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Aquafeeds

Nutritional disorders and aquatic animal health

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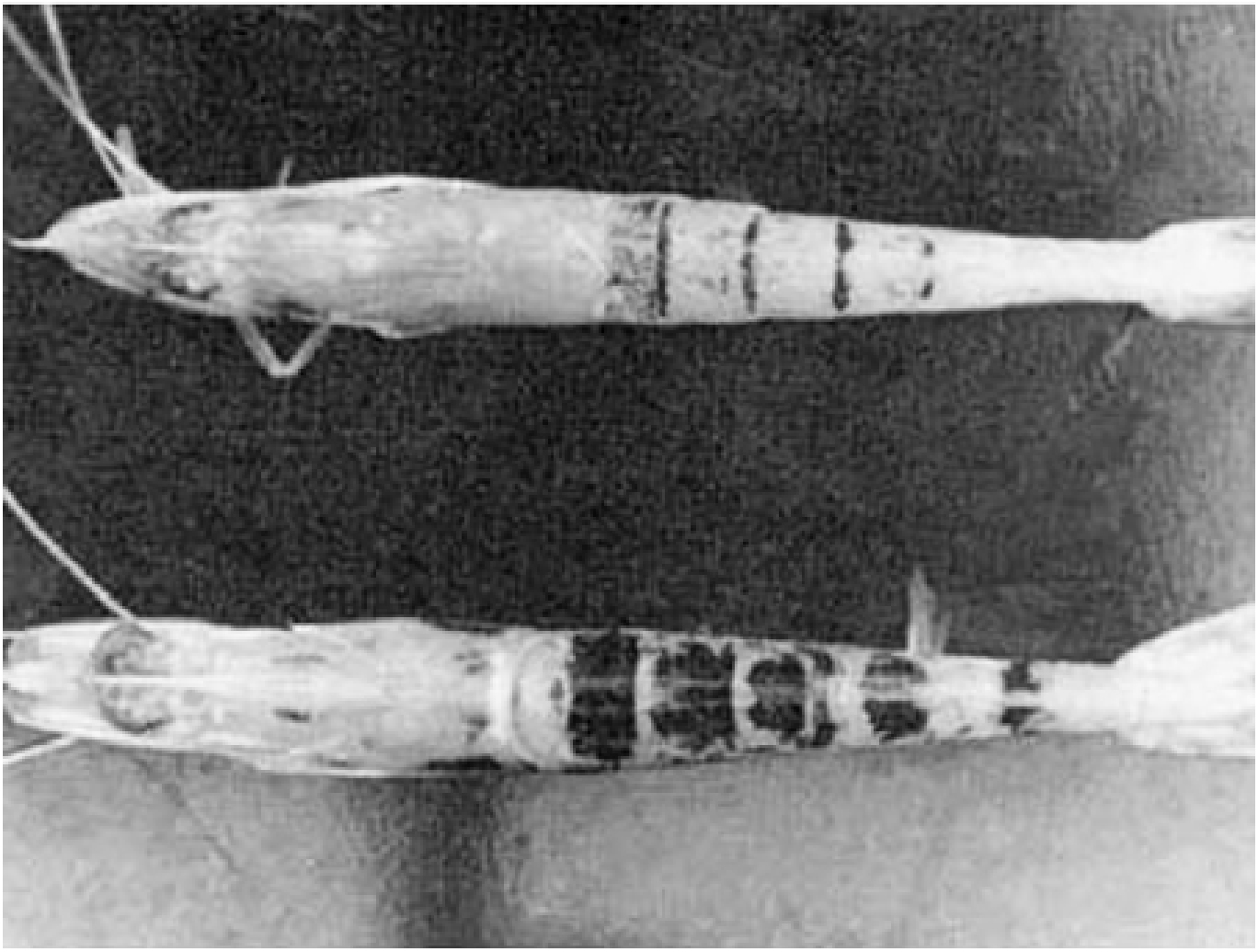
Nutritional characteristics and quality of most commercial aquafeeds is not always satisfactory

Dietary nutritional disorders in farmed aquatic animals can be broadly defined as diet-related imbalances due to “under-” or “over-” nutrition. These disorders are more readily apparent and prevalent as farming systems intensify and animals become less dependent upon endogenously produced natural food organisms and more dependent upon artificially compounded diets. To date, the science of nutritional pathology – often incorrectly termed nutritional “diseases” – remains one of the least studied areas of finfish and crustacean pathology.



