



# Alfalfa Leaf Protein Concentrate In Aquafeeds To Enhance Finfish Production And Reduce Environmental Impacts In Aquaculture Production

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## ABSTRACT

Bottlenecks to sustainable aquaculture include identifying acceptable plant proteins for fish feeds. Alfalfa foliage can be refined into a high protein concentrate (alfalfa nutrient concentrate; ANC) that shows promise for use in fish feeds as an alternative to fishmeal.

The project has the following objectives:

1. Evaluate ANC as an ingredient in feed for rainbow trout.
2. Evaluate the effect of ANC with plant defensin and phytase for improving rainbow trout growth, well-being, and immunity.
3. Carry out a techno-economic and market analysis of ANC production.

Five test diets were formulated to replace fishmeal with different levels of ANC (0, 5, 10, 15, and 20%). The durability index of pellets was significantly higher in the feed with 10 to 20% ANC than that in the control and the 5% ANC diets. Bulk density of pellets was significantly increased by ANC inclusion. The control and the pellets containing 5 to 10% ANC maintained neutral buoyancy. The increased density of feed pellets due to inclusion of ANC may facilitate storage or shipping and make the feed easy to handle because of the increased durability.

Palatability by rainbow trout did not change due to the inclusion of ANC. The apparent digestibility coefficient (ADC) of dietary protein was similar but the ADC of dry matter and phosphorus was significantly lower in the 20% APC diet. The test diets had no significant impacts on fish morphology (condition factor, carcass index, hepatosomatic index, visceral fat index). Proximate compositions of whole fish and liver tissues were not significantly different among dietary treatments except that the protein content of fish fed the 5% APC diet was higher than that of fish on other diets.

The results of this study provide baseline information for the potential of ANC as fishmeal replacement in diets for rainbow trout.

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## Need for Research

A major challenge facing the world in the 21<sup>st</sup> century is feeding the growing human population. Aquaculture is the fastest growing food sector in the world. Traditionally, aquaculture feeds contained high levels of fishmeal derived from wild fish. However, global fishmeal production is declining, and alternative plant-based protein and oil replacements are needed for sustainable aquafeed production.

Alfalfa produces more protein per acre than any other crop. Alfalfa nutrient concentrate (ANC) has more lysine than high lysine corn, more methionine and less water insoluble cell walls than soybean protein, is rich in linolenic acid, and has very low concentrations of the antinutrients found in seed-derived protein meals.

This research will determine the viability of ANC as an alternative to fishmeal in aquaculture feeds and provide an economic analysis of ANC production. The goal of this project is to lay the groundwork for commercialization of value-added products from alfalfa to expand alfalfa use and acreage through increased profitability.

## Methods

- Test diets contained 0, 5, 10, 15, 20% ANC to replace fishmeal
- Culture system: flow through water with a temperature 15° C
- Fish: 15 or 30 rainbow trout/tank, three replications/diet. Initial body weight 19 g

