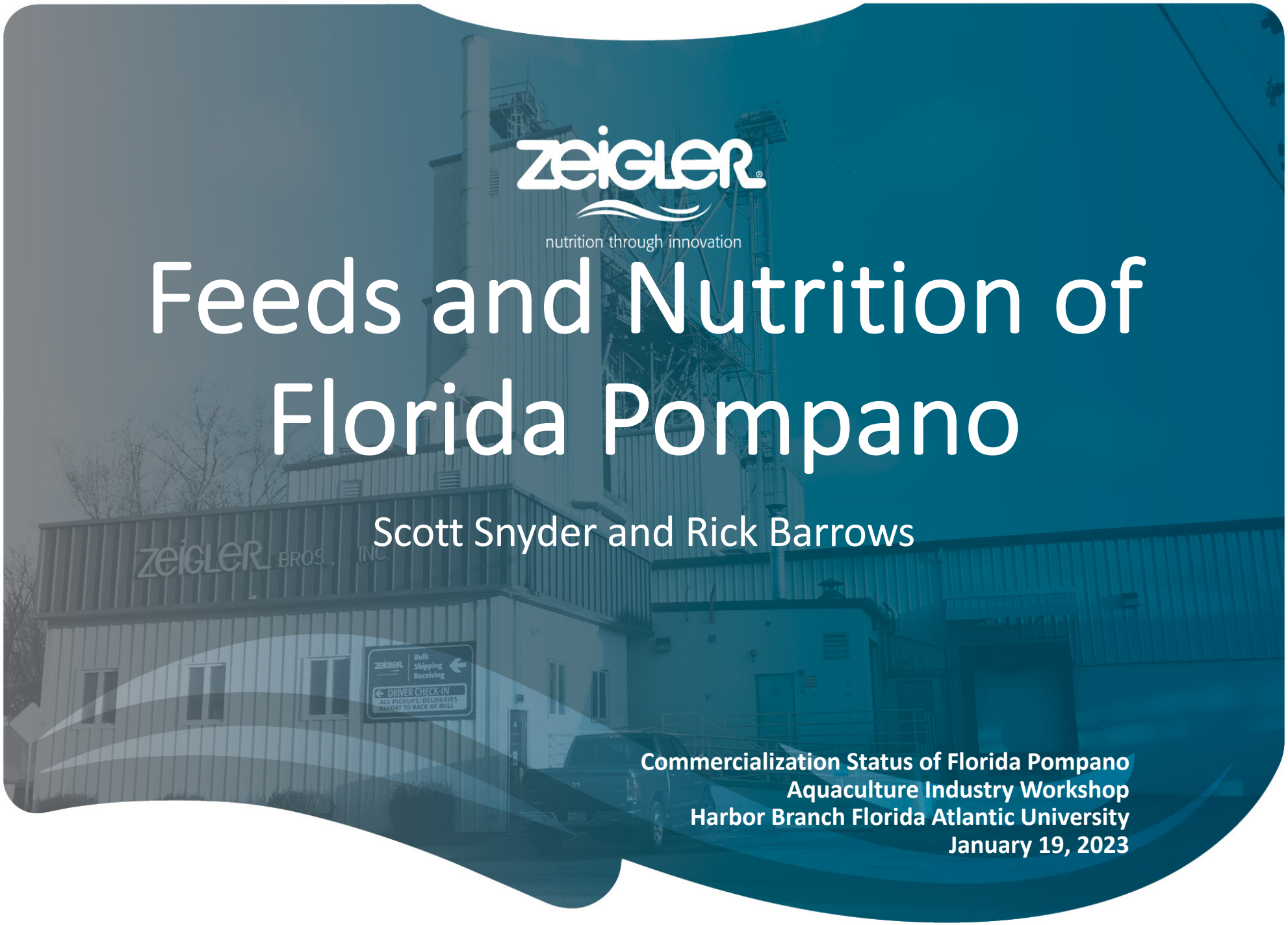

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Feeds and Nutrition of Florida Pompano

Scott Snyder and Rick Barrows

Commercialization Status of Florida Pompano
Aquaculture Industry Workshop
Harbor Branch Florida Atlantic University
January 19, 2023

Introductions

- **Who is Zeigler Bros., Inc.?**
- **Review of Florida pompano nutrition.**
- **Overview of feed manufacturing.**
- **Introduction to texturized feed manufacturing.**

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- **Founded in 1935 by brothers Ty and LeRoy as a local producer of poultry and livestock feeds.**
- **Dr. Tom Zeigler (son of LeRoy) assumed leadership in 1967 and changed the strategic direction towards R&D of specialty animal and aquatic feeds.**
- **Today, as Zeigler embarks on its 3rd generation of family leadership the company continues to develop new and innovative technologies for specialty markets.**
- **With just under 100 employees globally, Zeigler exports hatchery products to 50 countries and is responsible for about 80,000 MT of aquafeed production in five countries.**

