

# Plant-Based Catfish Feeds

*Edwin H. Robinson and Menghe H. Li*

## PREFACE

This research report contains a brief look at the current status of catfish feeds and is primarily intended for catfish producers and feed formulators and manufacturers. For readability purposes, references have been omitted. For those who desire more information, a list of suggested readings is provided.

## INTRODUCTION

Historically, commercial catfish feeds have contained fishmeal or other animal protein sources because these products were generally considered to be necessary to provide essential nutrients and to improve feed palatability. However, numerous research reports have shown that catfish grown from stocker to market size do not necessarily require animal protein. Over the last several years, we conducted a variety of studies comparing plant and animal protein sources in catfish feed. Treatment means averaged from weight gain (pound per fish) and feed conversion ratio were almost identical in these studies, regardless of whether plant or animal sources were used. For fish fed plant-based diets,

weight gain was 1 pound per fish and feed conversion ratio was 1.65. Compare these averages to fish fed feeds containing animal feedstuffs: weight gain of 1.04 pound and feed conversion ratio of 1.60. Other researchers have reported similar results, and plant-based feeds have been used successfully in commercial catfish culture for years. Even so, some catfish producers still insisted that animal protein be included in commercial catfish feeds—that is, until the price of these products rose to a level basically prohibiting their use. Currently, animal protein is used sparingly in feeds for catfish fry and small fingerlings, but most commercial catfish feeds used for grow out are plant-based.

Robinson and Li are research professors at the Delta Research and Extension Center in Stoneville, Mississippi. This document was approved for publication as Research Report 24:14 of the Mississippi Agricultural and Forestry Experiment Station. It was published by the Office of Agricultural Communications, a unit of the Division of Agriculture, Forestry, and Veterinary Medicine at Mississippi State University. Copyright 2014 by Mississippi State University. All rights reserved. This publication may be copied and distributed without alteration for nonprofit educational purposes provided that credit is given to the Mississippi Agricultural and Forestry Experiment Station.



MISSISSIPPI AGRICULTURAL & FORESTRY EXPERIMENT STATION • GEORGE M. HOPPER, DIRECTOR

MISSISSIPPI STATE UNIVERSITY • MARK E. KEENUM, PRESIDENT • GREGORY A. BOHACH, VICE PRESIDENT

## FEEDSTUFFS

Plant-based feedstuffs commonly used in catfish feeds include soybean meal, cottonseed meal, corn grain, corn gluten feed, corn germ meal, distillers dried grains with solubles, wheat middlings, and rice bran. Feedstuffs such as canola meal, peanut meal, sunflower meal, and others could be used, but they are generally not available at a reasonable cost in the primary catfish growing areas. Aside from soybean meal, other plant feedstuffs are typically deficient in lysine, but using supplemental lysine can compensate for this. Some plant proteins contain toxins and antinutritional factors, but these are typically not a problem because they are either present in very low concentrations or are inactivated during processing or during feed manufacturing.

Soybean meal has traditionally been the predominant feedstuff used in catfish feeds because it is high in protein (48%), has the best amino acid profile of all common plant feedstuffs, and is highly palatable and digestible to catfish. The inclusion rate for soybean meal in catfish feeds has been 40–50% of the feed. However, because of the dramatic increase in soybean meal prices in recent years, other feedstuffs are being used to replace as much soybean meal as possible without affecting fish performance. Cottonseed meal or a combination of cottonseed meal and corn gluten feed,

corn germ meal, or distillers dried grains with solubles plus supplemental lysine can be used in place of soybean meal. Though some studies indicate soybean meal can be completely replaced, data from more recent studies suggest that probably no more than about 50% of the soybean meal should be replaced in catfish feeds based solely on plant feedstuffs. Higher levels may reduce processed yield likely due to the lower protein digestibility, imbalanced amino acid composition, and high fiber content. Another consideration is product quality. For example, all corn-based feedstuffs contain yellow pigments that if fed in high enough concentrations can result in a discoloration of edible tissue that is unacceptable to the consumer. Distillers dried grains with solubles contain a relatively high amount of yellow pigment, thus its use may be limited more by this problem than nutritional quality. We recommend that the feed contain no more than about 7 parts per million of yellow pigment. At least 15–20% corn grain is generally needed to achieve proper expansion of feed pellets during extrusion, which allows the feed to float. Therefore, the use of other corn-based feedstuffs (particularly distillers dried grains with solubles) is limited. Feedstuffs such as wheat grain, wheat middlings, and rice bran may be used but are not currently widely used.