### 8 weeks



Feeding response  
 Fecal particle distribution  
 Digestibility

### 9 weeks



Growth performance  
 Nutrient utilization  
 Metabolism

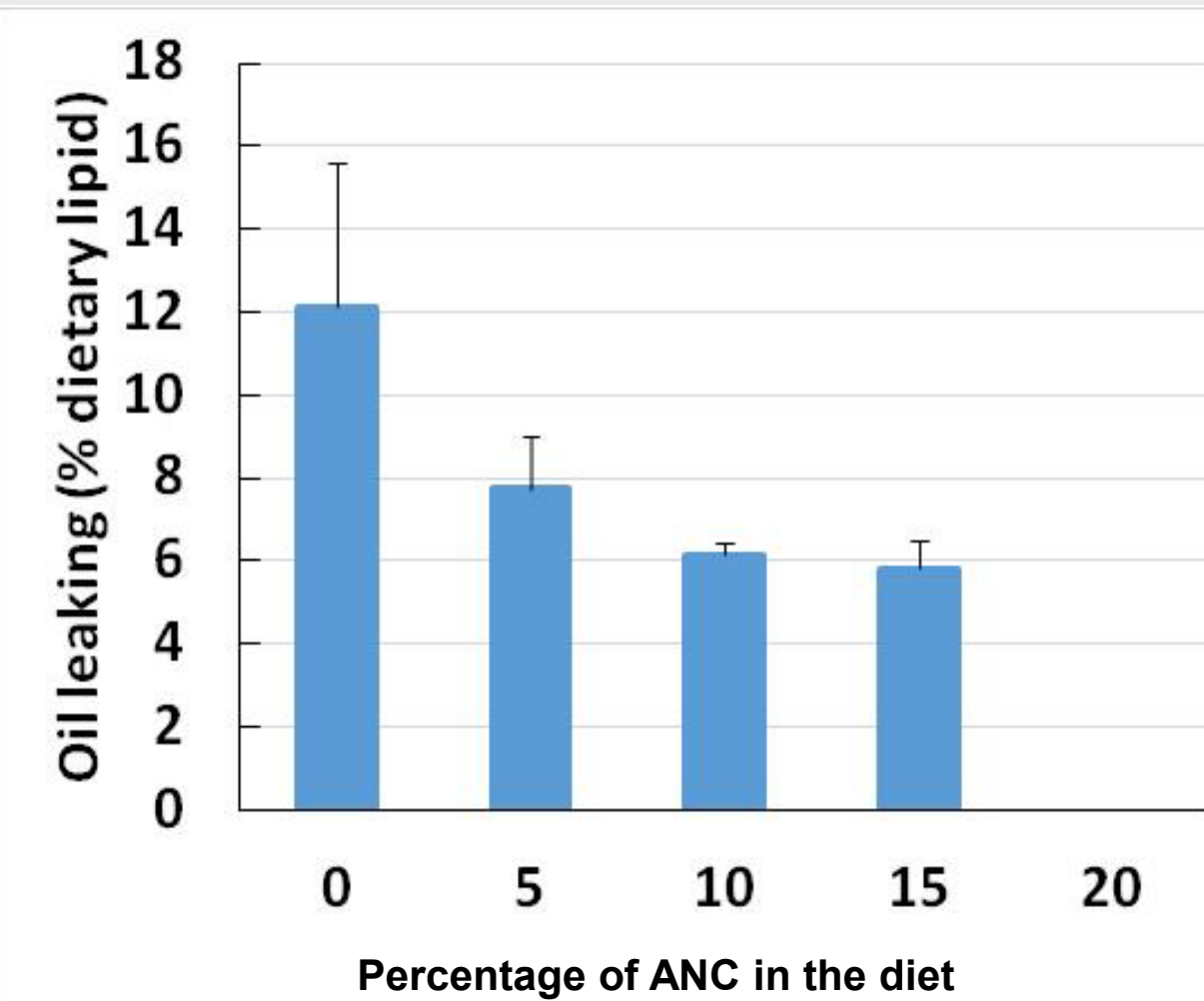
