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FINAL REPORT for Contract RG001-20

TITLE: Enhancing Sorghum Opportunities in Domestic and Export Aquafeed Sectors

Species: Hybrid Striped Bass

Enhancing Sorghum Opportunities in Domestic and Export Aquafeed Sectors.

Objective #1 - *From the previously funded rainbow trout research which developed proximate analyses for the following sorghum varieties such as; commodity #2 or higher grade, tan and/or white and high protein sorghum; from the most promising varieties, conduct baseline digestibility coefficients in* ***hybrid striped bass (HSB)****.*

In support of this objective, the VSAREC acquired live HSB in April of 2021. While these fish were supposed to average 200 g, they averaged over 700 grams. This was observed as a challenge because the fish were significantly larger than anticipated. These were the only live HSB available at the time. After significant internal discussion by PI/Co-Pi's, aside from needing more food for the trial, it was expected that all should go as planned. The USDA/ARS lab in Bozeman, MT, completed formulation and manufacturing of the HSB digestibility diets in June and shipped said diets to the VSAREC. The HSB digestibility trials commenced at the VSAREC in June, with the trial completed by the 4th week of June. During the course of the digestibility trial, there was ongoing concern about the fishes' low feeding response, and subsequent low feces production; which is the critical material needed for analysis in digestibility trials. At the end of the 4th week, due to feeding and feces collection, the trial was ended. There was general agreement this poor feeding performance was due to the fish being too large for the trial. The HSB digestibility trial is scheduled to be redone in the spring of 2022 with the appropriately sized fish.

After the original unsuccessful HSB sorghum digestibility trial conducted in the spring of 2021, this work was completed with support from Dr Sealey's USDA/ARS lab in Bozeman, as well as

Dr. Rawle's Lab from the USDA/ARS facility in Stuttgart, Arkansas. For the digestibility trials, hybrid striped bass were cultured at the Harry K Dupree Stuttgart National Aquaculture Research Center, Stuttgart, AR. In the summer of 2022, Dr. Sealey manufactured the HSB digestibility diets, and Dr Rawles conducted the HSB nutrition digestibility trial in Stuttgart. Resultant data and samples were sent to Dr. Sealey at the USDA/ARS Bozeman lab for further analysis; with the following resultant data.

Table 7. ADCs for sorghum varieties determined in Hybrid Striped Bass.

			Red Sorghum		Supersack Sorghum
ADCs					
	Dry Matter		44.5		38.8
	Crude lipid		92.2		73.6
	Crude protein		59.2		75.1
	Gross energy		51.0		48.1
	Phosphorus		30.5		22.2

Objective #2 - *Conduct baseline and optimizing nutrition trials with **hybrid striped bass** utilizing optimal varietals from Objective 1.*

In the summer of 2022, six hundred fingerling HSB were purchased from Artesian Aquafarms in NC, transported to the VSAREC, and raised to forty grams over a period of two months, the target size to begin the HSB nutrition trial. This trial was initiated in the fall of 2022. Fish were randomly stocked in 500 liter tanks, ten fish per tank. Fish were weighed at stocking so that every tank of fish was within two percent plus/minus every other tank of fish. Fish were fed twice a day, and fish were weighed as a tank every three weeks to monitor their growth. Fish feed was also weighed and recorded by tank number so that food conversion ratios could be determined by individual tanks. Water quality parameters of Dissolved Oxygen, and Temperature were collected and recorded daily. Total Ammonia, Nitrogen, Nitrites, Nitrates, pH, and Alkalinity were collected and recorded at least once a week. The study ran for nine weeks, and at week nine fish from each tank had individual weight and total length recorded. Five fish from each tank were frozen for whole body analysis and three fish were dissected to obtain viscera, liver and filet weights. The trial ended December 21, 2022. Resultant data and samples

were sent to Dr. Sealey at the USDA/ARS Bozeman lab for further analysis. Resultant HSB growth performance data.

Table 8. Composition of the practical-type control diet (% dry-weight) to which sorghum was substituted at four levels and fed to hybrid striped bass.

