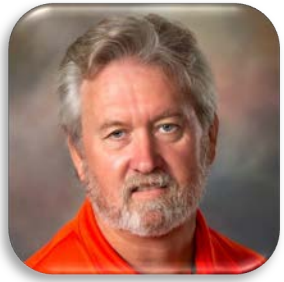
TAILORING SOY TO CATFISH

SOY AQUACULTURE Q4 WEBINAR

SOY AQUACULTURE
ALLIANCE

EVALUATING THE EFFECTS OF DIFFERENT SOYBEAN MEAL SOURCES ON CATFISH PERFORMANCE



By D. Allen Davis & T. Bruce
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INTRODUCTION

Catfish farming continues to be the largest segment of U.S. aquaculture sector and is a significant contributor to the local economies in the Southern states of Alabama, Arkansas, and Mississippi (Hedge et al., 2021).

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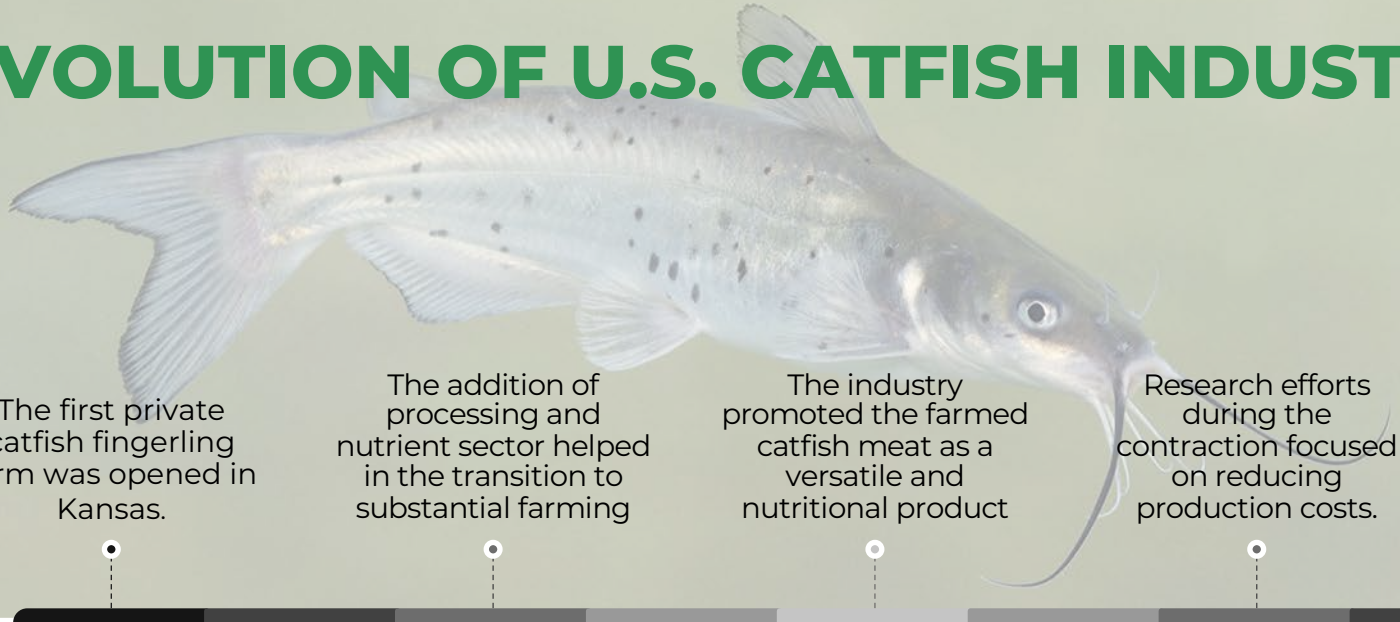
EVOLUTION OF U.S. CATFISH INDUSTRY



1950's — The first private catfish fingerling farm was opened in Kansas.

1960's — Trial and error approaches and Extension research helped to understand the production challenges

1970's — The addition of processing and nutrient sector helped in the transition to substantial farming

1980's — Catfish industry emerged as a major farming enterprise.

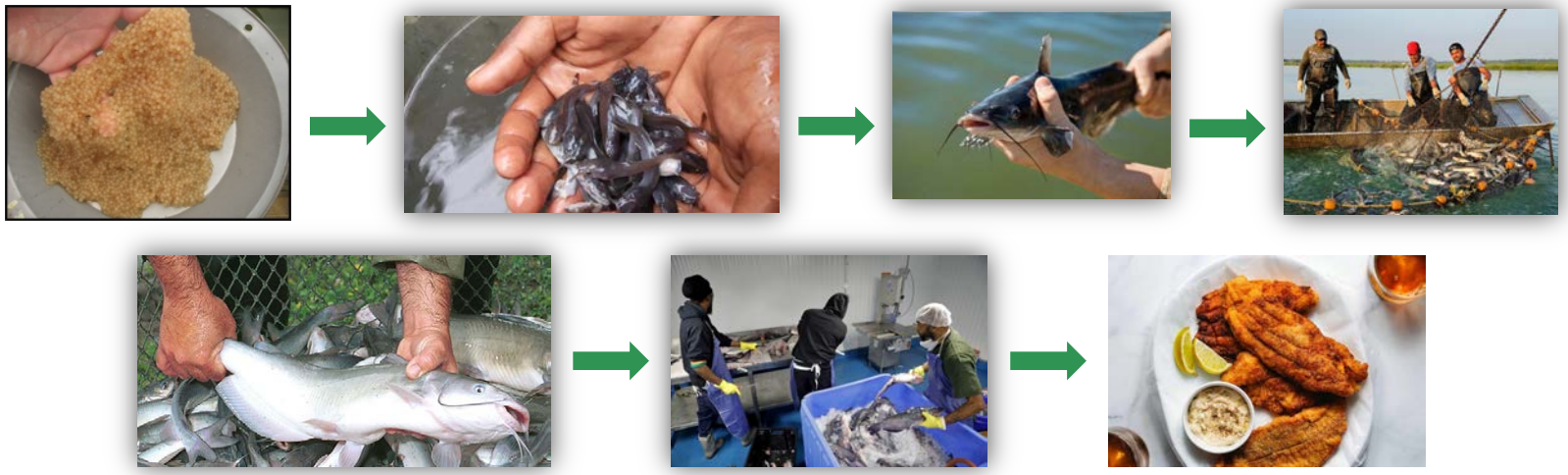
1990's — The industry promoted the farmed catfish meat as a versatile and nutritional product

2000's — The catfish industry contracted due to the imports of pangasius from foreign markets and other economic factors.

2010's — Research efforts during the contraction focused on reducing production costs.

2020's — More intensive production methods were applied, reducing costs and increasing catfish production

LONG HISTORY OF PRODUCTION HAS PRODUCED A WELL-DEVELOPED SUPPLY CHAIN AND A MATURE INDUSTRY.



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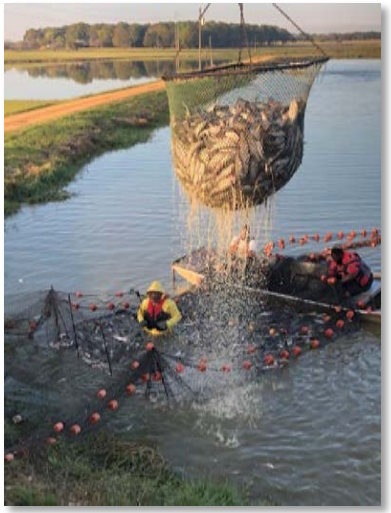
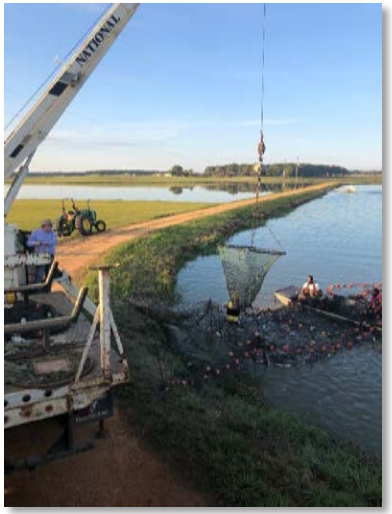
CATFISH – U.S.

- 398 foodfish farms (MS, AL, AR, TX primary states)[1]
- 370,701,000 lbs live weight harvested ($480 million in sales)[1]
- $2 Billion-dollar economic impact and 75% of U.S. Finfish aquaculture[2]
- Competes with other seafood items as well as protein sources





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[1]2023 U.S. Census of Aquaculture; [2]Hedge et al. 2022;

PROBLEMS U.S. CATFISH INDUSTRY

- Competition from imports & other protein sources
- Low farm gate prices
- Fingerling shortages
- “Big fish” issues (reduced price)
- Fish health/disease issues
- Fish-eating birds
- Toxic algae
- Feed related issues and fluctuating feed costs
- Shortage of labor (farms and processing plants)
- Weather related events (drought, flooding, and heat related losses)

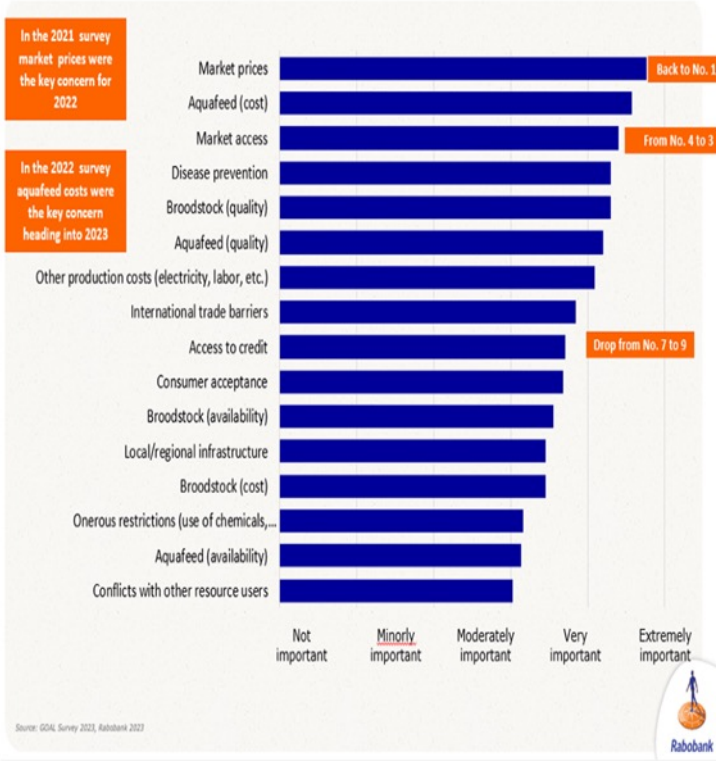

Fig. 6: Market prices are the clear No. 1 concern in 2024.