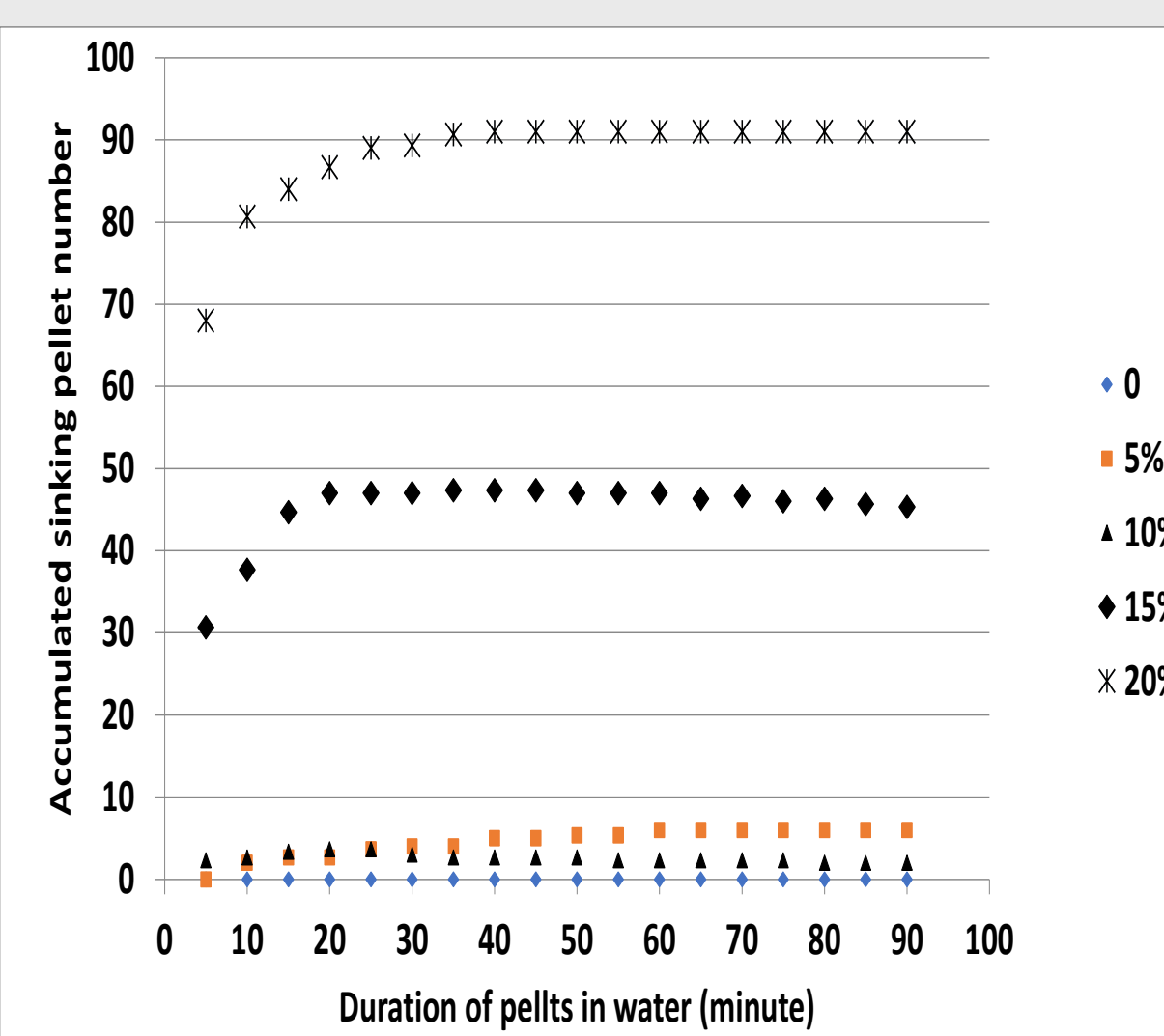
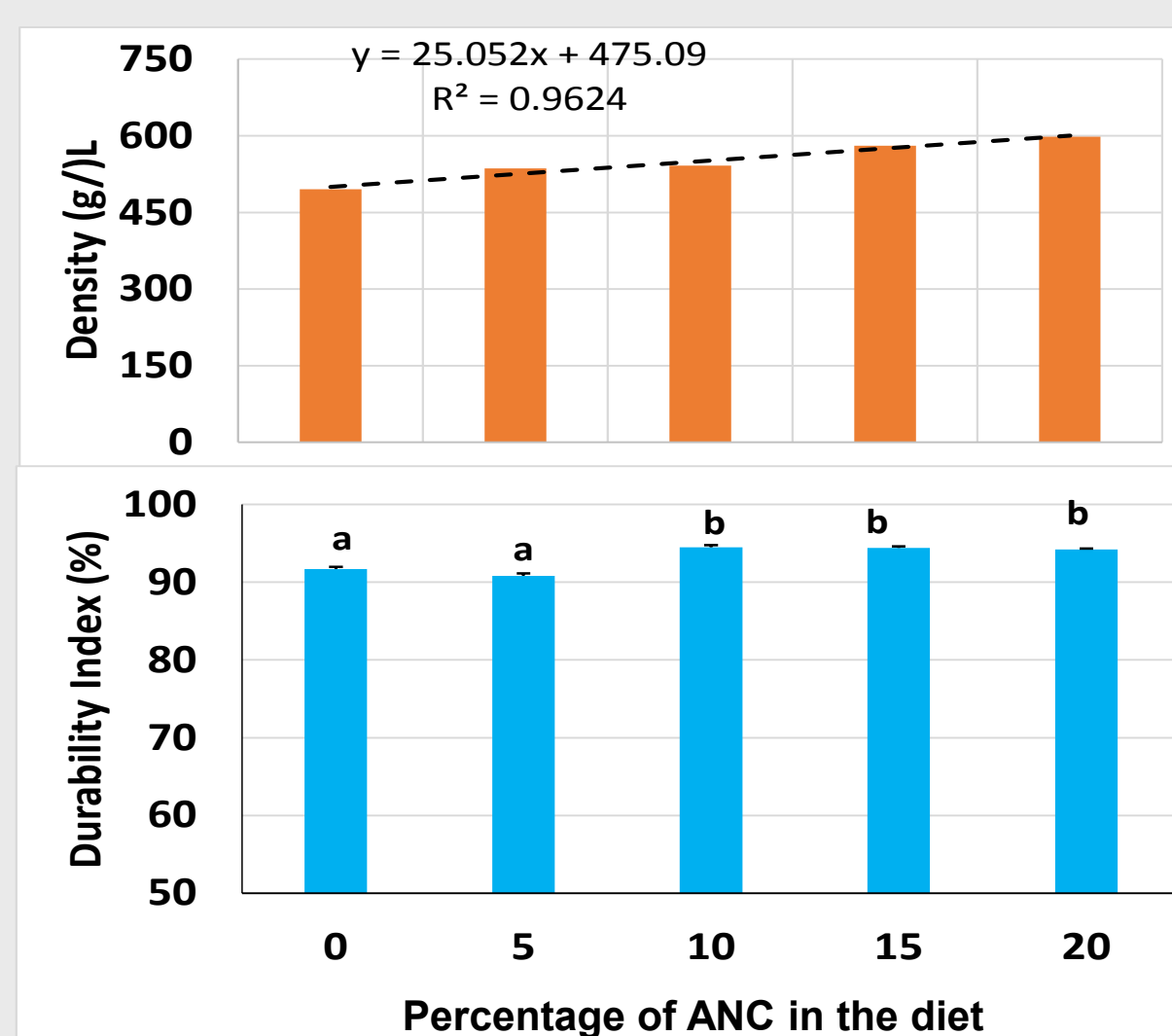
## Test Diets