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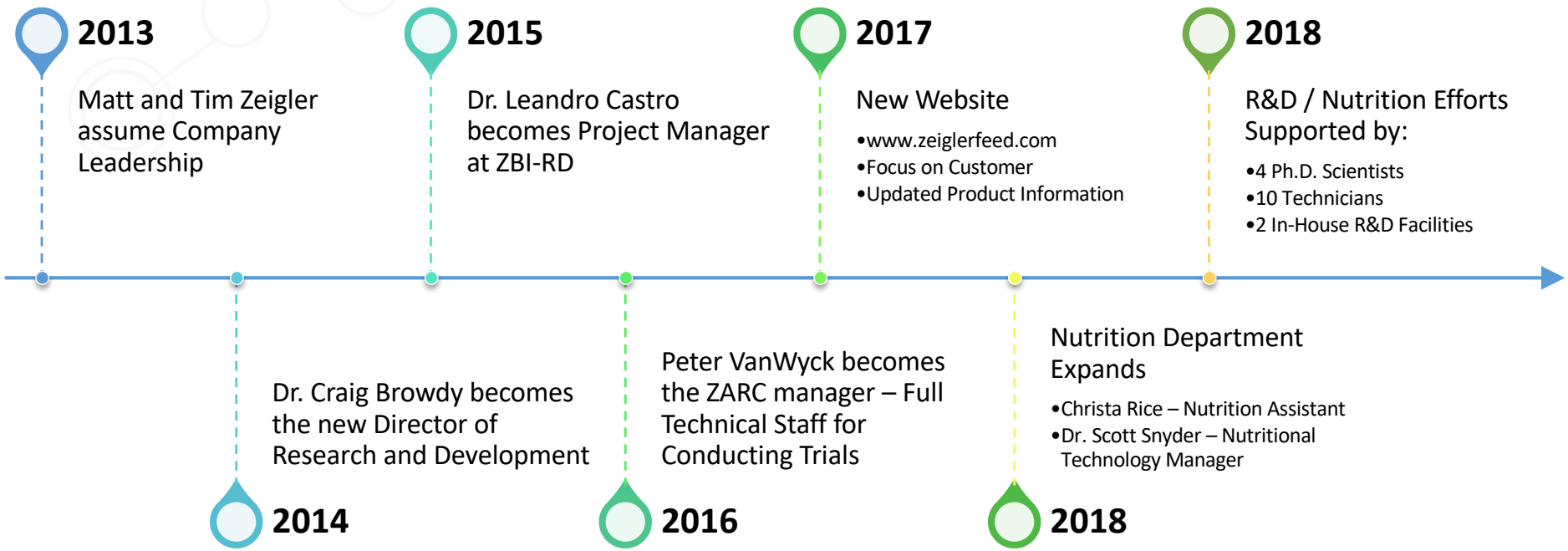
Company Profile



- **Zeigler maintains highly diverse ingredient stocks.**
- **Zeigler manages a sales portfolio of over 300 product SKU's; 80% of which are aqua products.**

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Florida Pompano Nutrition

- **Protein**
- **Fat**
- **Carbohydrates**
- **Vitamins and Minerals**
- **Specialty Additives**

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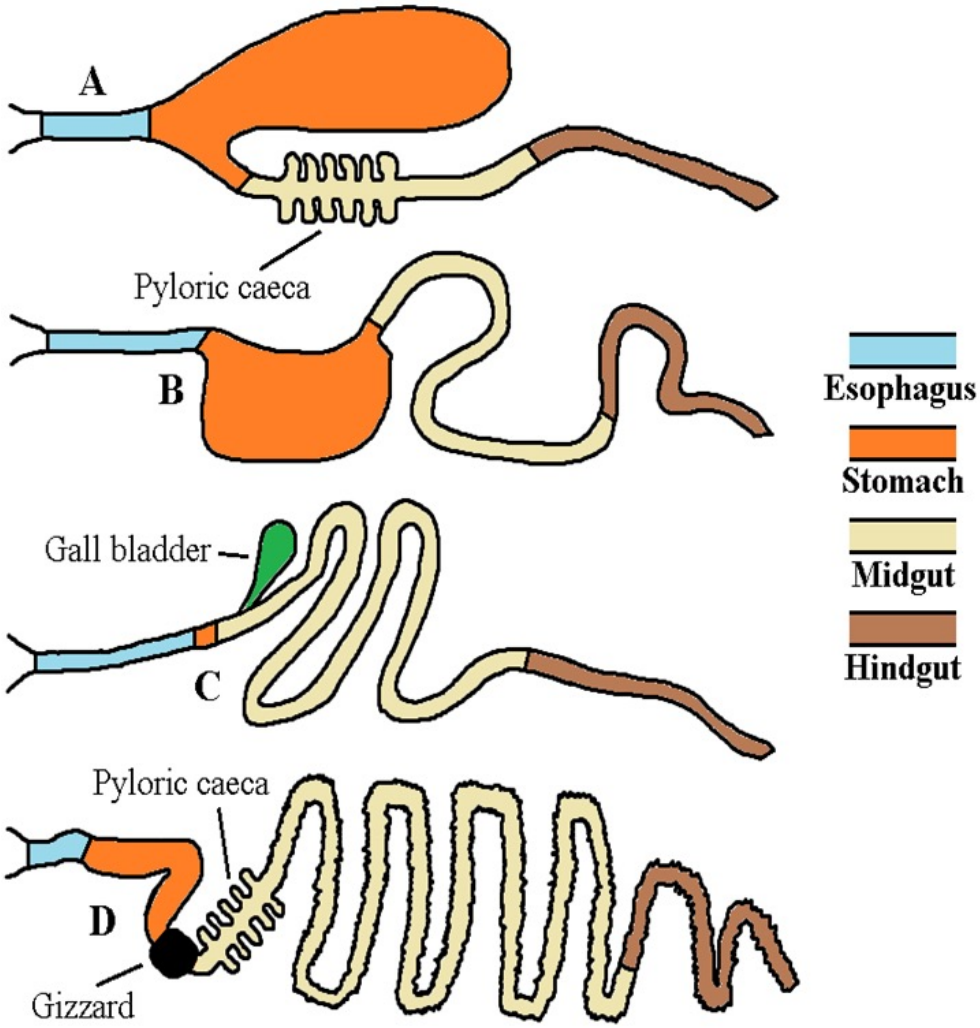
Determining Nutrient Requirements