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NUTRITION OF CATFISH

Historically, nutrition research has concentrated on defining nutritional requirements and reducing the cost of the feed by precisely formulating for nutrient requirements and relying on low-cost ingredients to reduce prices.

To continue to compete:
a. Increased efficiency of resource to reduce costs.

b. Shorten the time to market, which will improve turnover, reducing time in the ponds thus risk of loss due to diseases and other factors.

One potential solution is to move feeds towards better quality ingredients as well as more efficient practices.

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FEEDING CATFISH – COMMERCIAL FARMS

Photo Credits: Dr. Luke A. Roy, Auburn University

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ALLIANCE

FEEDING CATFISH

Photo Credit: Dr. Luke A. Roy, Auburn University

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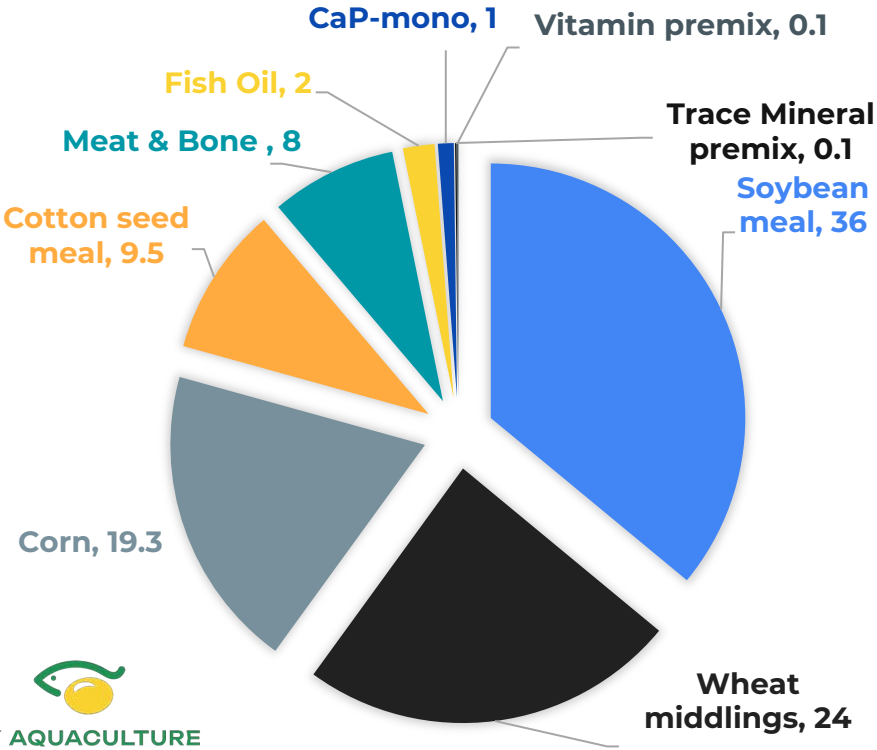
TYPICAL CATFISH PRODUCTION DIET



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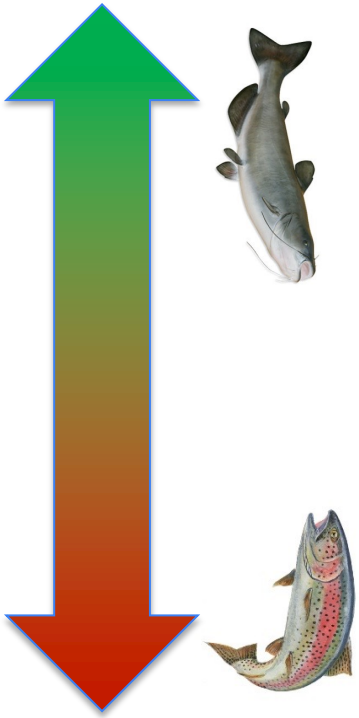
PLANT-BASED FEEDS IN AQUACULTURE



Very tolerant species – very high use

Pacific white shrimp - > 50% Soybean meal
Catfish & tilapia

Tolerant but Require 10-15% animal protein

Florida pompano – 47% soybean meal
California yellowtail (HSWRI) – 30% SBM + 15%SPC
White sea bass (HSWRI) – 30 % SBM + 8% SPC

Lower tolerance

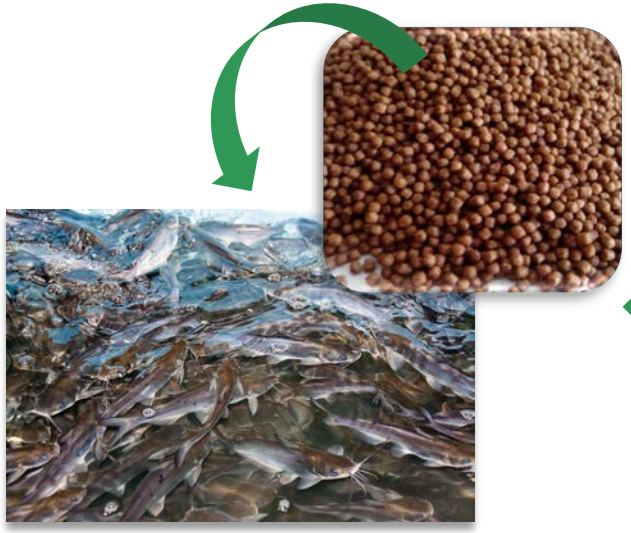
Salmonids (primarily “allergic” response, often 20%)
Can utilize highly processed soy products
Fractionated plant-based proteins

PLANT-BASED INGREDIENTS

Non-Starch
Polysaccharides

Hemicelluloses: Xylans,
Beta glucans, Mannans

Structure are composed of cellulose,
hemicellulose and lignin



Plant-based feed ingredient contain **anti-nutritional compounds** that impair digestive processes.

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SOY IS 30-50% DIET

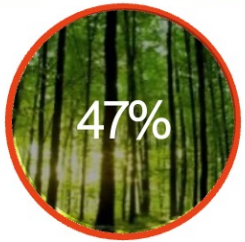
INCREASED PRODUCTION

U.S. Soy Sustainability Impact 1980-2021

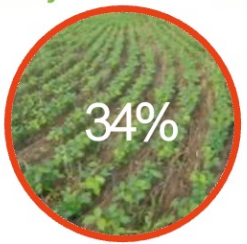
Reduced GHG Emissions per Bushel

Increase in Energy Use Efficiency

Improved Water Use Efficiency



Improved Land Use Efficiency



Improved Soil Conservation

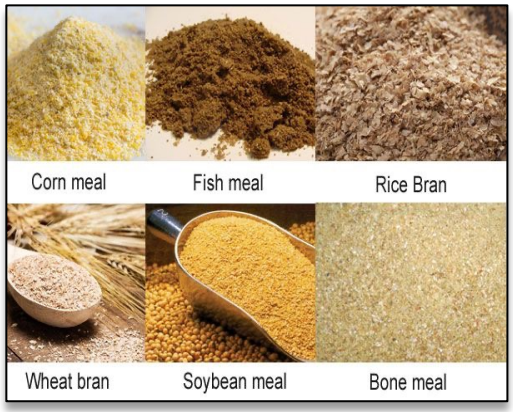
Source: Field To Market National Indicators Report 2021

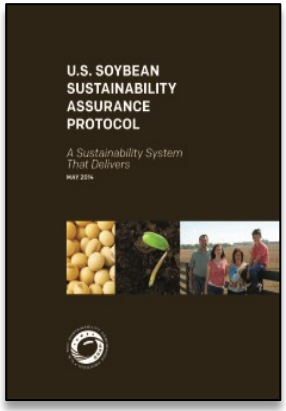
US SOY Delivers Solutions

SOYBEAN MEAL

Primary protein source for most fed animal production systems

- Gold standard of plant-based proteins
- Good amino acid profile
- High digestibility
- Availability and price point are favorable





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SOYBEAN MEAL (SOLVENT-EXTRACTED)

High protein

Intestinal morphology changes

Differently processed products

ANFs

SOYBEAN

Diverse cultivars

Health risk factor

Immune impairment

Readily available

Suitable for many species

SBMIE

- Quantitative and qualitative means of assessment
- Primary cause are ANFs
- Can influence: Inflammatory response, microbiota, tissue damage and nutrient uptake