Ingredients (%)	ANC-0	ANC-5	ANC-10	ANC-15	ANC-20
Menhaden fishmeal	32	29.1	26.2	23.3	20.5
Alfalfa nutrient concentrate (ANC)	0	5	10	15	20
Corn & soy protein concentrates	22	22	22	22	22
Poultry blood meal	8	8	8	8	8
Menhaden fish oil	9	9.24	9.46	9.69	9.94
Soybean oil	3	2.36	1.71	1.07	0.43
Wheat flour	16.34	14.33	12.45	9.93	7.79
Others	9.66	9.97	10.56	10.99	11.42
Total	100	100	100	100	100

## Physical Quality of Feed Pellets

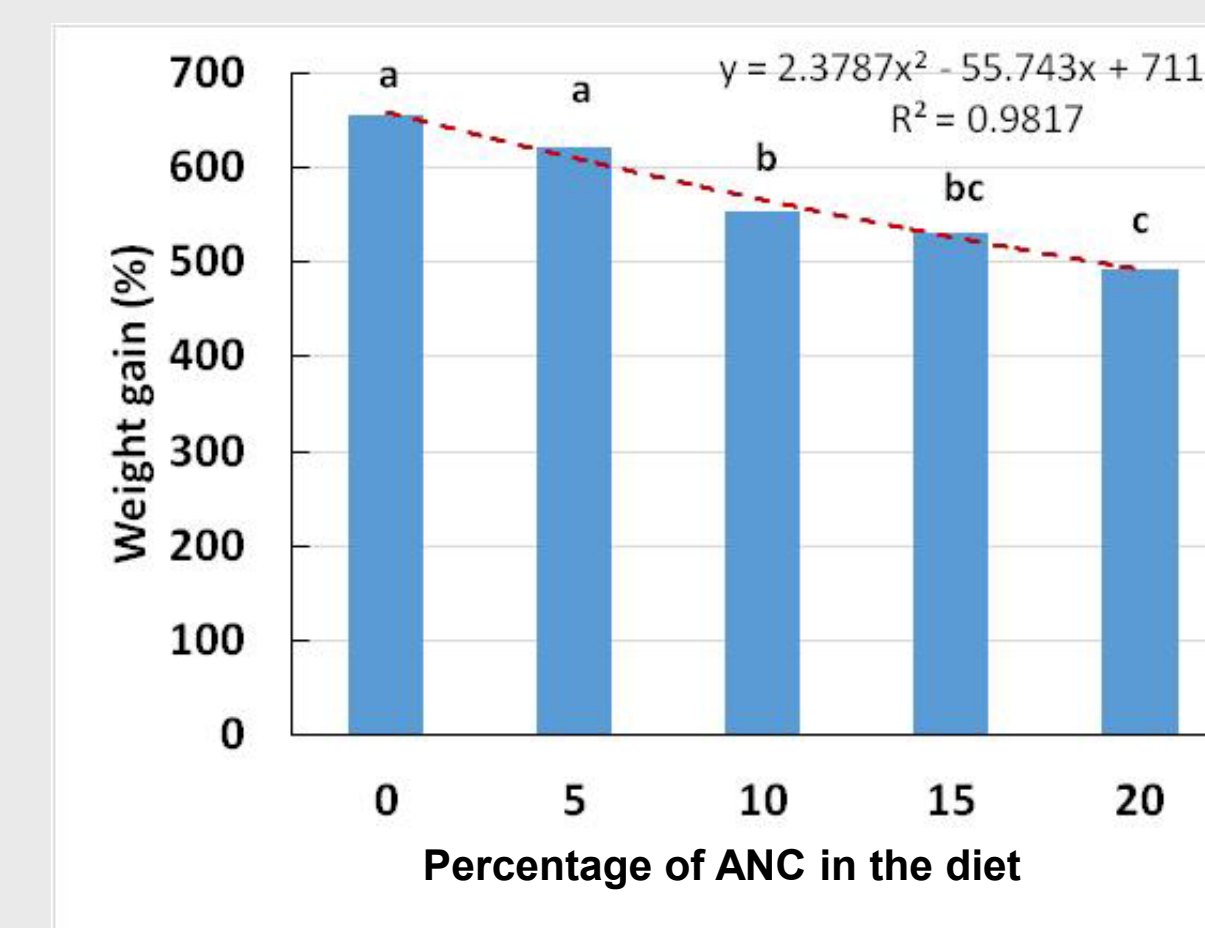
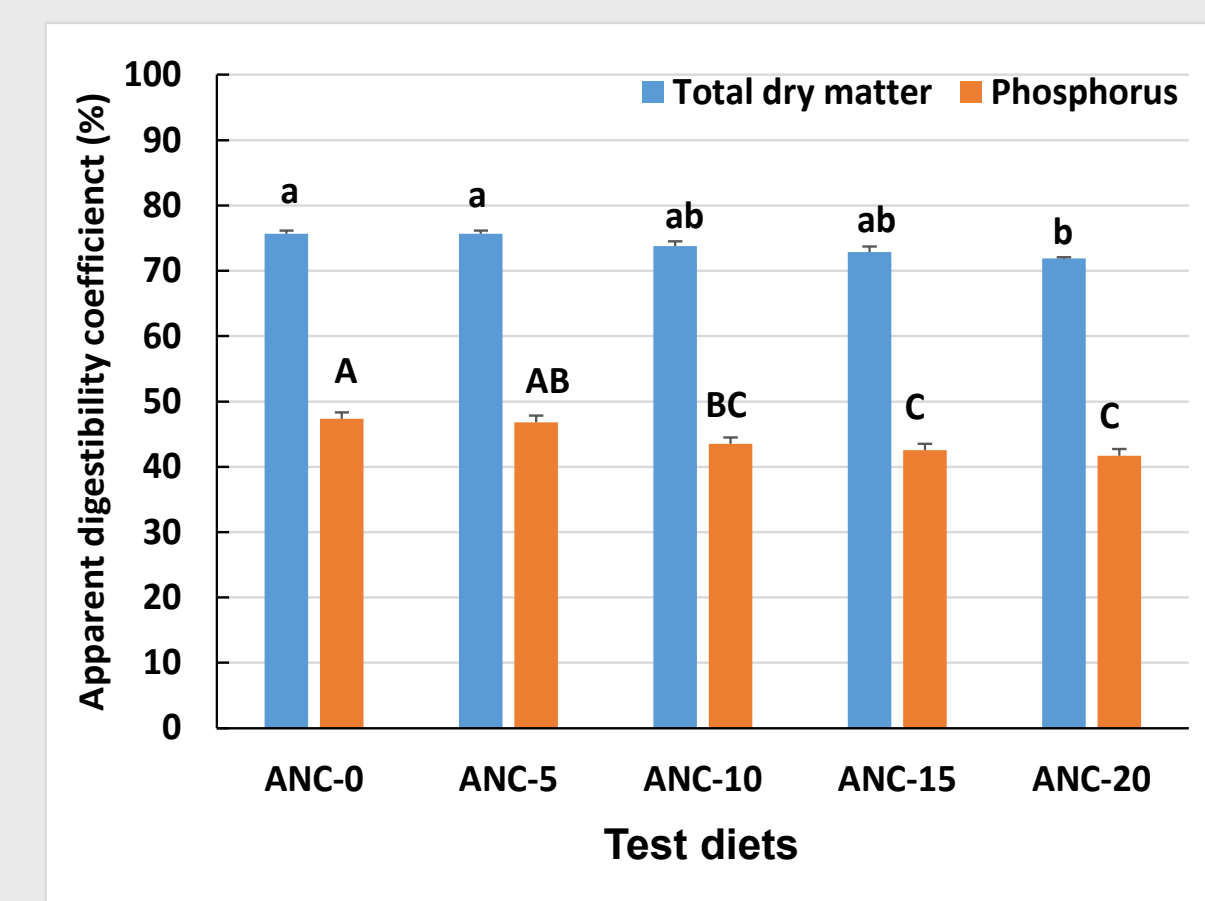
