

Thus, the U.S. farm-raised catfish industry is presently in a dire situation. It could be argued that the industry's unexpected fall in round weight processed (a whopping 25% decrease from 2003 to 2007) could be an unintended consequence of the U.S. ethanol policy. Consequently, it has been suggested that one way to help avert further devastation to this unique and largest aquaculture industry in the U.S. is an emergency feed assistance program for catfish farmers.

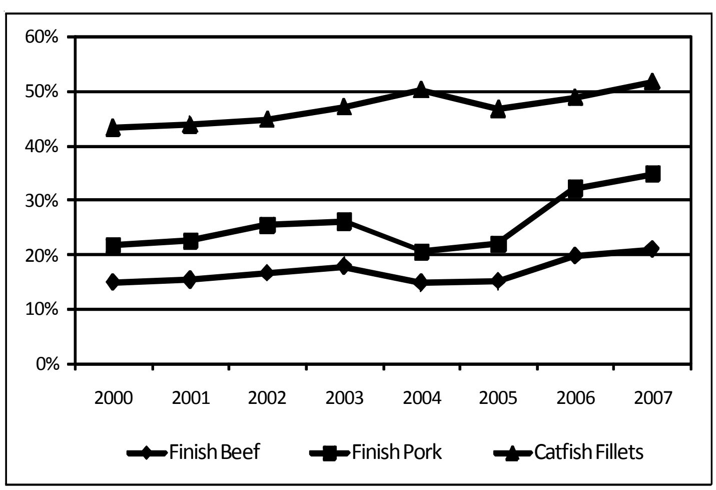

Figure 1. Feed cost as a percentage of total variable costs.

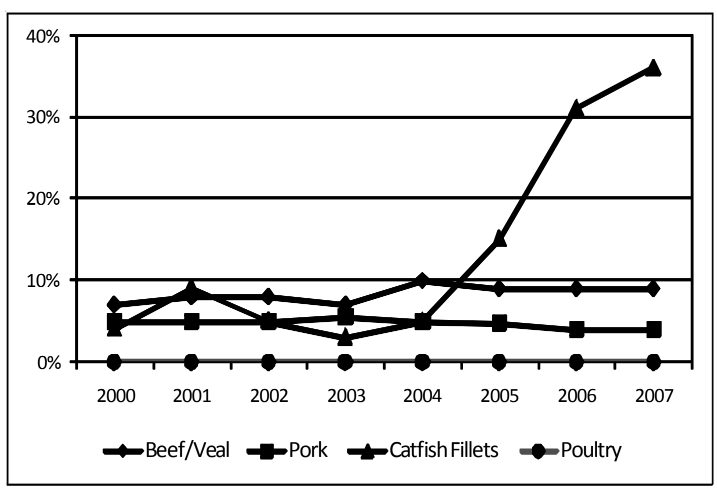

Figure 2. Import livestock quantities as a percent of total U.S. quantities sold 2000-2007.

Research to Improve Hybrid Catfish Reproduction

Craig Tucker and Sarah Harris
Southern Regional Aquaculture Center

It's obvious from the content of this newsletter that catfish farming is facing difficult times. The two factors most responsible for this downturn—high feed costs and competition from imports—are not easy to address through research because they involve global macroeconomic issues. However, the negative impact of these economic factors at the farm level can be addressed, at least in part, through research aimed at improving production efficiency.

Inefficiencies occur in all phases of catfish production. Some are related to the production system, some to production practices, and some to the nature of the fish itself. Problems related to using channel catfish as the culture species include disease losses (particularly during the fry and fingerling production phases), as well as effects of stress from poor water quality throughout the production cycle. Additional inefficiencies occur because channel catfish are particularly good at evading capture, meaning that many market-size fish are not harvested and continue to grow.

For more than 40 years, catfish farmers accepted these inefficiencies as simply part of catfish farming, and the phenomenal history of catfish aquaculture is testimony to the overall performance of the channel catfish under farm conditions. Times have changed, however, and scientists and some farmers are taking a serious look at the hybrid catfish produced by mating channel catfish females and blue catfish males.