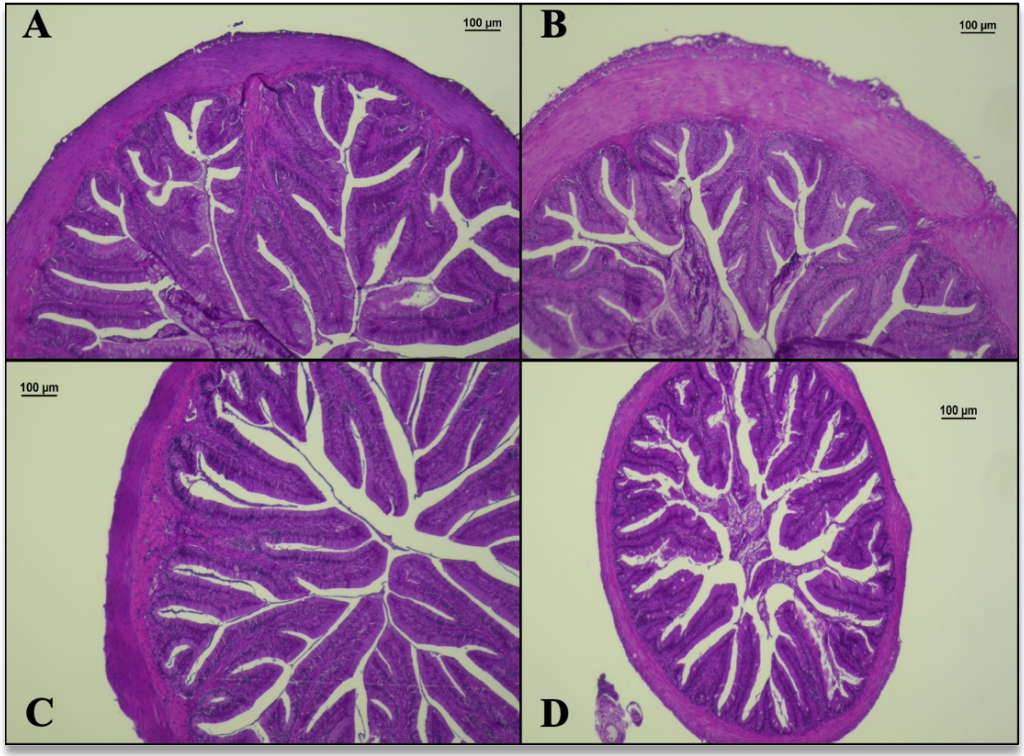

Figure 1. Cross-section images of the distal intestines of the largemouth bass (*M. nigricans*) fingerlings fed the diet of (A) control (Basal), (B) basal-soybean meal (B-SBM), (C) basal-enzyme-treated soybean meal (B-ESBM), and (D) basal-soy protein concentrate (B-SPC). Scale bar 100µm, H.E, x 10.

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Semla, J. L., Butts, I. A., Davis, D. A., Oladipupo, A. A., LaFrentz, B. R., & Bruce, T. J. (2025). Evaluation of processed soy ingredients for largemouth bass (*Micropterus nigricans*) fingerlings on growth performance, intestinal health, and disease susceptibility. *Animal Feed Science and Technology*, 116432.

Soy products can be improved through processing or breeding programs.

Processing

HAMLET PROTEIN™

Enzyme-treated soybean meal

Genetics

BENSON HILL®

Low-oligosaccharides soybean meal

Lower fiber

Higher protein

Lower lipid

Lower ANFs

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PRIMARY STUDY OBJECTIVES:

- Evaluate the efficacy and utility of advanced soy products in channel catfish feed formulations

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ELSEVIER

Assessment of different dietary soybean meals and corn fermented protein in practical diets for fingerling channel catfish.

Abel R. Paladines-Parrales, Khanh Q. Nguyen, Magida Tabbara, Uthpala Padeniya, Abigeal Adeyemi, Yoonhang Lee, Timothy J. Bruce, D. Allen Davis*

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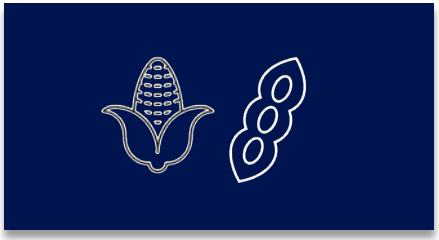
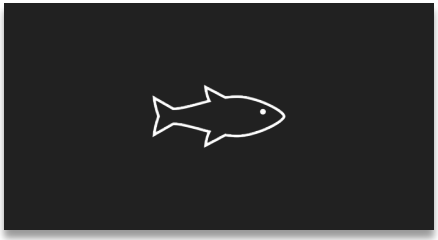
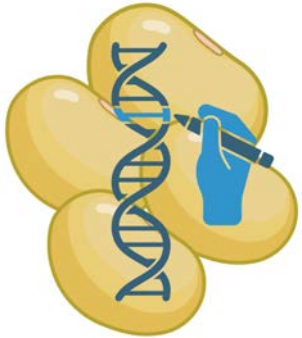




SOY AQUACULTURE ALLIANCE

MATERIALS AND METHODS: DIETS

BUNGE

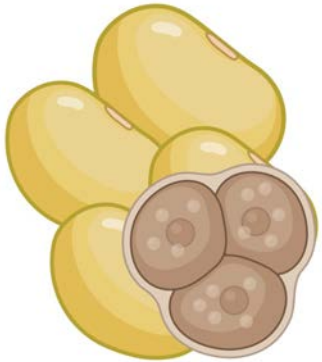


BENSON HILL

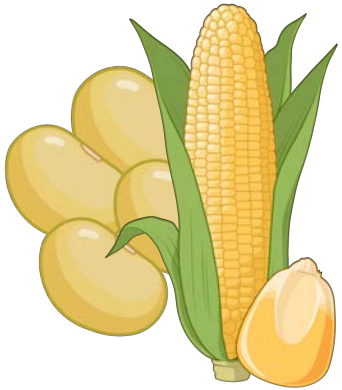
Basal Diet: Consisted of a solvent-extracted soybean meal. This soybean meal is obtained by extracting the fat from the soy flakes and then applying a heat treatment to remove the anti-nutritional factors.

Basal-LO: It is the result of a selected variety of soybean with **high protein and low oligosaccharides (LO).** This soybean meal is the result of genetic improvement. Processed via traditional solvent extraction.

MATERIALS AND METHODS: DIETS



HAMLET PROTEIN™



CFP-GT33

Basal-ET: Produced by enzyme treatment breaking down oligosaccharides and other anti-nutritional fractions of conventional soybean meal. Designed for **higher protein and lower anti-nutrients.**

Basal-CFP: Obtained by the mechanical separation of the plant producing ethanol Corn Fermented Protein (CFP). Designed to **improve the balance of AA and add bioactive compounds.**

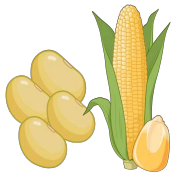
EXPERIMENTAL DESIGN - OBJECTIVES

BUNGE → Solvent Extracted soybean meal

HAMLET PROTEIN™ → HP300: Enzyme treated soybean meal (ET)

BENSON HILL® → Bright Day: Selected variety with high protein and low oligosaccharides (LO).

BUNGE + CFP-GT33 → Corn Fermented protein (CFP)



EXPERIMENTAL DESIGN - OBJECTIVES

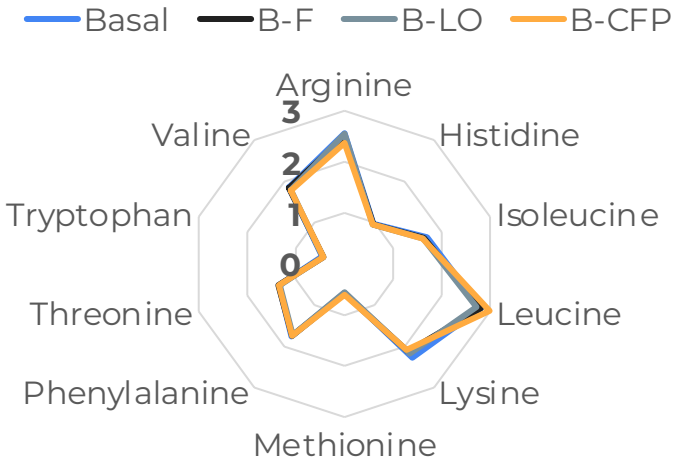
The composition of the test diets, commercially extruded as floating feed (36:6) by Optimal Aquafeeds (Green Plains Aquaculture, Omaha, NE. USA).

	Basal	B-ET	B-LO	B-CFP
Soybean Meal[1]	56.4			44.5
Enzyme Treated SBM[2]		43.0		
Low Oligosaccharide SBM[3]			45.0	
Corn Fermented Protein[4]				10.0
Poultry Meal	8.0	8.0	8.0	8.0
Menhaden Fish Oil	2.0	2.0	2.0	2.0
Soy Oil	1.4	0	0.8	0.4
Corn	20.3	34.7	31.9	22.8
Wheat Mids.	10.0	10.0	10.0	10.0
Premix	0.5	0.5	0.5	0.5
CaP-dibasic	1.8	1.8	1.8	1.8

Paladines-Parrales, A. R., Nguyen, K. Q., Tabbara, M., Padeniya, U., Adeyemi, A., Lee, Y., Bruce, T.J. & Davis, D. A. (2025). Assessment of different dietary soybean meals and corn fermented protein in practical diets for fingerling channel catfish. Animal Feed Science and Technology, 321, 116239. [1] Solvent extracted soybean meal, Bunge; [2] Fermented soybean meal, HP300, Hamlet Inc.; [3] Low oligosaccharide soybean meal, Bright Day, Benson Hill; [4] Corn Fermented Protein CFP-GT33 (proprietary blend). Feeds were commercially extruded by Optimal Aquafeed Inc.