Ingredients	(% dry-weight)			
	S0	S5	S10	S20
Menhaden Fish Meal	*13.55*	*13.55*	*13.55*	*13.55*
Poultry by-product meal	*14.00*	*14.00*	*14.00*	*14.00*
Corn protein concentrate	*5.00*	*5.00*	*5.00*	*5.00*
Blood meal	*5.00*	*5.00*	*5.00*	*5.00*
Feather meal	*5.00*	*5.00*	*5.00*	*5.00*
Soybean meal	*13.00*	*13.00*	*13.00*	*13.00*
Red Sorghum	0.00	5.00	10.00	20.00
Wheat flour	20.00	15.26	10.54	1.06
Monocalcium phosphate	2.45	2.40	2.30	2.20
Lysine HCl	2.45	2.44	2.43	2.41
DL-Methionine	0.65	0.64	0.63	0.61
Threonine	0.67	0.66	0.66	0.64
Lecithin	*1.50*	*1.50*	*1.50*	*1.50*
Stay-C 35	*0.20*	*0.20*	*0.20*	*0.20*
Vitamin premix ARS 702	*1.00*	*1.00*	*1.00*	*1.00*
Choline chloride 50%	*1.00*	*1.00*	*1.00*	*1.00*

Yttrium oxide	*0.10*	*0.10*	*0.10*	*0.10*
TM ARS 1440	*0.10*	*0.10*	*0.10*	*0.10*
Astaxanthin	*0.08*	*0.08*	*0.08*	*0.08*
CaProprionate	*0.15*	*0.15*	*0.15*	*0.15*
Menhaden Fish Oil	7.55	7.46	7.38	7.20
Poultry Fat	6.55	6.46	6.38	6.20
Analyzed composition				
Crude protein (%)	47.5	48.3	49.3	49.4
Crude fat (%)				
Energy (cal/g)	*5261*	5276	5286	5303
Total P (%)				
Pellet Durability (% pellet loss ± sd)	*20.6±1*	*18.6±1*	*15.3±1*	*14.7±2*

Table 9. Growth performance and body condition indices of juvenile hybrid striped bass (27.1 ± 0.1 g) fed test diets containing sorghum for 9 weeks.

Inclusion level	9-week data				Condition Indices	
	Final Fish Wt (g) [1]	Percent Increase (%) [2]	FCR (feed g/gain g)[3]	Intake (%) [4]	Fillet Ratio (%) [5]	Hepatosomatic Index (%)[6]
0%	80.7	198	0.88	3.5	39.2	2.0
5%	89.7	231	0.70	2.9	40.4	2.0
10%	80.2	196	0.84	3.2	40.1	2.0
20%	72.1	166	1.00	3.6	39.8	1.6
P value	0.0689	0.0735	0.0794	0.4190	0.7618	0.0531
Pooled SEM	5	18	0.1	0.3	0.8	0.2

[1] Final tank weight (g) / number of fish in the tank.

[2] Percent increase (%) = (final weight – initial weight) x 100 / initial weight.

[3] FCR, feed conversion ratio = g feed consumed / g weight gained.

[4] Feed intake (%) = g dry feed consumed/average fish biomass (g) /culture days x 100.

[5] Fillet ratio (%) = fillet with rib mass X 100 / fish mass.

[6] Hepatosomatic index (%) = liver mass X 100 / fish mass.

Objective #3 - Conduct economic analysis of results from industrial context.

Based upon the current data generated in this study, it appears **as a substitute carbohydrate source, sorghum can be incorporated into commercial HSB diets at about 10%**. This will certainly become of greater interest as more producers potentially target production of non-GMO products. Current domestic HSB production was about 8,688 tonnes in 2018 (https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/Aquaculture/aqua_1_0002_0002.pdf). If we utilize a very conservative 2.2 FCR, at 10% dietary inclusion, that yields about 19,113 tonnes of feed needed on an annual basis, or potentially 1,911 tonnes of sorghum per year. If we similarly use HSB as a reference species for seabream/seabass (would need feed trial verification), combined, 2020 data (Rabobank: Global farmed seabass, seabream production moves to more stable footing | IntraFish.com) shows global seabream/seabass production of approximately 480,000 metric tons. If we utilize a very conservative 2.2 FCR, at 10% dietary inclusion, that yields about 1,056,000 tons of feed needed on an annual basis, or potentially 105,600 tons of sorghum per year.

Furthermore, this data helps validate the current ongoing initiatives to optimize and test novel sorghum protein concentrates in RBT as a salmonid reference species, tilapia as a warm water/ freshwater omnivore, and pompano as a target warmwater marine species.