- Comparative gut physiology is useful in determining basic dietary tolerances.
- Digestive System A is representative of a carnivorous species like salmonids.
- System B represents an omnivore species with carnivore preference like a catfish.
- System C represents omnivore species with herbivore preference like tilapia.
- System D represents herbivore species like carp.



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Pompano Digestive System

- Pompano have a carnivorous digestive system.
- Indicates the need for high protein levels and low tolerance for carbohydrates.
- Indicates a preference animal-derived proteins and fats.
- Feeds must be composed of highly digestible ingredients.
- This basic understanding of the digestive system and early gross protein and energy requirement studies identified that a pompano diet should be relatively high in crude protein (40-50%) and contain moderate levels of fat (10-15%).

Gothreaux, 2008

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Protein Requirement

- We are referring to amino acid requirements.
- Experimental feeds designed to mimic the amino acid profile of the Florida pompano have led to a better understanding of dietary amino acid requirements for this species.
- Several labs have made requirement estimates for key amino acids methionine, lysine, arginine and taurine
- The use of the ideal protein concept has allowed rapid development of highly digestible feeds.
- However, there is much more to determine.

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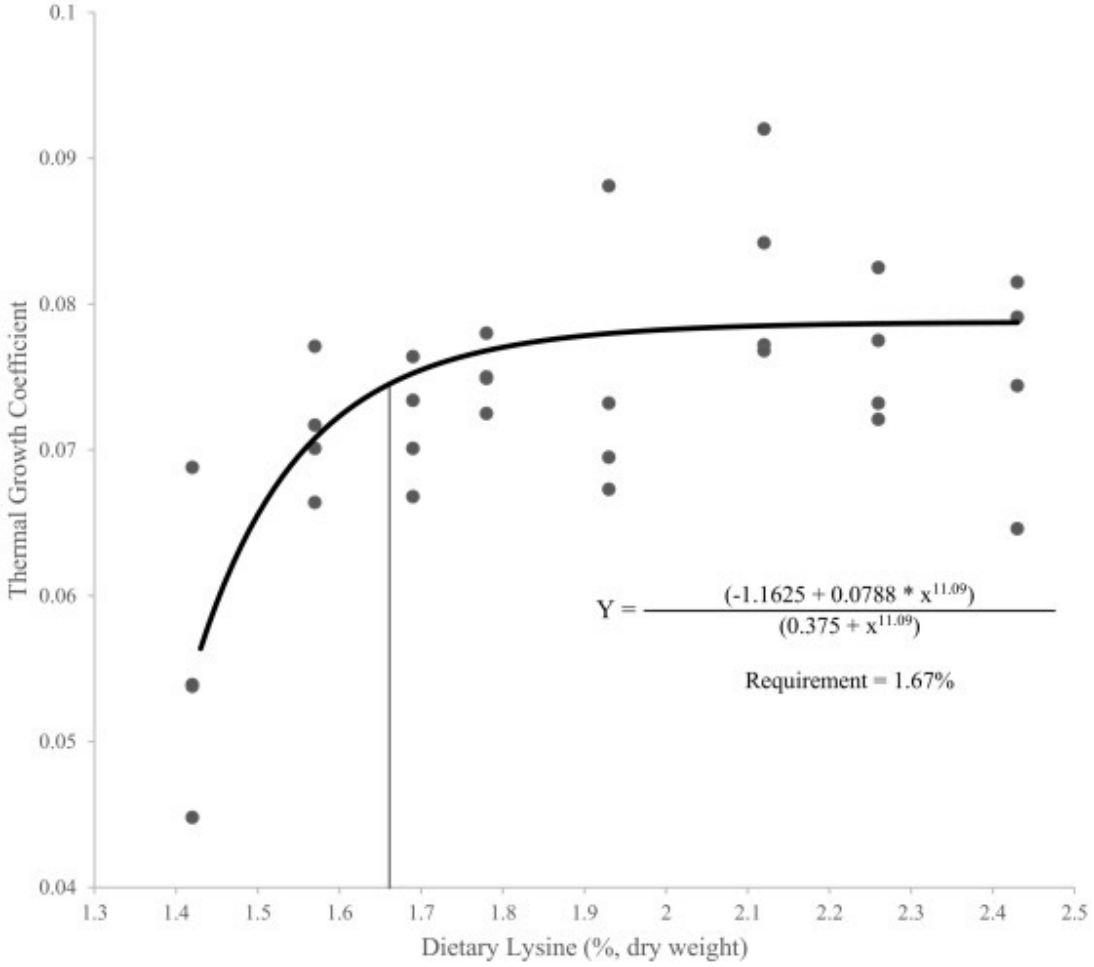
Lysine Requirement