Proximate and amino acid composition (g/100g dry weight)

	Basal	B-ET	B-LO	B-CFP
Crude protein*	36.42	35.8	35.48	35.93
Moisture	7.56	7.36	10.35	8.05
Acid Hydrolysis Fat	6.02	8.19	7.35	8.43
Crude Fiber	4.37	4.41	3	4
Ash	6.94	6.8	6.55	6.48



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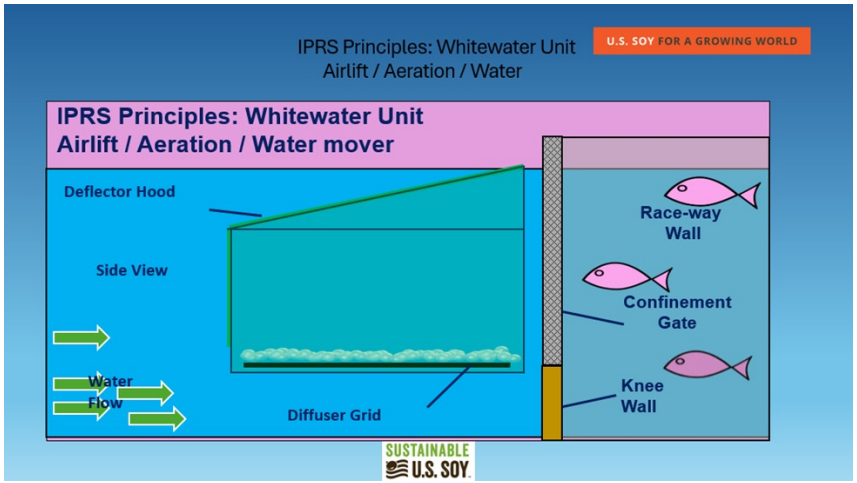
	Basal	B-F	B-LO	B-CFP
Arginine	2.56	2.49	2.55	2.37
Histidine	0.97	0.96	0.95	0.95
Isoleucine	1.7	1.64	1.62	1.61
Leucine	2.81	2.81	2.72	2.99
Lysine	2.27	2.12	2.17	2.08
Methionine	0.57	0.58	0.55	0.6
Phenylalanine	1.76	1.74	1.73	1.74
Threonine	1.35	1.36	1.33	1.35
Tryptophan	0.46	0.43	0.45	0.43
Valine	1.85	1.84	1.79	1.78
Alanine	1.79	1.84	1.74	1.9
Aspartic Acid	3.81	3.6	3.74	3.5
Cysteine	0.58	0.55	0.53	0.57
Glutamic Acid	6.41	6.12	6.31	6.22
Glycine	1.89	1.9	1.86	1.84
Hydroxylysine	0.01	0.03	0.03	0.03
Hydroxyproline	0.22	0.23	0.24	0.25
Lanthionine §	0.08	0.12	0.11	0.09
Ornithine §	0.06	0.09	0.06	0.06
Proline	1.98	2.01	1.98	2.09
Serine	1.42	1.45	1.43	1.45
Taurine §	0.24	0.24	0.22	0.26
Tyrosine	1.24	1.23	1.21	1.26

RESEARCH SIZE : IN-POND RACEWAY SYSTEMS, USING AIR LIFT TO MOVE WATER.



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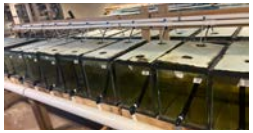
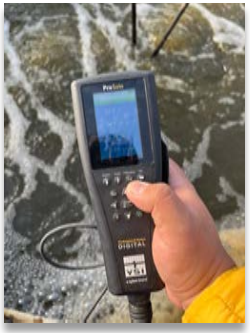
WATER QUALITY

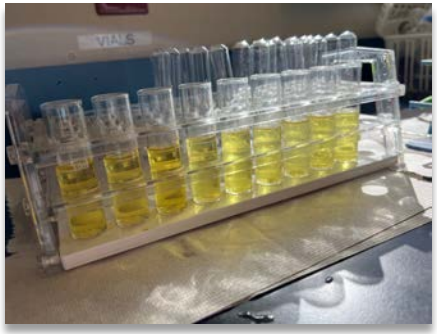


Values of water quality observed over the 12-week growth trial in RAS system.

Parameters	Mean ± SE
DO (mg/L)	6.81 ± 0.05 (8.7 – 4.7)
Temperature (°C)	25.67 ± 0.06 (27.3 – 23.2)
Salinity (ppt)	2.02 ± 0.12 (5.0 – 0.1)
pH	7.53 ± 0.08 (8.5 – 6.8)
TAN (mg/L)	0.4 ± 0.19 (5.0 – 0.0)
Nitrite (mg/L)	0.17 ± 0.04 (1.1 – 0.0)



YSI Probe



Nitrite Analysis

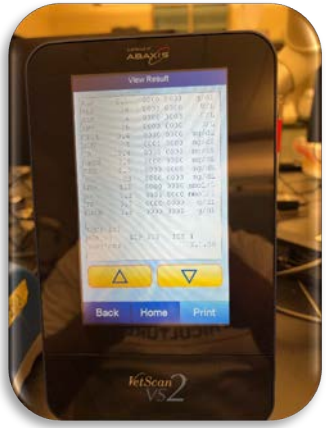
Paladines-Parrales, A. R., Nguyen, K. Q., Tabbara, M., Padeniya, U., Adeyemi, A., Lee, Y., Bruce, T.J. & Davis, D. A. (2025). Assessment of different dietary soybean meals and corn fermented protein in practical diets for fingerling channel catfish. Animal Feed Science and Technology, 321, 116239.

Monitor growth and FCR then at the end of the trial, sample the fish for final weights as well as blood and tissue work.

SUPPLIES FOR BLOOD COLLECTION

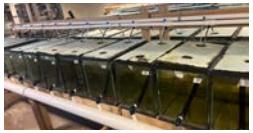
BLOOD COLLECTION

VETSCAN DISC



VETSCAN ANALYSIS

SOY AQUACULTURE ALLIANCE

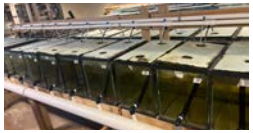


RESULTS

Response of **channel catfish** fingerling (2.14 ± 0.03 g mean weight) cultured over an 84-day period.

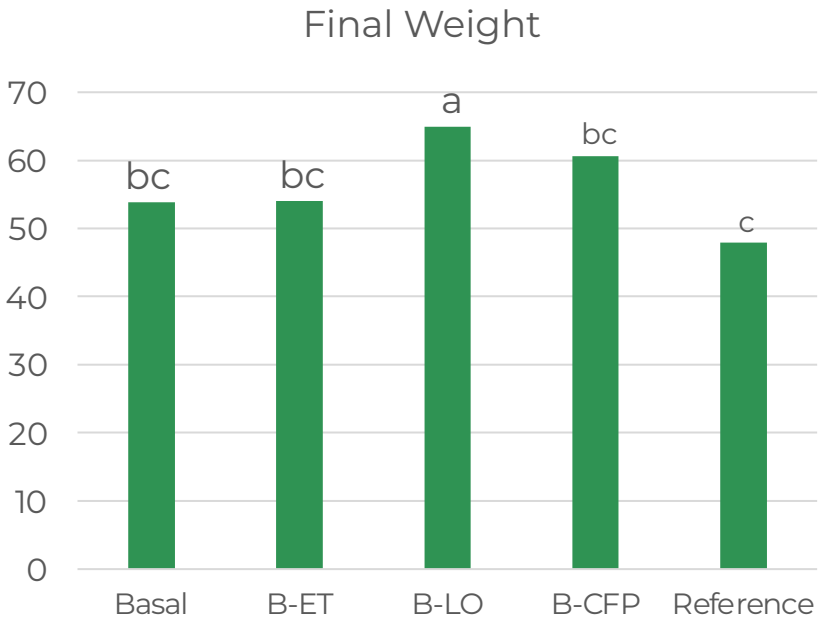
	Basal	B-ET	B-LO	B-CFP	Commercial Reference	p-value
Biomass (g)	1065.10^{bc}	1066.18^{bc}	1305.30^{a}	1181.9^{ab}	932.7^{c}	0.0872
Final Weight (g)	53.88^{bc}	54.05^{bc}	64.94^{a}	60.61^{ab}	47.91^{c}	0.0017
Weight gain (g)	51.73^{bc}	51.89^{bc}	62.84^{a}	58.5^{ab}	45.8^{c}	0.0016
Weight gain (%)	2405.78^{bc}	2406.32^{bc}	2998.91^{a}	2746.3^{ab}	2119.7^{c}	0.0007
Survival (%)	98.75^{a}	98.75a	91.25^{a}	97.50^{a}	97.50^{a}	0.9265
FCR	1.20^{a}	1.14^{ab}	1.04^{b}	1.11^{ab}	1.25^{a}	0.0070
IPF[2] (%)	1.7 ^{a}	2.2 ^{a}	2.1 ^{a}	2.0 ^{a}	1.1 ^{b}	0.0010
HSI[3] (%)	1.7 ^{b}	2.0 ^{b}	1.7 ^{b}	1.9 ^{b}	2.4 ^{a}	0.0120