The hybrid catfish possesses many of the best features of the parents and is a highly desirable fish for commercial culture. Considerable research has been conducted on the hybrid over the past 30 years, mostly to identify and quantify the superior characteristics of the fish. The fish grows fast, is resistant to channel catfish virus disease and enteric septicemia of catfish, and is much easier to harvest than channel catfish. The major obstacle to the commercial use of this hybrid is the low hybridization rate, which makes it difficult to obtain adequate numbers of fry for commercial use. Problems presently exist with synchronizing maturation of eggs and sperm. Also, males must be sacrificed to obtain blue catfish sperm, which is wasteful. Other problems include damage of sperm or eggs during handling, fertilization protocol, incubation procedures, or preparation of broodstock, which results in poor hatching and fry production rates.

Technologies applicable to small-scale production have been developed, but they need to be improved to allow large-scale adoption of the hybrid. To that end, the Southern Regional Aquaculture Center (SRAC) funded a 4-year project to improve the hatching rate of hybrid catfish embryos and to improve numbers of hybrid fry produced per weight of brood stock. The overall goal was to develop technologies to allow economical delivery of the hybrid technology to the catfish industry. The project began in April 2004 and involved nine scientists from the following institutions: Auburn University, Louisiana State University, Mississippi State University, University of Memphis, and the USDA/ARS Catfish Genetics Research Unit.

Technologies developed in the project include broodstock selection and management protocols; induced spawning techniques and management strategies to optimize gamete collection and storage; techniques to identify, assess and improve gamete quality; and economically viable, standardized hatchery procedures and fertilization protocols to optimize hatching rate of hybrid embryos.

The project was quite successful and results have been discussed and presented to farmers at several meetings and workshops. Overall hybrid catfish production strategies based on past work and work funded by the SRAC project can be used on a commercial scale with results much improved over those used just a couple of years ago. Hybrid catfish fry production increased from about 4 million per year in 2004 to more than 30 million in 2007. Fry production must increase far beyond these numbers to significantly impact overall industry performance, but many of the farmers who have used the fish in the past few years feel that the improved production efficiency achievable with the fish may be a significant factor in allowing them to weather the current crisis in catfish farming.

A detailed summary of this research can be found in SRAC's 20th Annual Progress Report: http://www.msstate.edu/dept/srac/apr20.pdf

Freshwater Prawn Marketing Studies

Terry Hanson

Two freshwater prawn (FWP) marketing studies were recently completed. An in-store pricing experiment was conducted at two nationally known grocery stores (at a rural and urban location) to determine consumer's willingness to pay for individually quick frozen FWP products. Products were either whole (heads-on) or tail-only in two sizes, jumbo and large, and were offered for sale at the fresh seafood counter. The whole and tail-only product forms were alternated on a weekly basis, when prices were changed according to a pre-determined set of prices and pre-determined week for each price set. Quantities of prawn products sold at each price level were collected and analyzed. A companion mail-out survey was conducted in the same zip code area as the location of the grocery store to determine population willingness to pay for FWP, marine shrimp and lobster products. The survey also asked questions about consumer's attitudes and opinions toward FWP products as well. Major findings from these two FWP marketing studies are presented here.

FWP were found to be a new product in the eyes of most consumers with only 30% of the respondents having previously consumed FWP. However, results indicated a good potential market for regular FWP consumption with 93% of those who had previously consumed FWP said they would consume them again, and 83% of those who had never consumed freshwater prawns said they would consider consuming them. Respondents indicated that grocery stores and restaurant outlets were the places they most often purchased FWP. They also had a positive opinion toward farm-raised shellfish products when asked to compare them to wild-harvested shellfish products.