Stites, et al., 2022

Nutrient Requirements – Amino Acids

Freshwater Fish Requirements, AA

% protein	Channel Catfish		Rainbow trout		Pacific salmon		Common Carp		Tilapia	
AMINO ACIDS	old (1993)	New (2011)	old (1993)	New (2011)	old (1993)	New (2011)	old (1993)	New (2011)	old (1993)	New (2011)
Arginine	1.20	1.20	1.50	1.50	2.04	2.20	1.31	1.70	1.18	1.20
Histidine	0.42	0.60	0.70	0.80	0.61	0.70	0.64	0.50	0.48	1.00
Isoleucine	0.73	0.80	0.90	1.10	0.75	1.00	0.76	1.00	0.87	1.00
Leucine	0.98	1.30	1.40	1.50	1.33	1.60	1.00	1.40	0.95	1.90
Lysine	1.43	1.60	1.80	2.40	1.70	2.20	1.74	2.20	1.43	1.60
Methionine		0.60		0.70		0.70		0.70		0.70
Methionine, cystine	0.64	0.90	1.00	1.10	1.36	1.10	0.94	1.00	0.90	1.00
Phenylala-nine		0.07		0.90		0.90		1.30		1.10
Phenylala-nine, tyrosine	1.40	1.60	1.80	1.80	1.73	1.80	1.98	2.00	1.55	1.60
Threonine	0.56	0.70	0.80	1.10	0.75	1.10	1.19	1.50	1.05	1.10
Trypto phan	0.14	0.20	0.20	0.30	0.17	0.30	0.24	0.30	0.28	0.30
Valine	0.84	0.80	1.20	1.20	1.09	1.20	1.10	1.40	0.78	1.50

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Nutrient Requirements - Vitamins

Table 10. Dietary vitamin requirements for rainbow trout, channel catfish and common carp (mg/kg dry diet unless specified)

Mineral	Rainbow trout	Channel catfish	Common carp
Vitamin A (IU)	2000-15000	5500	1000-20000
Vitamin D (IU)	2400	500-4000	NR
Vitamin E	30-50	50-100	80-300
Vitamin K	10	10	NR
Thiamine	1-12	1-20	NR
Riboflavin	3-30	9-20	4-10
Pyridoxine	1-15	3-20	4
Pantothenic acid	10-50	10-50	25
Niacin	1-150	14	29
Folic acid	5-10	NR or 5	NR
Vitamin B_{12}	0.02	0.02	NR
Choline	50-3000	400	500-4000
Inositol	200-500	NR	200-440
Biotin*	0.8	0.1	1.1
Ascorbic acid	100-500	NR or 100	R

NR = Not required;
R = Required
Source: Lall (1991); *After Hepher (1990)

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Commercial Formulation

- **Identify what is known.**
- **Use the numerous resources to fill in the unknown with data from species as similar as possible.**
- **Strike a balance between manageable requirements and cost.**
- **Formulation is the practice of constructing a finished feed recipe that both nourishes the animal and satisfies the requirements of the farmer in terms of cost, and overall objectives.**

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Commercial Formulation

- **Responsibility to customer.**
- **Responsibility to animal.**
- **Limitations of culture system.**
  - Digestibility and waste characteristics.
- **Overall customer objectives.**
  - Animal performance.
  - Sustainability.
  - Certification scheme.

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Practical Feedstuffs for Pompano

Analyzed dietary gross energy, apparent digestibility coefficient (ADC) of dietary dry matter and energy, and ADC of energy of the evaluated vegetable feed ingredients for Florida pompano.