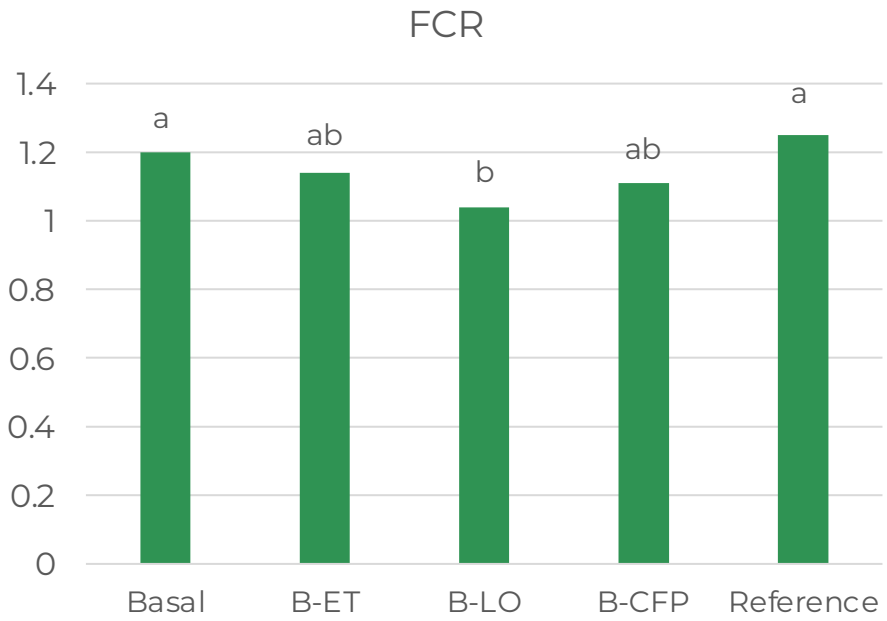
Paladines-Parrales, A. R., Nguyen, K. Q., Tabbara, M., Padeniya, U., Adeyemi, A., Lee, Y., Bruce, T.J. & Davis, D. A. (2025). Assessment of different dietary soybean meals and corn fermented protein in practical diets for fingerling channel catfish. Animal Feed Science and Technology, 321, 116239.



RESULTS

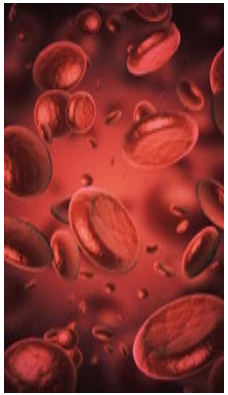
Response of **channel catfish** fingerling (2.14 ± 0.03 g mean weight) cultured over an 84-day period.





Paladines-Parrales, A. R., Nguyen, K. Q., Tabbara, M., Padeniya, U., Adeyemi, A., Lee, Y., Bruce, T.J. & Davis, D. A. (2025). Assessment of different dietary soybean meals and corn fermented protein in practical diets for fingerling channel catfish. Animal Feed Science and Technology, 321, 116239.

RESULTS



Compiled results of statistical analysis for bloodwork using a portable chemistry analyzer VetScan.

	Basal	B-F	B-LO	B-CFP	Reference	p-value
ALB (g L^{-1})	1.8	2.0	1.9	1.9	1.8	0.660
ALP (U l^{-1})	84.0	93.0	89.7	97.3	79.7	0.280
ALT (U l^{-1})	18.3	15.7	21.0	16.0	22.7	0.058
AMY (U L^{-1})	79.0	88.0	82.3	81.0	107.0	0.309
TBIL (µmol L^{-1})	0.30^{b}	0.40^{a}	0.33^{ab}	0.40^{a}	0.27^{b}	0.004
BUN (mmol urea L^{-1})	1.0	1.3	1.3	1.3	1.6	0.655
CA^{++} (mmol L^{-1})	12.4	12.9	12.4	12.6	12.7	0.843
PHOS (mmol L^{-1})	16.1	15.3	15.6	17.0	14.6	0.082
CRE (µmol L^{-1})	0.23^{ab}	0.20^{ab}	0.37^{a}	0.20^{ab}	0.03^{b}	0.048
GLU (mg dL^{-1})	79.7	75.0	82.7	84.3	74.3	0.896
NA^{+} (mmol L^{-1})	143.0	141.0	142.3	142.0	139.0	0.688
K^{+} (mmol L^{-1})	0.9	0.8	1.2	1.2	0.9	0.526
TP (g L^{-1})	3.5	3.7	3.5	3.5	3.5	0.587
GLOB (g L^{-1})	1.7	1.7	1.7	1.6	1.7	0.411

Paladines-Parrales, A. R., Nguyen, K. Q., Tabbara, M., Padeniya, U., Adeyemi, A., Lee, Y., Bruce, T.J. & Davis, D. A. (2025). Assessment of different dietary soybean meals and corn fermented protein in practical diets for fingerling channel catfish. Animal Feed Science and Technology, 321, 116239. ALB, Albumin; ALP, Alkaline Phosphatase; ALT, Alanine Aminotransferase; AMY, Amylase; TBIL, Total Bilirubin; BUN, Blood Urea Nitrogen; CA, Calcium; PHOS, Phosphorous; CRE, Creatinine; GLU, Glucose; NA+, Sodium; K+, Potassium, TP, Total Protein; GLOB, Globulin.

SOY AQUACULTURE
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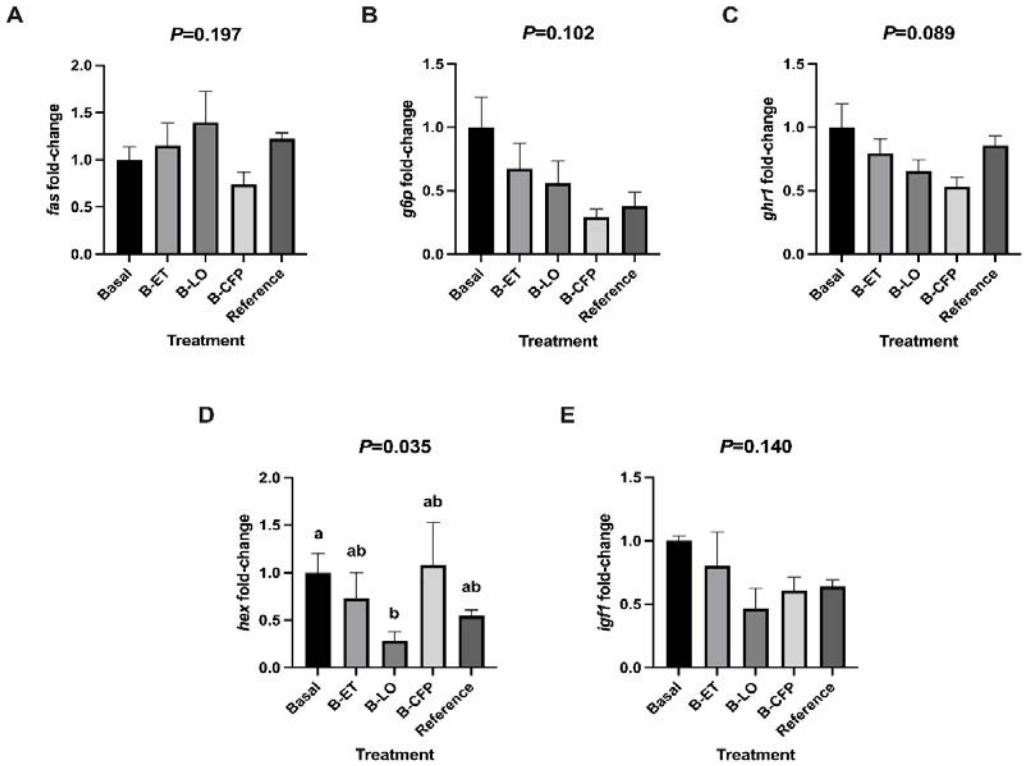
FIGURE 1. Liver gene expression of **channel catfish** fed different soybean substitutes. Values are represented as mean ± SEM of four replicate tanks and statistical analyses were performed on log-transformed data



* Targeted primers developed by Schroeter et al. (2018)

SOY AQUACULTURE ALLIANCE

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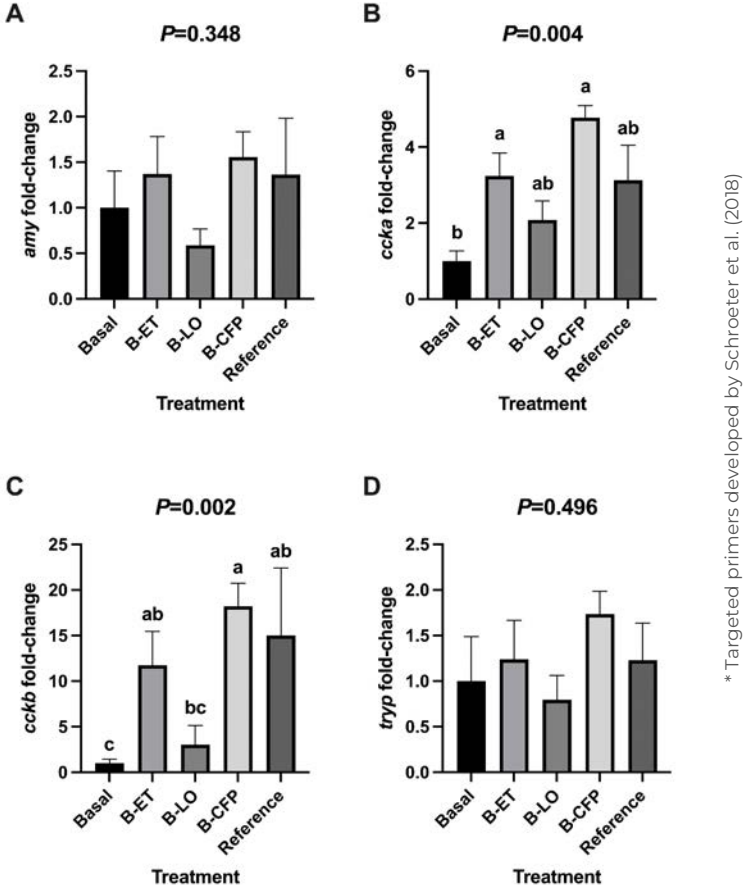
FIGURE 2. Intestinal gene expression of **channel catfish** fed different soybean substitutes. Values are represented as mean ± SEM of four replicate tanks and statistical analyses were performed on log-transformed data.