## FORMULATING PLANT-BASED FEEDS

When nutritionists use least-cost computer programs to formulate catfish feeds, the goal is to make the least expensive product possible given a specific set of criteria that ensure the feed is of the quality needed for catfish. In other words, a properly balanced feed should meet the nutritional and energy requirements of an animal in a palatable and digestible form. Regardless of the specifications used, it is essential to check the formula to ensure that ingredient composition is practical and nutritional requirements are met. Once a basic formula is established, typically only minor adjustments are needed to get a practical formula that meets the set criteria. The ingredient specifications in Table 1 should be used as a guideline because actual amounts of feed-

stuffs used may vary somewhat due to differences in nutrient content or product quality. Nutrient specifications given in Table 2 are for a 28% protein feed, which we recommend for catfish. Numerous studies have shown that 28% protein provides the same growth as 32% protein. Over the last 15 years or so, we conducted many studies comparing these protein concentrations. Means averaged from these studies show that weight gain and feed conversion ratios were similar for 28% and 32% protein feed. Weight gain (pounds per fish) and feed conversion ratio were 1.13 and 1.67, respectively, for fish fed a 32% protein feed; 1.18 and 1.65, respectively, for fish fed 28% protein.

**Table 1. Ingredient specifications for a plant-based catfish feed at least cost.**

Ingredient	Specification	Amount	Unit
Soybean meal (48% <sup>1</sup> )	Minimum	20.0	%
Cottonseed meal (41%)	Maximum	20.0	%
Corn grain <sup>2</sup>	Minimum	15.0	%
Corn gluten feed or germ meal <sup>3</sup>	Maximum	35.0	%
Distillers dried grains with solubles <sup>4</sup>	Maximum	20.0	%
Rice bran	Maximum	15.0	%
Wheat middlings	Maximum	25.0	%
Lysine, supplemental	Maximum	0.4	%
Supplemental fat	Minimum	1.5	%
	Maximum	3.0	%
Phytase enzymes	Minimum	230.0	FTU <sup>5</sup> /lb
	Maximum	230.0	FTU/lb
Dicalcium phosphate	Maximum	2.0	%
Vitamin premix	Include		
Trace mineral premix	Include		

<sup>1</sup> This number represents percentage of protein.

<sup>2</sup> Some corn grain is needed for feed manufacture. Because of expense, maintain as low a level as possible.

<sup>3</sup> Use depends on price. Corn germ meal contains a lower yellow pigment level than corn gluten meal.

<sup>4</sup> Yellow pigment levels can vary greatly among different sources and should be closely monitored. Even though various combinations of these corn-based products may be used, it is probably best to use corn germ meal or wheat middlings instead of corn gluten feed if significant levels of distillers dried grains are used.

<sup>5</sup> FTU = phytase unit.

**Table 2. Nutrient specifications for 28% protein least-cost catfish feed.**

Nutrient	Specification	Amount	Unit
Crude protein	Minimum	28.00	%
	Maximum	28.00	%
Crude fiber	Maximum	7.00	%
Total fat	Maximum	6.00	%
Available phosphorus	Minimum	0.30	%
Available phosphorus	Maximum	0.40	%
Digestible energy	Minimum	2.80	kcal/g
Digestible energy	Maximum	3.00	kcal/g
Available lysine <sup>1</sup>	Minimum	1.43	%
Available methionine	Minimum	0.26	%
Available methionine + cystine <sup>2</sup>	Minimum	0.65	%
Yellow pigments <sup>3</sup>	Maximum	7.00	ppm

<sup>1</sup> Available lysine should be 5.1% of the dietary protein.

<sup>2</sup> Total available sulfur amino acids should be 2.3% of the dietary protein.

<sup>3</sup> Lutein and zeaxanthin.