The reasons consumers gave for FWP consumption were enjoyment of flavor (65%), availability of fresh product (34%), convenience (28%), and variety in diet (25%). The reasons FWP consumers gave for <u>not</u> consuming prawns more frequently were lack of availability of fresh prawn products, price, and lack of preparation knowledge. The reasons non-consumers reported for *not* consuming FWP were lack of familiarity with the product, non-availability of fresh products, and lack of preparation knowledge. Factors given that would increase FWP consumption included: increased availability of quality products, lower prices, and availability of recipes.

Survey results indicated that consumers were willing to pay the same amount for prawns as for marine shrimp, indicating acceptance of prawn products, i.e., consumer's perceived prawns to have the same qualities as marine shrimp products. However, results also indicated that consumers were not willing to pay a premium for FWP.

Freshwater prawns had a considerably higher market share (percent of FWP sales to total fresh seafood counter sales of shellfish) of fresh shellfish sales (78%) than marine shrimp (22%) at the rural grocery store, and a slightly higher share at the urban grocery store (FWP, 35%; marine shrimp, 31%; lobster, 34%), but the volume of sales at the urban store were much higher than at the rural grocery store.

Estimated net returns to FWP producers is encouraging and indicates the potential for freshwater shrimp products in grocery store markets. When production, processing and mark-up costs were accounted for, net returns to producers ranged from negative to positive depending on product form and size (Table 1).

Jumbo FWP products, whether in whole or tail form, were preferred over large FWP products. Lower net returns were found in urban grocery stores than in rural grocery stores, though larger quantities of FWP were sold in more populated and higher income urban locations than in less populated, lower income rural locations. Generally consumers were not willing to pay a premium price for FWP; they showed an equal acceptance for marine shrimp and freshwater prawns.

At rural grocery stores, average price was $9.46/pound for large tail FWP products (23-45 count) and $12.07/pound for jumbo tail FWP products (14-22 count). For comparison, the fresh marine shrimp tail price was $10.47/pound for large and $13.99/pound for jumbo size marine shrimp tails.

At urban grocery stores, average price was $6.83/pound for large FWP tail products (23-45 count) and

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$11.88/pound for jumbo tail FWP products (14-22 count). For comparison, the fresh marine shrimp tail price was $7.87/pound for large and $12.76/pound for jumbo size marine shrimp tails.

At rural grocery stores, average price was $5.83/pound for large whole FWP product (12-22 count) and $7.39/pound for jumbo whole FWP product (7-11 count). For comparison, the fresh marine shrimp tail price was $10.23/pound for large and $13.99/pound for jumbo size marine shrimp tails. No heads-on marine shrimp products were sold in the fresh seafood counter.

At urban grocery stores, average price was $4.66/pound for large whole FWP product (12-22 count) and $5.43/pound for jumbo whole FWP product (7-11 count). For comparison, the fresh marine shrimp tail price was $8.58/pound for large and $9.21/pound for jumbo size marine shrimp tails. No heads-on marine shrimp products were sold in the fresh seafood counter.

Implications

Market share results showed that freshwater prawns, although a new product to consumers, have a high potential of being accepted by consumers. Jumbo and large FWP tail products sold in greater quantities than whole (heads-on) product form, though the differences in sales at the fresh seafood counter were small. Therefore, the whole product form, if properly promoted, could gain consumers' acceptance, especially in the upscale urban grocery stores.

In-store FWP taste promotions had a positive effect on sales, emphasizing the importance of promotional activities to stimulate new product introductions. Results suggest advertising campaigns would be important in familiarizing consumers with the prawn product and marketing efforts should focus on freshwater prawns' flavor attributes. FWP consumer and non-consumer groups have different reasons for not consuming prawns or not consuming prawns more often, indicating the need for different marketing approaches.

If you would like more information about these two studies, a bulletin is being prepared for distribution in the near future. Terry Hanson can be contacted at (662) 325-7988 for more information or a copy of the bulletin.

Table 1. Estimated net returns to producers from sales of freshwater prawn (FWP) products to rural and urban grocery store outlets.