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SOY AQUACULTURE ALLIANCE

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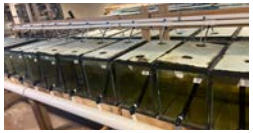
Hybrid catfish (**Channel catfish** ♀ crossed with blue catfish ♂) represents around 50% of the industry.

Blue Catfish Sperm
X
Channel Catfish Eggs

SOY AQUACULTURE
ALLIANCE

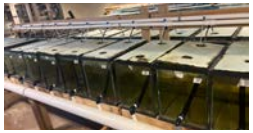


Response of **Hybrid catfish** (6.28 g ± 0.17g) stocked at 15 fish per aquaria and reared on 3 soy-based feeds in RAS over a 62-day period.

	Biomass (g)	Weight (g)	Weight gain (%)	FCR*	ANPR*	Survival %	HSI%*	IPF %*
Basal	797.68	55.05	785.18	1.0	43.5 ^{ab}	97.0	1.64	2.52 ^{a}
Basal- ET	765.03	51.00	717.31	1.1	40.43 ^{b}	100.0	1.57	3.42 ^{b}
Basal- LO	839.28	55.95	794.64	1.0	47.93 ^{a}	100.0	1.47	2.74 ^{a}
P-value	0.1122	0.0922	0.0612	0.0911	0.0270	0.1004	0.3904	0.0236

SOY AQUACULTURE ALLIANCE

Davis, D.A., et. al. *Advanced Soy in Production Diets for Catfish*. National Soybean Checkoff Research Database. July 17, 2025. https://www.soybeanresearchdata.com/Project.aspx?id=55551. FCR= feed conversion ratio, feed offered / (final weight-initial weight); ANPR = apparent net protein retention; HSI= hepatosomatic index; IPF= intraperitoneal fat; C.I. = condition index



Diet formulation (g/100g as is) and the proximate analysis (as is) of each diet (CP 40% and CL 8%) offered fingerling **hybrid catfish** (*I. punctatus* female x *I. furcatus* male) in 11-weeks growth trial in clear water aquaria.

Composition	SBM	LO-SBM 50%	LO-SBM 100%	ET-SBM 50%	ET-SBM 100%	SPC 50%	SPC 100%
Poultry byproduct meal[1]	14.00	14.00	14.00	14.00	14.00	14.00	14.00
Soybean meal[2]	**50.00**	**25.00**		**25.00**		**25.00**	
LO-SBM[3]		**20.96**	**41.92**				
ET-SBM[4]				**20.68**	**41.35**		
Soy Protein Concentrate[5]						**16.54**	**33.08**
Corn protein concentrate[6]	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Menhaden fish oil[7]	3.41	3.41	3.41	3.41	3.41	3.41	3.41
Soy oil	1.84	1.78	1.72	1.43	1.01	1.91	1.97
Lecithin (soy)[8]	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Corn Starch	0.00	4.10	8.20	4.73	9.48	8.39	16.79
Whole wheat	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Mineral premix[9]	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vitamin premix[10]	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Choline chloride[11]	0.20	0.20	0.20	0.20	0.20	0.20	0.20
CaP-dibasic[12]	1.75	1.75	1.75	1.75	1.75	1.75	1.75

Davis, D.A., et. al. *Advanced Soy in Production Diets for Catfish*. National Soybean Checkoff Research Database. July 17, 2025. https://www.soybeanresearchdata.com/Project.aspx?id=55551.

Response of juvenile **hybrid catfish** (initial mean weight 4.29±0.07g) *I. punctatus* female x *I. furcatus* male stocked at 20 fish per tank and reared on seven feeds after 11 weeks (78 days).

Treatments	Final weight (g)	Weight gain (g)	Weight gain (%)	FCR	TGC	ANPR (%)	Survival (%)
SBM	50.61	46.38	1099.40	1.08	0.73	36.64	98
LO-SBM50%	54.07	49.84	1178.72	1.04	0.78	36.79	99
LO-SBM100%	55.53	51.20	1182.72	1.05	0.80	37.75	100
ET-SBM50%	53.77	49.55	1174.10	1.04	0.78	38.84	99
ET-SBM100%	52.94	48.64	1130.57	1.05	0.76	37.25	100
SPC 50%	58.65	54.27	1236.62	1.03	0.85	37.00	100
SPC 100%	53.71	49.35	1133.52	1.05	0.77	36.46	99
PSE	1.7847	1.7634	37.7946	0.0179	0.0275	1.0514	0.8018
p-value	0.1140	0.1190	0.2433	0.5746	0.1230	0.7204	0.5162

SOY AQUACULTURE ALLIANCE

Davis, D.A., et. al. *Advanced Soy in Production Diets for Catfish*. National Soybean Checkoff Research Database. July 17, 2025. https://www.soybeanresearchdata.com/Project.aspx?id=55551.

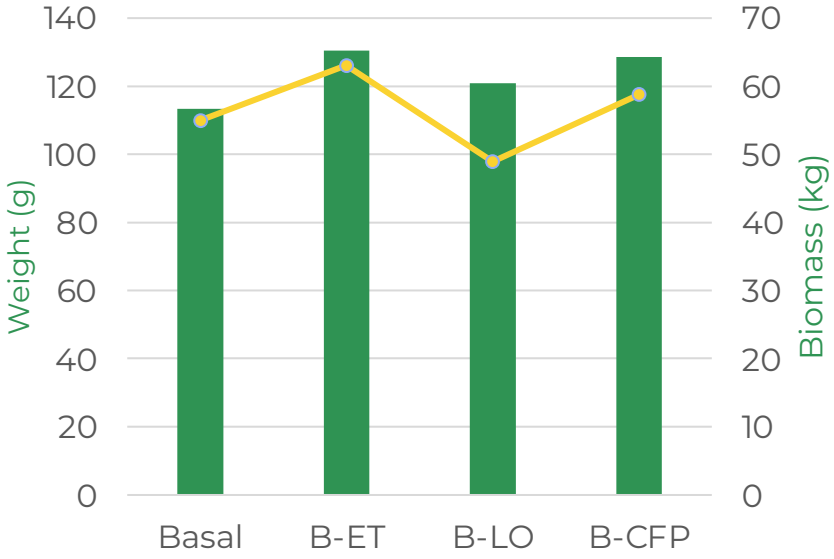
IN-POND RACEWAYS (ADV. FINGERLING AND GROWOUT)

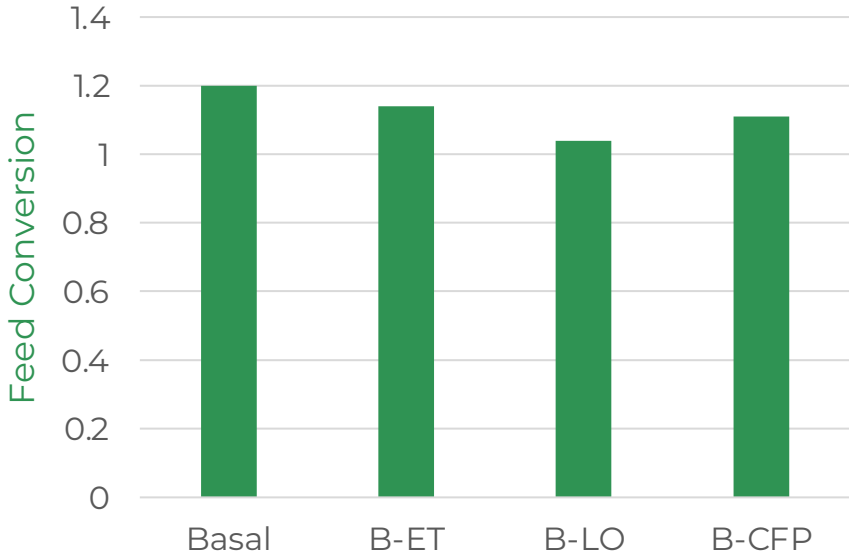
Response of **channel catfish** (*Ictalurus punctatus*) fingerlings (mean initial weight 32.56 ± 0.72 g) offered one of four practical diets over a 70-day feeding period conducted in an IPRS system. Four diets were open formulations (Table 1) using solvent-extracted soybean meal (Basal-36), enzyme treated soybean meal (B36-ET), low oligosaccharide soy (B36-LO), and SBM in combination with corn fermented protein (B36-CFP). Values represent the means for four experimental diets with three replicates each and were evaluated with an ANOVA followed by Tukey's HSD test.

	Basal	Basal-ET	Basal-LO	Basal-CFP	PSE[1]	p-value
Final biomass (kg)	54.97	63.06	48.93	58.79	4.55	0.2490
Final weight (g)	113.4	130.4	120.9	128.6	8.82	0.8276
Weight gain (g)	81.83	98.54	87.75	95.70	7.73	0.7326
Weight gain (%)	276	309	266	290	18.74	0.4426
Survival (%)	78.1	81.3	70.5	75.5	6.78	0.7304
FCR[2]	2.0	1.6	2.2	1.9	0.19	0.3056
ANPR[3] (%)	26.4	32.7	27.7	30.7	1.64	0.0934
Whole body analysis						
Dry matter	26.7 [b]	32.2 [a]	32.0 [a]	31.8 [a]	0.576	0.0004
Protein	14.3	15.6	15.1	15.7	0.324	0.0536
Lipid	11.8	15.3	13.9	13.0	0.799	0.0723
Ash	1.17 [b]	2.28 [a]	3.09 [a]	2.79 [a]	0.335	0.0164

Paladines-Parrales, A. R., Nguyen, K. Q., Tabbara, M., Padeniya, U., Adeyemi, A., Lee, Y., Bruce, T.J. & Davis, D. A. (2025). Assessment of different dietary soybean meals and corn fermented protein in practical diets for fingerling channel catfish. Animal Feed Science and Technology, 321, 116239.[1]Pooled Standard Error of Treatment Means, [2]Feeding Conversion Ratio, [3]Apparent Net Protein Retention

Response of **channel catfish** (*Ictalurus punctatus*) fingerlings (mean initial weight 32.56 ± 0.72 g) offered one of four practical diets (36% protein) over a 70-day feeding period conducted in an IPRS system.





