

# FARM-RAISED,

ON LAND & in WATER



## Purpose of study

# Selectively bred, high-protein soybean meals for commercial production of California yellowtail

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## Purpose

This study investigated the inclusion of three different soybean meal (SBM) products in existing formulations for California yellowtail (*Seriola dorsalis*) using up to 34% SBM solely or in combination. This was done toward both increasing the inclusion rate of soy products as feed and developing new markets (additional species, life stages, and/or products) where soy can be introduced.

## Objectives

The California yellowtail represents a high-value species with an existing market for fresh sushi-grade product and successful rearing methods in hatchery and growout. High-protein selectively bred strains of soy meal were fed in a laboratory optimization trial of the yellowtail in order to further maximize the inclusion levels of soy meal in marine fish diets. Among the SBM

products was a high-protein (58%) variety produced by Benson Hill.

## Study Design

The eight-week feeding study was conducted in a 24-tank recirculating system at Hubbs-SeaWorld Research Institute's laboratory in San Diego, CA. Juvenile yellowtail were fed various formulations using three different SBMs for a total of five treatment combinations and a fishmeal control. Each treatment had four replicates for statistical validity. Initially the study began with fish that averaged 5 grams individual weight, but these fish did not accept the diets, including the control. Through experimentation, researchers found a 10% fishmeal mix was finally accepted, at which point the fish weighed an average of 16g.

Biochemical composition of the feed and whole fish was determined at the end of the study, along with growth and survival metrics, and health assessments histopathology and gene expression. Samples of distal intestine were collected, stored in DNA/RNA Shield, and processed for histology and stained with H&E for analysis. Slide images were randomized and were qualitatively assessed blind by three independent reviewers using a grading system by Barnes et. al. (2014).



## Diet formulations for six treatments fed to replicate groups of yellowtail starting at 16g.

	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6
Menhaden fishmeal <sup>1</sup>						212.0
Chicken by product meal <sup>2</sup>	200.0	200.0	200.0	200.0	200.0	0.0
SE Soybean meal <sup>3</sup>	380.0					380.0
SBM Bright Day <sup>4</sup>		320.0		412.0		0.0
SPC Soycomil PE <sup>5</sup>	80.0	80.0	80.0			80.0
SBM Hamlet HP 300 <sup>6</sup>			308.0		398.0	
CPC - Empareal 75 <sup>7</sup>	85.0	85.0	85.0	85.0	85.0	85.0
Menhaden fish oil <sup>8</sup>	67.9	68.9	64.7	68.9	63.5	76.2
Corn Starch <sup>9</sup>	15.2	74.2	90.4	62.2	81.6	0.5
Whole wheat <sup>10</sup>	130.0	130.0	130.0	130.0	130.0	125.0
Mineral premix <sup>11</sup>	2.5	2.5	2.5	2.5	2.5	2.5
Vitamin premix <sup>12</sup>	5.0	5.0	5.0	5.0	5.0	5.0
Choline chloride (0.2% all diets) <sup>9</sup>	2.0	2.0	2.0	2.0	2.0	2.0
Rovimix Stay-C 35% <sup>12</sup>	1.0	1.0	1.0	1.0	1.0	1.0
CaP-dibasic <sup>9</sup>	25.0	25.0	25.0	25.0	25.0	25.0
Methionine <sup>13</sup>	1.4	1.4	1.4	1.4	1.4	0.8
Taurine <sup>13</sup>	5.0	5.0	5.0	5.0	5.0	5.0

<sup>1</sup> Special Select™, Omega Protein Inc., Houston, Texas, USA.

<sup>2</sup> River Valley Ingredients., 1170 Country Road 508. PO. Box 429 Hanceville, AL.

<sup>3</sup> Solvent Extracted Soybean Meal, De-hulled solvent-extracted soybean meal, Bunge Limited, Decatur, AL, USA.

<sup>4</sup> Benson Hill, St. Louis, MO 55.1% protein.

<sup>5</sup> Hamlet Protein Inc., Findlay, OH 56.0% protein.

<sup>6</sup> Empyrean 75™, Cargill Corn Milling, Cargill Inc., Blair, Nebraska, USA.

<sup>7</sup> Omega Protein Inc., Reedville, Virginia, USA.

<sup>8</sup> MP Biomedicals Inc., Solon, OH, USA.

<sup>9</sup> Bobs Red Mill Natural Foods, Milwaukie, OR, USA.

<sup>10</sup> Trace mineral premix (g/100g premix): cobalt chloride 0.004, cupric sulphate pentahydrate 0.250, ferrous sulphate 4.0, magnesium sulphate anhydrous 13.862, monohydrate 0.650, potassium iodide 0.067, sodium selenite 0.010, zinc sulphate heptahydrate 13.193, filler 67.964.

<sup>11</sup> Vitamin premix (g/kg premix): Thiamin HCl 0.751, riboflavin 4.505, pyridoxine HCl 1.502, D-Pantothenic acid hemicalcium salt 7.508, nicotinic acid 7.508, biotin 0.075, folic acid 0.270, vitamin B12 0.003, inositol 7.508, menadione 3.003, vitamin A acetate (500,000 IU/g) 0.300, vitamin D3 (1,000,000 U/g) 0.60, DL-α-tocopheryl acetate (250/ IU g-) 12.012, α-cellulose 804.847.

<sup>12</sup> Stay C®, (L-ascorbyl-2-polyphosphate 35% Active C), Roche Vitamins Inc., Parsippany, New Jersey, USA.

<sup>13</sup> TCI (Tokyo Chemical Industry), Portland, OR, USA.

## Results

The trial was successfully run for eight weeks, during which time the fish grew to a maximum average of 141 g. Survival was high among all treatments (>96%) and feed conversion ratios (FCRs) were low (1.11-1.16). There were no statistical differences among treatments for any performance measurement.

After it was shown the 5g fish would not accept the diets presented, including the fishmeal control, and further diet combinations were tested, those diets were also tested on subgroups of fish held separately from the main experiment. Two of those diets were consumed readily by these subgroups, suggesting the size of fish may play an important role in diet acceptability.

### Benefit for the Soybean Farmer

With similar performance in fish (growth, survival, FCR) fed SBM as those fed the fishmeal control, this suggests there is room to sell more soy meal feed formulation for California yellowtail. This is good news for soybean producers looking to market more of their volume to the fisheries sector.

### Next steps

This study showed fish performance was not impacted by different SBMs or different inclusion rates used in it; in fact, performance was similar to the fishmeal control. This bodes well for future commercial application. Further refinements are needed to include more SBM in the diets.

The study suggested it is possible larger fish would have performed well on the zero-fishmeal formulations fed to the 5g fish. Larger fish would be the target for growout trials where most of the feed biomass is consumed, so this should be explored in future research. Additional research should be conducted with a longer time period to better understand response in a standard growout period.

### Producer implications

- Commercial California Yellowtail producers can push soy inclusion to 34% during growout with no apparent change to fish health
- The inclusion of soy at 34% maintains a solid FCR of 1.2 for yellowtail, which may improve profitability and sustainability of other feed ingredients
- Yellowtail grow very fast among marine fish species - from 16 to 141g (9-fold) in only two months in this study
- Juvenile yellowtail below 5g apparently require a different formulation that will need to be determined. Soy formulations applied here should be considered starting at a 15g size in fish development



Increased soybean efficiency