	Jumbo Whole FWP (7-11/lb)	Large Whole FWP (12-22/lb)	Jumbo Tail FWP (14-22/lb)	Large Tail FWP (23-45/lb)
Rural Grocery Store				
Selling Price, $/lb	7.39	5.83	12.07	9.46
- Mark-up cost, $/lb	2.22	1.75	3.62	2.84
- Processing cost, $/lb	0.70	0.70	0.75	0.75
- Cost of production, $/lb	3.00	3.00	6.00	6.00
Return to FWP producer, $/lb	1.47	0.38	1.70	-0.13
Urban Grocery Store				
Selling Price, $/lb	5.43	4.66	11.88	6.83
- Mark-up cost, $/lb	1.63	1.40	3.56	2.05
- Processing cost, $/lb	0.70	0.70	0.75	0.75
- Cost of production, $/lb	3.00	3.00	6.00	6.00
Return to FWP producer, $/lb	0.10	-0.44	1.57	-1.97

Note: These returns do not include other costs that may exist, such as safe-food related measures and product losses occurring after day-long fresh counter display.

Toxicity of Selected Mosquito Repellents to Channel Catfish Sac Fry

Chuck Mischke

In the spring when catfish hatcheries are in full operation, the associated moisture and warm temperatures provide a haven for mosquitoes. Large swarms of biting mosquitoes in a hatchery can make the tedious work of egg-picking and feeding fry almost unbearable. Besides causing undesirable working conditions, workers sensitive ot mosquito bites may sustain blisters, bruises, or large inflammatory reactions. Mosquitoes also harbor viruses or other diseases that can be transmitted to humans including West Nile Virus.

In many hatcheries, a few strategically placed fans for air movement can remediate the mosquito problem. However, during certain years and in some hatcheries, additional control is needed. Several chemical repellents are available for mosquito control, but their toxicity to catfish fry is not known. The objective of this study was to screen chemical mosquito repellents for their toxicity to channel catfish sac fry.

For each of the chemicals tested (Table 1), standard acute toxicity tests were used to calculate 24-h LC50 values (the concentration of chemical required to kill 50% of the fish in 24 hours). Two chemicals tested contained common mosquito repellents as their active ingredient (Malathion and Permethrin). One chemical was an 'all-natural' mosquito spray containing several plant extracts. The final chemical tested was an emulsifiable concentrate for use with synthetic pyrethroids and carbamates.

In instances where air movement by fans is not sufficient to control hatchery mosquitoes, chemical control methods (with the chemicals tested) should be safe as far as direct acute toxicity to catfish fry. I would not recommend the use of emulsifying agents, as the emulsifier tested here was more toxic than the actual mosquito control chemicals.

Table 1. Acute toxicity (24-hour LC50 and 95% confidence interval) of four chemicals to 1-2 day old channel catfish sac fry. All results are given in parts per million active ingredient.

Chemical	24-hour LC50	95% CI
Malathion[1]	64 ppm	60.4 – 67.6
Permethrin[2]	8 ppm	7.9 – 8.9
All Natural Spray[3]	357 ppm	50.4 – 64.0
Piperonyl Butoxide[4]	410 ppm	9.3 – 11.1

[1] Fyfanon ULV Insecticide (a.i. 96.5% malathion).
[2] Evercide Permethrin 10% EC2784 (a.i. 10% Permethrin).
[3] CPC 128-1 (proprietary formulation, considered 100% active).
[4] Prentox PBO-8 (a.i. 91.3% Piperonyl Butoxide).

A Liquid Oxygen Calculator for Fasted Channel Catfish
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sufficient LOX capacity, and that at maximum flow rate it should provide approximately 86% of the estimated O_2 requirement (1,163 SCF). Liquid Oxygen Expense, which included the cost of LOX and amortization of capital investment, was approximately $247 (1.3%) of gross revenue.

The LOX Calculator is available at: http://www.ars.usda.gov/services/software/download.htm?softwareid=149#downloadForm

Mississippi State University and U.S. Department of Agriculture Cooperating