Experimental diet	Gross energy of diet (cal/g)	ADC of dry matter of diet (%)	ADC of energy of diet (%)	ADC of energy of ingredient (%)
Diet $1_{Reference}$	4813.8	$69.1^{a} \pm 2.45$	$81.6^{a} \pm 0.64$	–
Diet $2_{Corn,\ grain}$	4704.9	$58.1^{b} \pm 3.66$	$71.4^{c} \pm 1.70$	$44.8^{b} \pm 6.14$
Diet $3_{Sorghum,\ grain}$	4788.5	$45.4^{d} \pm 4.03$	$63.9^{d} \pm 1.03$	$21.6^{c} \pm 3.52$
Diet $4_{Whole\ wheat\ flour}$	4739.7	$63.3^{b} \pm 1.81$	$74.1^{b} \pm 1.21$	$55.4^{a} \pm 4.25$
Diet $5_{Wheat\ bran}$	4876.8	$51.5^{c} \pm 3.47$	$70.1^{c} \pm 2.23$	$44.9^{b} \pm 7.10$
Diet $6_{Wheat\ middlings}$	4881.9	$24.4^{e} \pm 5.45$	$58.6^{e} \pm 0.71$	$8.2^{d} \pm 2.25$
Diet $7_{Full\ fat\ rice\ bran}$	4805.4	$42.2^{d} \pm 2.71$	$64.7^{d} \pm 0.85$	$24.9^{c} \pm 2.85$
Diet $8_{Defatted\ rice\ bran}$	4611.2	$44.6^{d} \pm 0.62$	$63.8^{d} \pm 1.36$	$12.6^{d} \pm 5.28$

Values represent means ± SD (n = 3). Values in the same column with different superscripts are significantly different ($P<0.05$).

Gonzalez-Felix et al., 2010

Table 3 Mean (±SD) water quality parameters in each of four replicated systems used to determine digestibility coefficients for select feed ingredients fed to Florida pompano, *Trachinotus carolinus* held at 3 g L^{-1} and 28 g L^{-1}

Parameter	System 1	System 2	System 3	System 4
Dissolved oxygen (m g L^{-1})	5.84 ± 0.14	4.93 ± 0.37	4.40 ± 0.49	5.52 ± 0.36
Salinity (g L^{-1})	2.7 ± 0.3	31.0 ± 0.8	30.4 ± 0.8	2.9 ± 0.3
Temperature (°C)	27.5 ± 0.3	27.1 ± 0.4	27.4 ± 0.5	27.5 ± 0.6
Ammonia-N (m g L^{-1})	0.22 ± 0.20	0.28 ± 0.17	0.21 ± 0.12	0.18 ± 0.12
Nitrite (m g L^{-1})	0.41 ± 0.25	1.41 ± 0.63	1.78 ± 1.00	1.16 ± 0.58
pH	8.1 ± 0.2	7.8 ± 0.3	7.8 ± 0.3	8.4 ± 0.3
Alkalinity (ppm $CaCO_3$)	170 ± 62	182 ± 49	186 ± 49	179 ± 43

Riche et al., 2017

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Feed Formulation

Process of selecting and blending ingredients into a product that meets the nutritional requirements of the animal and can be manufactured in a utilizable form cost effectively

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Finished Formula

Ingredient	Reference diet	Test diet
Fish meal, menhaden	379.4	265.6
Soybean meal (49% CP)	250.0	175.0
Soy protein concentrate	100.0	70.0
Wheat middlings	153.3	107.3
Oil, menhaden	65.0	45.5
Soy lecithin	10.0	7.0
CMC[1]	20.0	14.0
Vitamin mix[2]	5.0	3.5
Mineral mix[3]	2.5	1.8
Stay-C[4]	0.6	0.4
Chromic oxide	10.0	7.0
Ethoxyquin	0.2	0.1
Choline chloride	4.0	2.8
Test ingredient[5]		300.0

[1]Carboxymethylcellulose, sodium salt.
[2]Per kg diet: vitamin A, 6000 IU; vitamin D, 1000 IU; vitamin E, 0.1 g; biotin, 0.2 g; folic acid, 9 mg; niacin, 0.2 g; pantothenic acid, 0.1 g; vitamin B-6, 25 mg; riboflavin, 40 mg; thiamin, 40 mg; vitamin B-12, 20 mg.
[3]Per kg diet: iron, 0.1 g; manganese, 25 mg; copper, 10 mg; zinc, 0.1 g; iodine, 4.5 mg; cobalt, 50 mcg; selenium, 0.5 mg.
[4]Stay-C stabilized vitamin C (L-ascorbyl-2-polyphosphate), 35% ascorbic acid activity.
[5]Canola meal, corn gluten meal, or distillers dried grains with solubles.
doi:10.1371/journal.pone.0034981.t003

Lech & Reigh, 2012

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Pompano-specific Formulation

- **Today, there is adequate data available to construct high-quality pompano-specific feeds.**
- **There are still numerous nutrient requirements to determine.**
- **If the formulator considers the rearing environment and the producer's objectives, superior profitability can be achieved over general marine feeds.**