SOY AQUACULTURE ALLIANCE

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Compiled statistical analysis results for bloodwork values obtained using a portable chemistry analyzer VetScan2 for **channel catfish** (*Ictalurus punctatus*) fingerlings (mean initial weight 32.56 ± 0.72 g) offered one of four practical diets over a 12-week growth trial in an IPRS system.

	Basal	Basal-ET	Basal-LO	Basal-CFP	PSE	p-value
ALB (g L^{-1})	2.1	2.2	2.3	2.2	0.12	0.397
ALP (U l^{-1})	23.3	24.7	26.7	29.3	4.0	0.245
ALT (U l^{-1})	13.7	14.3	15.7	16.3	5.5	0.899
AMY (U L^{-1})	61.7	53.7	52.7	71.7	17.0	0.413
TBIL (µmol L^{-1})	0.40^{b}	0.50^{a}	0.40^{b}	0.43^{ab}	0.03	0.009
BUN (mmol urea L^{-1})	1.0	1.7	1.0	1.0	0.3	0.052
CA^{++} (mmol L^{-1})	11.4	11.5	11.7	11.1	0.9	0.820
PHOS (mmol L^{-1})	9.4	9.4	9.2	8.6	1.3	0.802
CRE (µmol L^{-1})	0.47	0.47	0.43	0.37	0.15	0.743
GLU (mg dL^{-1})	28.7	23.3	32.7	24.7	8.1	0.407
NA^{+} (mmol L^{-1})	137.3	137.7	137.0	138.3	4.4	0.977
K^{+} (mmol L^{-1})	0.9	0.9	0.8	1.0	0.4	0.895
TP (g L^{-1})	3.9	4.0	4.0	4.0	0.2	0.859
GLOB (g L^{-1})	1.9	1.8	1.8	1.8	0.2	0.705

ALB, Albumin; **ALP**, Alkaline Phosphatase; **ALT**, Alanine Aminotransferase; **AMY**, Amylase; **TBIL**, Total Bilirubin; **BUN**, Blood Urea Nitrogen; **CA^{++}**, Calcium; **PHOS**, Phosphorous; **CRE**, Creatinine; **GLU**, Glucose; **NA^{+}**, Sodium; **K^{+}**, Potassium, **T.P.**, Total Protein; **GLOB**, Globulin.

Paladines-Parrales, A. R., Nguyen, K. Q., Tabbara, M., Padeniya, U., Adeyemi, A., Lee, Y., Bruce, T.J. & Davis, D. A. (2025). Assessment of different dietary soybean meals and corn fermented protein in practical diets for fingerling channel catfish. Animal Feed Science and Technology, 321, 116239.

GROWOUT: COMPOSITION OF THE DIETS.

	Basal	B-ET	B-LO	B-CFP
Soybean Meal[1]	56.4			44.5
Enzyme Treated SBM[2]		43.0		
Low Oligosaccharide SBM[3]			45.0	
Corn Fermented Protein[4]				10.0
Poultry Meal	8.0	8.0		8.0
Menhaden Fish Oil	2.0	2.0		2.0
Soy Oil	1.4	0		0.4
Corn	20.3	34.7	1.	22.8
Wheat Mids.	10.0	10.0	10.0	10.0
Premix	0.5	0.5	0.5	0.5
CaP-dibasic	1.8	1.8	1.8	1.8

[1] Solvent extracted soybean meal, Bunge; [2] Fermented soybean meal, HP300, Hamlet Inc.; [3] Low oligosaccharide soybean meal, Bright Day, Benson Hill; [4] Corn Fermented Protein CFP-GT33 (proprietary blend). Feeds were commercially extruded by Optimal Aquafeed Inc. Paladines-Parrales, A. R., Nguyen, K. Q., Tabbara, M., Padeniya, U., Adeyemi, A., Lee, Y., Bruce, T.J. & Davis, D. A. (2025). Assessment of different dietary soybean meals and corn fermented protein in practical diets for fingerling channel catfish. Animal Feed Science and Technology, 321, 116239.

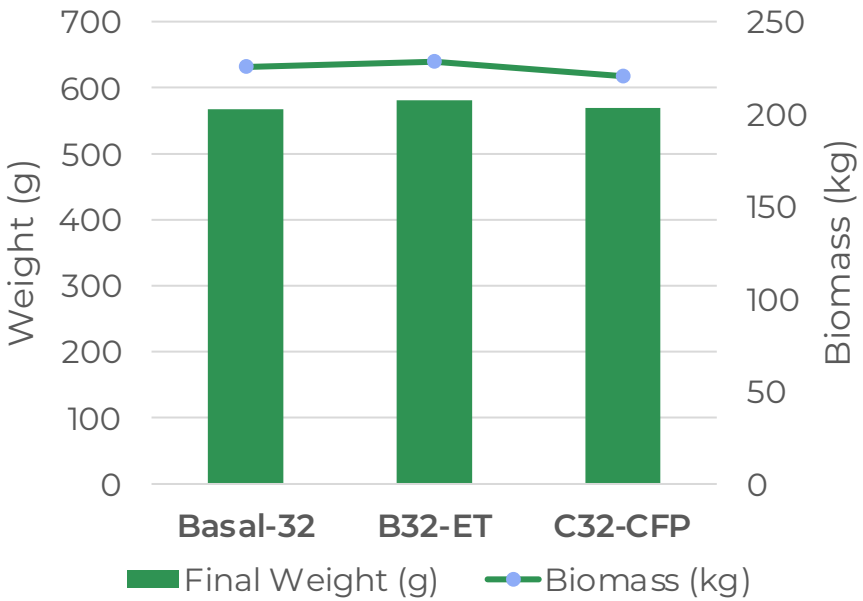
Response of **channel catfish** growth out (initial 102.88± 1.79g) stocked at 400 fish per raceway and reared on three feeds (Soybean meal, Enzyme-treated soy protein, and Corn fermented protein) after four months (109 days). Data was subjected to one-way ANOVA followed by a Tukey's Test to determine significant differences between treatments.

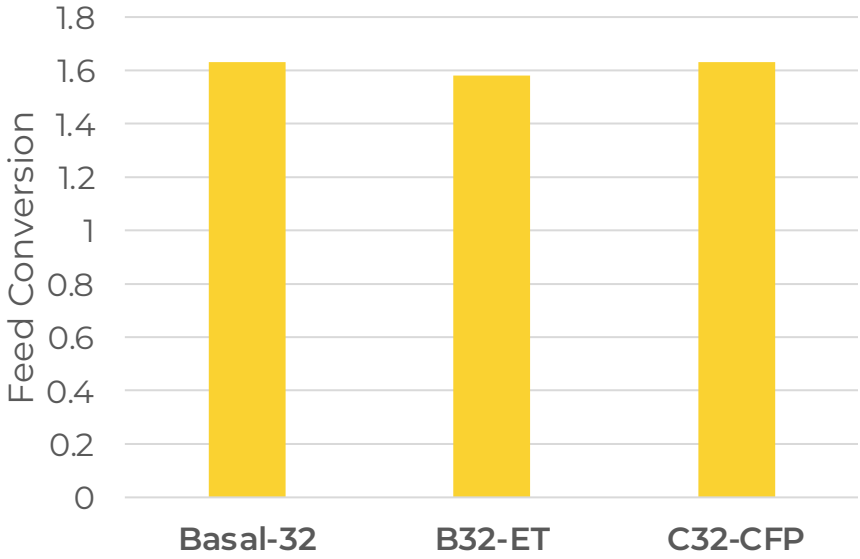
	Basal-32	B32-ET	C32-CFP	PSE[1]	p-value
Biomass (kg)	225.5	228.3	220.5	12.93	0.6982
Final weight (g)	567.0	580.7	569.5	20.57	0.6982
Weight gain (g)	462.9	477.0	468.7	18.54	0.5785
Weight gain (%)	445.7	462.4	465.5	33.77	0.6840
Survival (%)	99.38	98.25	96.81	3.08	0.7817
FCR[2]	1.63	1.58	1.63	0.0545	0.4886
ANPR[3] (%)	26.82	27.61	24.99	1.076	0.2584
IPF[4] (%)	5.73	5.52	5.11	0.4567	0.2046
HSI[5] (%)	1.30^{b}	1.47^{a}	1.29^{b}	0.0866	0.0283
Dress out (%)	37.16^{ab}	38.34^{a}	34.37^{b}	1.7740	0.0303

SOY AQUACULTURE ALLIANCE

[1]Pooled Standard Error of Treatment Means, [2]Feeding Conversion Ratio, [3]Apparent Net Protein Retention, [4]Intraperitoneal Fat Index, [5]Hepatosomatic Index. Paladines-Parrales, A. R., Nguyen, K. Q., Tabbara, M., Padeniya, U., Adeyemi, A., Lee, Y., Bruce, T.J. & Davis, D. A. (2025). Assessment of different dietary soybean meals and corn fermented protein in practical diets for fingerling channel catfish. Animal Feed Science and Technology, 321, 116239.