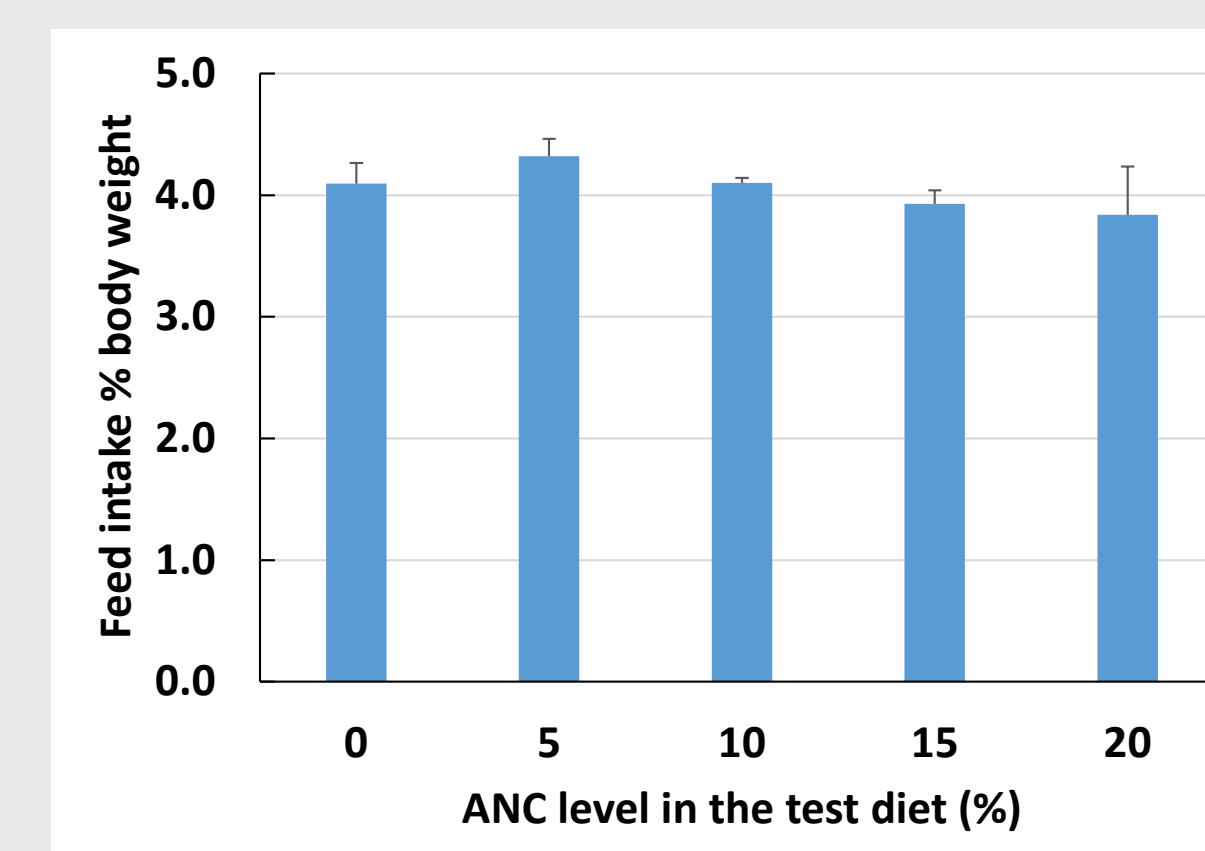
Inclusion of ANC resulted in:

- Decreased water absorption
- Increased water stability
- Reduced oil leakage



## Feeding Response

- Palatability was not affected by ANC in the diet.
- Replacement of fishmeal with 10% and 20% ANC significantly decreased the digestibility of total dry matter and P.
- The apparent digestibility coefficient of protein was 89-90% for different test diets and was not impacted by ANC inclusion (data not shown).



## Summary

- Substitution of fishmeal with ANC changed pellet physical quality by increasing the density, durability, and water stability but decreased oil leakage out of pellets.
- Feeding was not impaired due to fishmeal replacement by ANC.
- When ANC was >10% in the feed, nutrient digestibility and growth were decreased.
- ANC based feed could potentially alter some major metabolism pathways such as branch chain amino acid metabolism, TCA pathway, and ketone metabolism.