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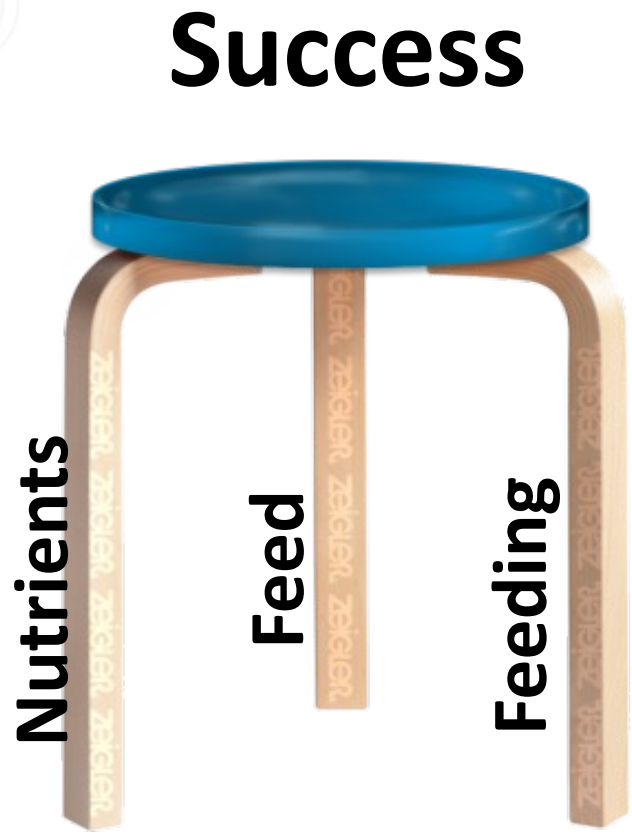
Good Nutrition



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Feed Physical Characteristics

- **Particle size and uniformity depend on fish size and uniformity**
- **Freshness – check labels for manufacture dates**
- **Packaged to retain quality, shelf life and palatability**
- **Water stability adequate to retain nutrients**
- **Shape and texture as preferred by the animal**
- **Proper storage**

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Aquafeed Processing

- **Traditional dry extrusion review.**

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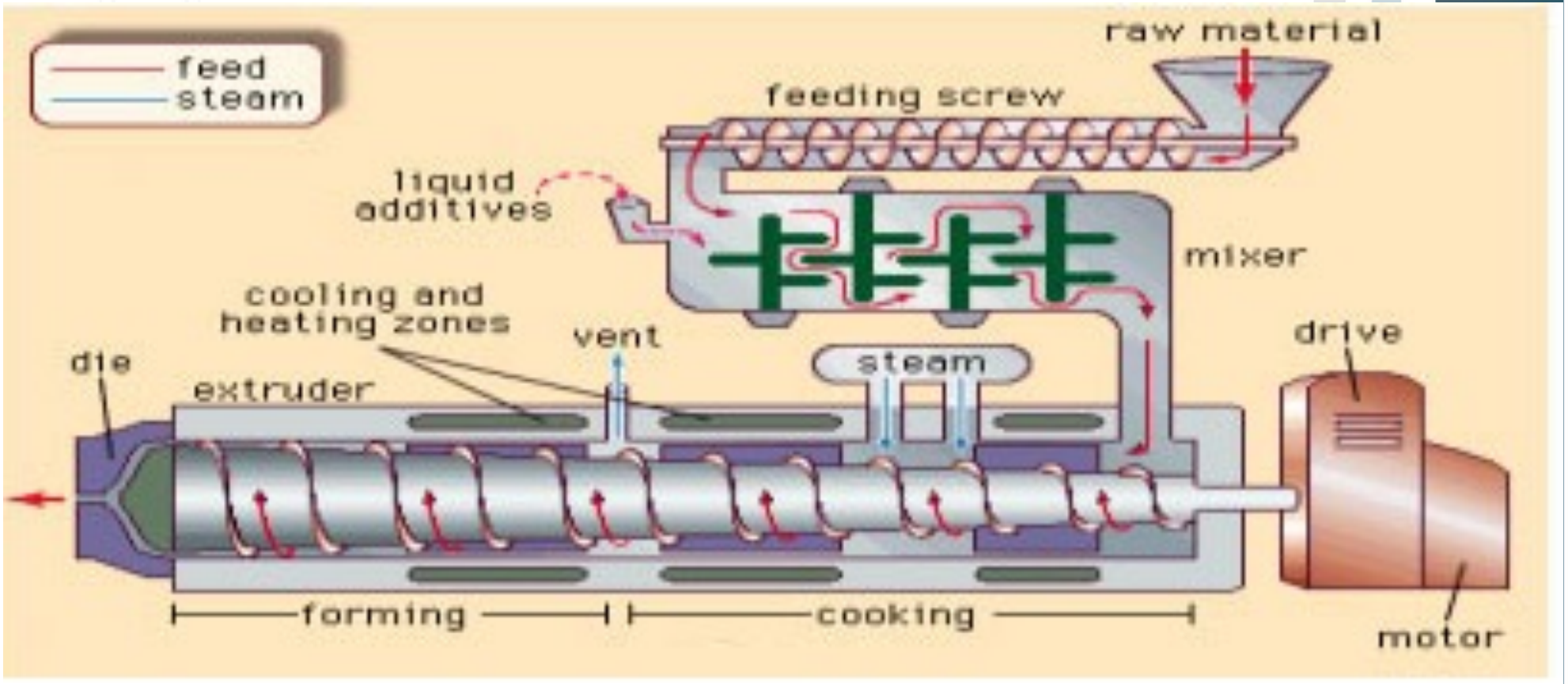
Traditional Extrusion