Response of **channel catfish** growth out (initial 102.88± 1.79g) stocked at 400 fish per raceway and reared on three feeds (Soybean meal, Enzyme-treated soy protein, and Corn fermented protein) after four months (109 days).





SOY AQUACULTURE ALLIANCE

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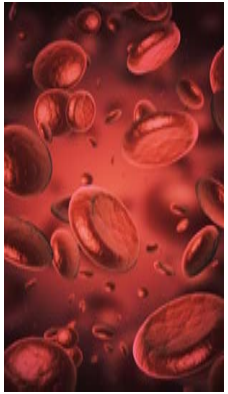
Compiled statistical analysis results for bloodwork values obtained using a portable chemistry analyzer VetScan2 for **channel catfish** (*Ictalurus punctatus*) advanced stockers (initial 102.88 ± 1.79g) offered one of three practical diets over a 109-day growth trial in an IPRS system.

	Basal	Basal-F	Basal-CFP	PSE	p-value
ALB (g/L)	2.2	2.3	2.2	0.0743	0.4024
ALP (U/l)	72.0	71.8	71.0	5.0952	0.9914
ALT (U/l)	13.3	14.0	12.3	0.9908	0.5684
AMY (U/l)	19.5	22.8	19.7	2.8417	0.6837
TBIL (µmol/l)	0.4	0.5	0.5	0.0228	0.1838
BUN (mmol urea/l)	2.5	2.5	2.3	0.2887	0.9140
CA^{++} (mmol/l)	14.2	17.0	14.0	0.7276	0.0403
GLU (mg/dl)	38.5	36.8	33.7	5.8960	0.8673
NA^{+} (mmol/l)	155.3	152.5	153.7	1.9074	0.6117
K^{+} (mmol/l)	6.5	6.8	6.6	0.4477	0.9226
TP (g/l)	4.4	4.7	4.5	0.1578	0.5406
GLOB (g/l)	2.3	2.4	2.2	0.0909	0.5336



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Hybrid catfish (**Channel catfish** ♀ crossed with blue catfish ♂) represents around 50% of the industry.

Blue Catfish Sperm
X
Channel Catfish Eggs

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IPRS-I: Response of **hybrid catfish** fingerlings (57.9 ± 3.6 g) stocked at 425 fish per raceway and reared on four soy-based feeds formulated to contain 36% protein and fed for a 137-day period in an IPRS. FCR is based on net gain and feed input.

	Final Biomass (Kg)	Average Weight (g)	Weight gain (g)	Weight gain (%)	FCR*	ANPR*	Survival
Basal	92.9	230.3	176.3	325.4	1.54	26.75 [b]	95.06
Basal-ET	105.2	254.8	193.8	320.0	1.41	32.40 [ab]	96.00
Basal-LO	125.2	294.6	236.2	404.5	1.29	37.06 [a]	100.00
Basal-CFP	127.5	300.8	242.6	417.2	1.37	32.84 [ab]	98.98
P-value	0.3454	0.2231	0.2421	0.2717	0.1221	0.0384	0.9302

SOY AQUACULTURE ALLIANCE

Davis, D.A., et. al. *Advanced Soy in Production Diets for Catfish*. National Soybean Checkoff Research Database. July 17, 2025. https://www.soybeanresearchdata.com/Project.aspx?id=55551.

IPRS-II: Response of **hybrid catfish** (226.5 g ± 13.1 g) stocked at 350 fish per raceway and reared on four soy-based feeds in IPRS over an 81-day period.

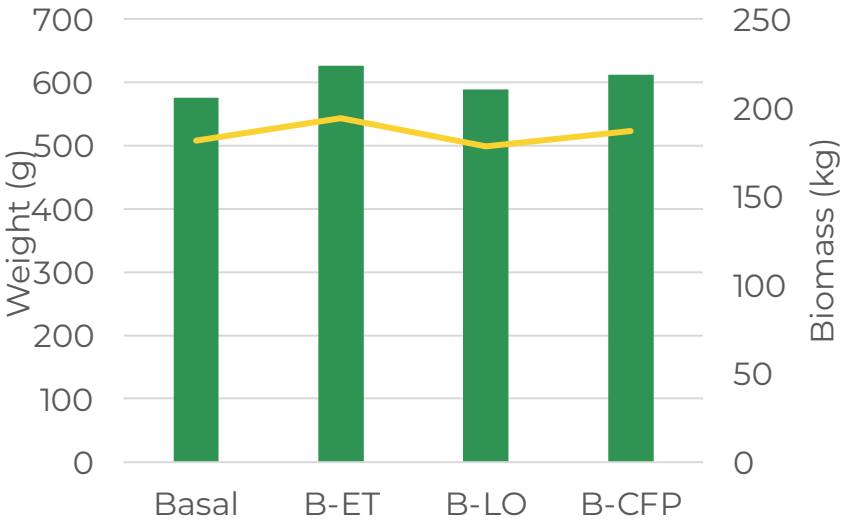
	Final Biomass (Kg)	Average Weight. (g)	Weight gain (%)	FCR*	ANPR*	Survival %	HSI %	IPF %	CI %
Basal	181.2	575.2	151.13	2.2	21.34	90.1	1.74	4.51	1.07
Basal-ET	194.0	626.4	180.69	1.4	22.00	88.5	1.83	4.58	1.08
Basal- LO	178.1	589.1	163.19	1.8	27.01	86.6	1.66	4.29	1.12
Basal-CFP	186.6	611.6	167.72	2.0	25.91	87.3	1.70	4.71	1.11
P-value	0.4803	0.4814	0.3804	0.2083	0.1852	0.8521	0.6090	0.7806	0.6903

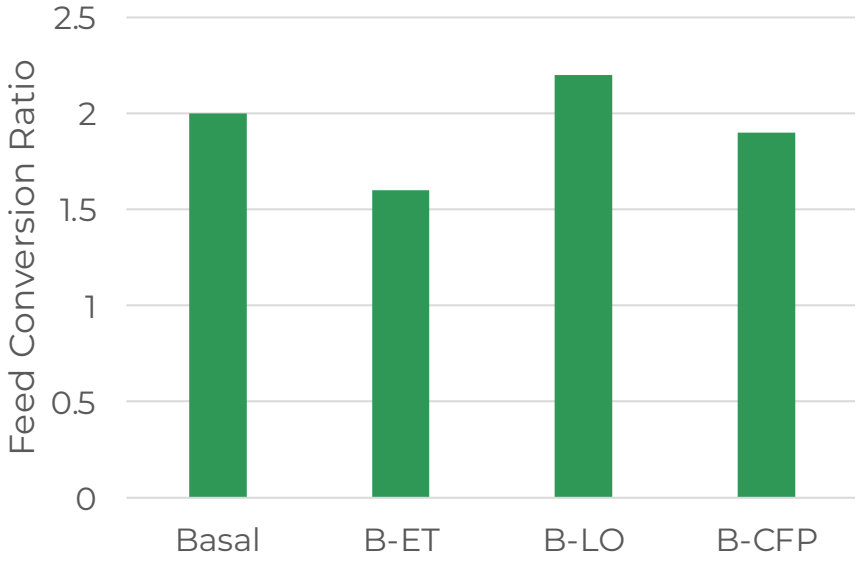
Davis, D.A., et. al. *Advanced Soy in Production Diets for Catfish*. National Soybean Checkoff Research Database. July 17, 2025. https://www.soybeanresearchdata.com/Project.aspx?id=55551.

FCR = feed conversion ratio, feed offered / (final weight-initial weight); ANPR = apparent net protein retention; HSI= hepatosomatic index; IPF= intraperitoneal fat; CI = condition index

SOY AQUACULTURE ALLIANCE

Response of **hybrid catfish** (226.5 g ± 13.1 g) stocked at 350 fish per raceway and reared on four soy-based feeds in IPRS over an 81-day period.





SOY AQUACULTURE ALLIANCE

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EXPERIMENTAL DESIGN - OBJECTIVES

BUNGE

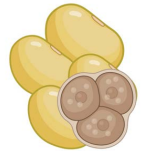
Solvent Extracted soybean meal

HAMLET PROTEIN™

HP300: Enzyme treated soybean meal (ET)

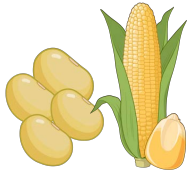
BENSON HILL

Bright Day: Selected variety with high protein and low oligosaccharides (LO).



BUNGE + CFP-GT33

Corn Fermented protein (CFP)



OUR OBSERVATION

- Very different response to soy products across species
  - Channel catfish, tilapia, red drum, Florida pompano, trout

- There were some indications of the potential to improve typical practical diets for catfish using advanced soy products. However, catfish are very tolerant to solvent extracted soybean meal so there is little advantage
- In other species that are less tolerant to SE-Soybean meals there are clear advantages to more processed soy protein sources
- In higher protein diets (fingerlings) there seem to be advantages due to higher protein content and lower levels of antinutrients

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FUTURE OF U.S. CATFISH INDUSTRY

- For the catfish industry to thrive in the U.S. farmers will need to use innovative techniques to address production and disease-related issues, adequately manage feeds, and improve marketing efforts to remain competitive in a global market
- The catfish industry has always been and continues to be a leader and catalyst for U.S. aquaculture

Photo Credit: Dr. Anita Kelly, Auburn University

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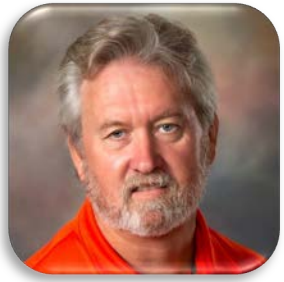
THANK YOU TO US SOY FARMERS FOR THE SUPPORT.



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