## SUMMARY

Considerable research has been conducted over the last two decades on plant-based catfish feeds, including the evaluation of plant-based feeds containing various protein levels. The data show that a feed prepared from feedstuffs of plant origin containing 28% protein is adequate for rapid catfish growth from stocker to market size. We recommend that no more than about one-half of the soybean meal be replaced with alternative

feedstuffs. In addition, when you use corn-based by-products to replace part of the corn grain and/or soybean meal, we recommend that yellow pigments not exceed 7 parts per million. The information presented in Tables 1 and 2 is based on the best information we have, but it should be considered as a guideline and therefore is subject to change.

## SELECTED READINGS

- Robinson, E. H., and M. H. Li.** 2005. A summary of nutrition research conducted under a cooperative agreement between MAFES and Delta Western Research Center. Bulletin 1144. Mississippi Agricultural and Forestry Experiment Station, Mississippi State, Mississippi.
- Robinson, E. H., and M. H. Li.** 2007. Catfish feeds and feeding. Bulletin 1163. Mississippi Agricultural and Forestry Experiment Station, Mississippi State, Mississippi.
- Robinson, E. H., and M. H. Li.** 2007. Catfish protein nutrition, revised. Bulletin 1159. Mississippi Agricultural and Forestry Experiment Station, Mississippi State, Mississippi.
- Robinson, E. H., and M. H. Li.** 2008. Replacement of soybean meal in channel catfish, *Ictalurus punctatus*, diets with cottonseed meal and distillers dried grains with solubles. Journal of the World Aquaculture Society 39:521–527.
- Li, M. H., E. H. Robinson, B. G. Bosworth, D. F. Oberle, and P. M. Lucas.** 2010. Effects of varying dietary compositions using common feed ingredients on growth and feed efficiency of pond-raised channel catfish. Aquaculture Research 41:1133–1139.
- Li, M. H., E. H. Robinson, D. F. Oberle, and P. M. Lucas.** 2010. Effects of various corn distillers by-products on growth and feed efficiency of channel catfish, *Ictalurus punctatus*. Aquaculture Nutrition 16:188–193.
- Li, M. H., D. F. Oberle, and P. M. Lucas.** 2011. Evaluation of corn distillers dried grains with solubles and brewers yeast in diets for channel catfish *ictalurus punctatus* (Rafinesque). Aquaculture Research 42:1424–1430.
- Robinson, E. H., and M. H. Li.** 2011. Reducing catfish feed cost. Research Report 24 (10). Mississippi Agricultural and Forestry Experiment Station, Mississippi State, Mississippi.
- Li, M. H., E. H. Robinson, D. F. Oberle, P. M. Lucas, and B. G. Bosworth.** 2012. Evaluation of corn gluten feed and cottonseed meal as partial replacements for soybean meal and corn in diets for pond-raised hybrid catfish, *ictalurus punctatus* x *I. furcatus*. Journal of the World Aquaculture Society 43:107–113.
- Robinson, E. H., and M. H. Li.** 2012. Composition and formulation of channel catfish feeds. Bulletin 1200. Mississippi Agricultural and Forestry Experiment Station, Mississippi State, Mississippi.
- Robinson, E. H., and M. H. Li.** 2012. Summary of distillers grains studies for pond-raised catfish. Research Report 24 (11). Mississippi Agricultural and Forestry Experiment Station, Mississippi State, Mississippi.
- Robinson, E. H., and M. H. Li.** 2013. Comparative quality of feedstuffs for catfish feeds. Bulletin 1205. Mississippi Agricultural and Forestry Experiment Station, Mississippi State, Mississippi.
- Li, M. H., E. H. Robinson, D. F. Oberle, P. M. Lucas, and B. G. Bosworth.** 2013. Use of corn germ meal in diets for pond-raised channel catfish, *Ictalurus punctatus*. Journal of the World Aquaculture Society 44:282–287.



**MISSISSIPPI STATE**  
**UNIVERSITY**™



Printed on Recycled Paper

**Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the Mississippi Agricultural and Forestry Experiment Station and does not imply its approval to the exclusion of other products that also may be suitable.**

Discrimination based upon race, color, religion, sex, national origin, age, disability, or veteran's status is a violation of federal and state law and MSU policy and will not be tolerated. Discrimination based upon sexual orientation or group affiliation is a violation of MSU policy and will not be tolerated.