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Traditional Extrusion

- **Primary Objectives**
  - Starch-based pellet binding.
  - Aquafeed industry standard.
  - Process and ingredient combinations are vast.
  - Efficient and low-cost operations
  - Consistent final product physical characteristics.
  - Predictable.

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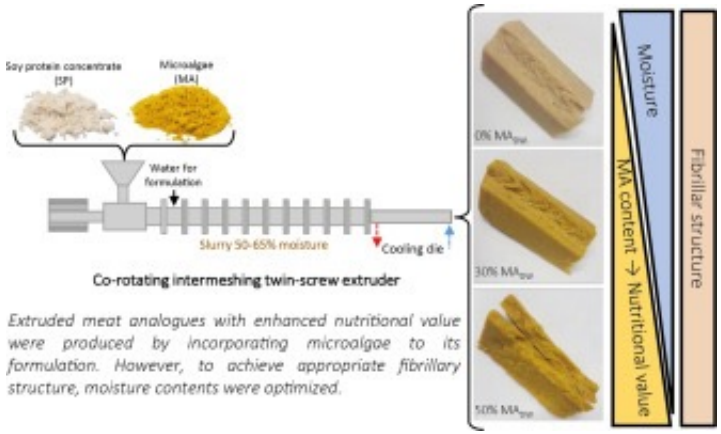
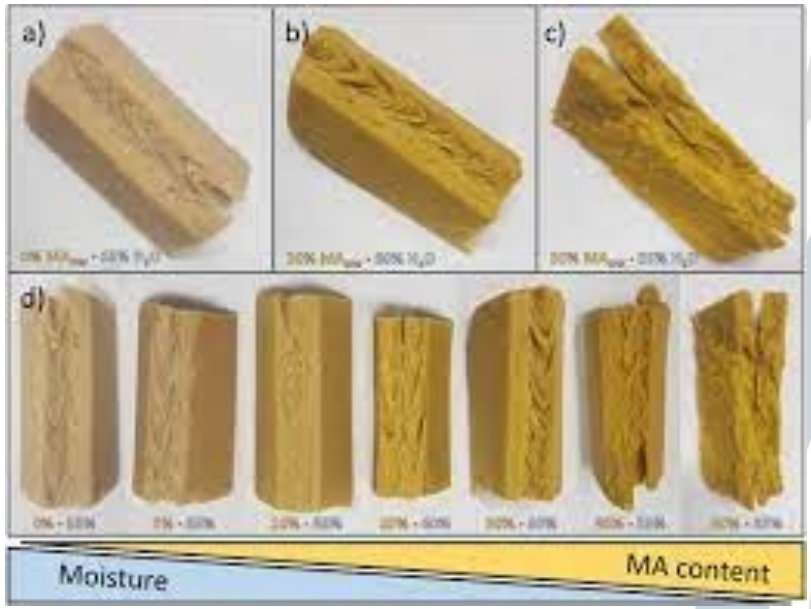
Texturized Extrusion



Extruded meat analogues with enhanced nutritional value were produced by incorporating microalgae to its formulation. However, to achieve appropriate fibrillary structure, moisture contents were optimized.



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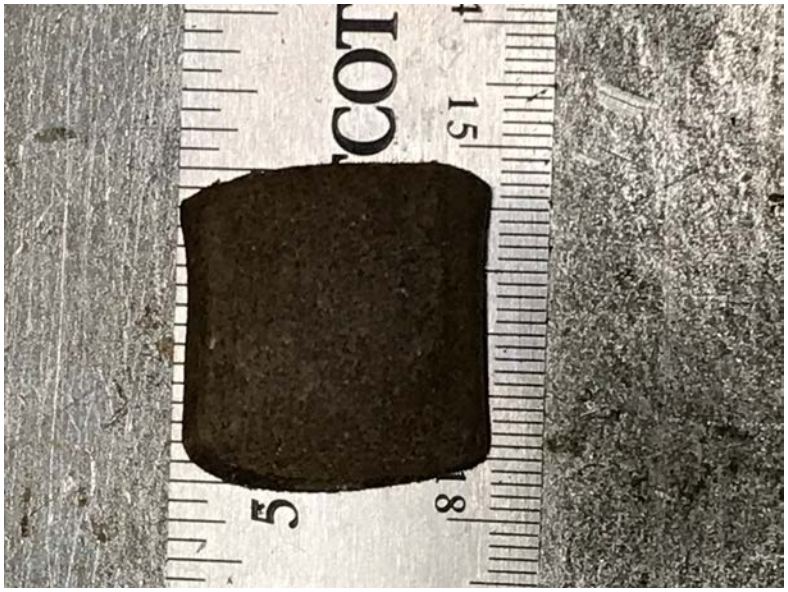
Texturized Extrusion

- **Primary objectives**
  - Offer a feed with natural mouth-feel.
  - Offer a feed with incredible water stability.
  - Increased performance over traditional extrusion.
  - Increased use of alternative ingredients.

Texturized Extrusion



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Texturized Extrusion

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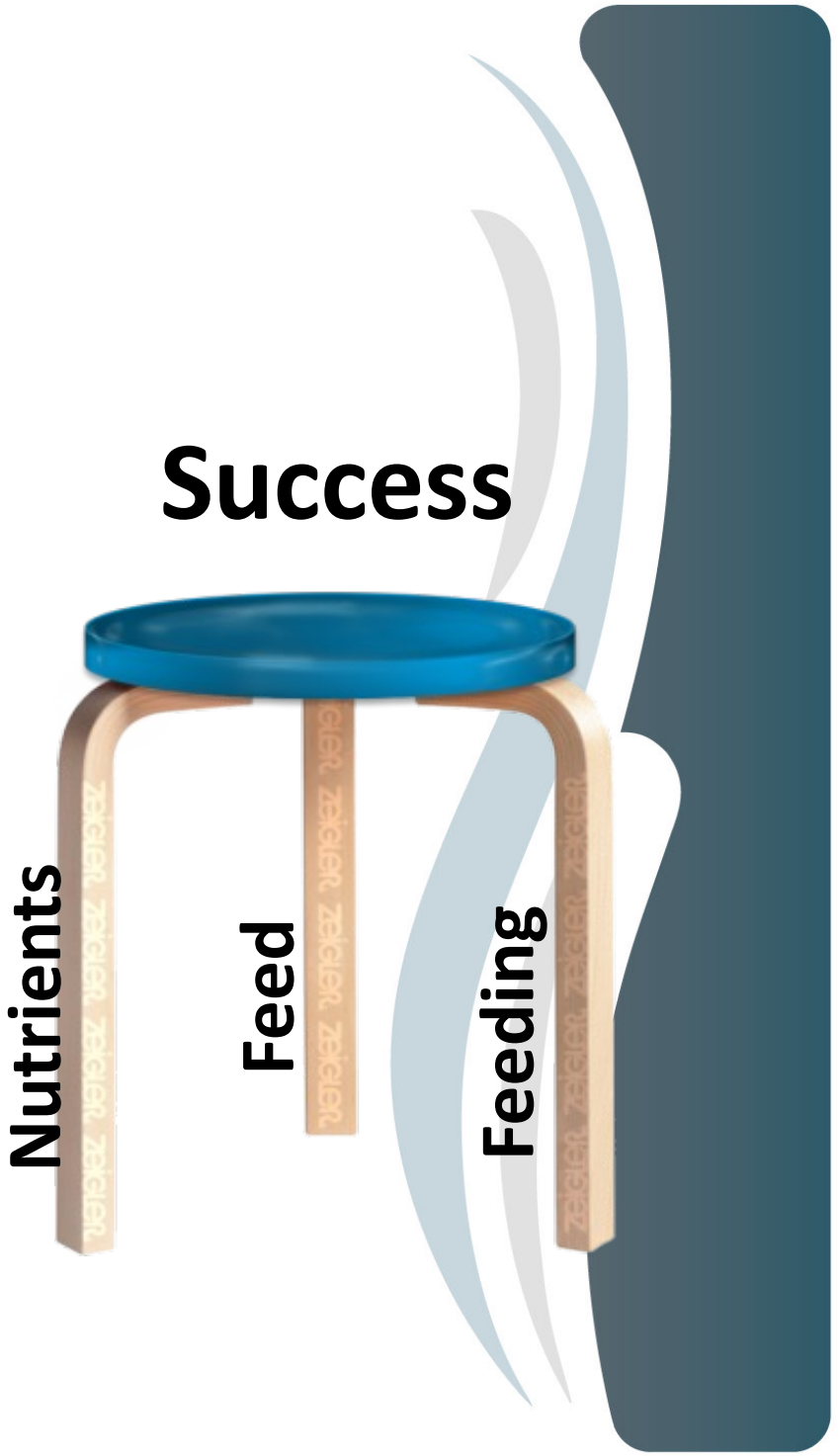
Complete Feed Program

- **Formulation**
- **Manufacturing**
- **Feeding Methods**



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Conclusions

- **Current state is that the texturized extrusion is costly.**
- **Texturized extrusion did not result in improved FCR.**
- **There is much more to learn about this species in terms of nutrition, feeds, and feeding.**

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