"Black death," or ascorbic acid defficiency syndrome (AADS), is a nutritional deficiency disease of penaeid shrimp. Gross signs of AADS include large melanized lesions in the subcuticular tissues. Photo by Don Lightner.

Diets for optimum health and disease resistance

As in humans, the nutritional intake and status of an animal has a profound effect upon its overall health and well-being, including its subsequent growth and resistance to environmental stressors and disease-causing agents. In general, the poorer the diet and nutritional status of an animal, the less able it is to combat disease agents and withstand overt environmental changes and stress. It is important to emphasize that all animals have dietary nutrient requirements for optimum health over and above those normally required for optimum growth and feed efficiency.

Sadly, most nutrient requirement studies to date were conducted under indoor laboratory conditions, where strict environmental controls are placed on test animals. They are not subjected to the normally varied outdoor rearing conditions and stresses, including varying water quality and husbandry conditions, and water-borne disease agents.

Nutrients that enhance health

To date, nutrients and dietary components reported to exert a positive response on the health and/or disease resistance (including immune response) of farmed finfish and crustaceans, have included specific essential amino acids (lysine, methionine, tryptophan, arginine, histidine, leucine, isoleucine), nucleotides, polysaccharides (peptidoglycans, beta 1,3, and 1,6 glucans, lipopolysaccharides), essential fatty acids (18:2 omega-6, 18:3 omega-3; 20:4 omega-6, 20:5 omega-3, 22:6 omega-3 depending upon species), sterols, phospholipids, and essential minerals (P, K, Mg), trace elements (Fe, Zn, Mn, Cu, Se, I), vitamins (B1, B2, B6, B12, pantothenic acid, niacin, biotin, folic acid, inositol, choline, D3, A, K3, E, and C) and carotenoids.

Causes of nutritional disorders

Under practical farming conditions, nutritional disorders may arise from a variety of causes, including:

- Deficiencies and imbalances due to poor feed formulation, excessive heat treatment during the feed manufacturinprocess (resulting in the loss or destruction of heat-sensitive nutrients), poor/prolonged feed storage (resulting in the loss of essential nutrients through oxidation or spoilage), or through nutrient loss on immersion in water through leaching or poor feed stability.
- Anti-nutrients and contaminants, including toxic polyamines, oxidized polyunsaturated fatty acids and toxic amino acids, heavy metal contaminants, anti-vitamin factors, specific enzyme inhibitors, toxic glycosides, toxic phenols, food allergens, microbial toxins, and specific synthetic contaminants (including pesticide residues and organochlorine compounds) and residues arising from ingredient/feed processing.

Common deficiency signs resulting from nutritional disorders

Examples of some major morphological signs and nutritional disorders reported in finfish fed diets with specific nutrient deficiencies and/or toxicities under experimental conditions are shown in Table 1. Nutritional diseases reported for penaeid shrimp include Ascorbic Acid Deficiency Syndrome (“Black Death Disease”), Cramped Muscle Syndrome, Chronic Soft Shell Syndrome, and Blue Disease.

Table 1. Major nutritional pathology conditions and reported causes in finfish.

SCOLIOSIS/LORDOSIS (bent/curved spine)	
Deficiency of:	Tryptophan
	Magnesium
	Phosphorus
	Vitamin C
	Essential fatty acids
	(lordosis)

	(lordosis)
Toxicity of:	Lead
	Cadmium
	Leucine
	Vitamin A
	Oxidized fish oil
CATARACT (white/cloudy eye)	
Deficiency of:	Methionine
	Tryptophan
	Zinc
	Magnesium
	Copper
	Selenium
	Manganese
	Vitamin A
	Riboflavin
Toxicity of:	Choline
	Oxidized fish oil
FIN EROSION	
Deficiency of:	Lysine
	Tryptophan
	Zinc
	Riboflavin
	Inositol
	Niacin
	Vitamin C
Toxicity of:	Lead
	Vitamin A
FATTY LIVER (pale/ceroid)	
Deficiency of:	Choline
	Essential fatty acids
Toxicity of:	Oxidized fish oil
EXOPHTHALMIA (popeye)	
Deficiency of:	Pantothenic acid
	Niacin
	Folic acid

	Vitamin A
	Vitamin E
Toxicity of:	Oxidized fish oil
FIN/SKIN HEMORRHAGE	
Deficiency of:	Riboflavin
	Pantothenic acid
	Niacin
	Thiamine
	Inositol
	Vitamin C
	Vitamin A
	Vitamin K
Toxicity of:	Oxidized fish oil

Conclusion

Pale coloration can be caused by inadequate dietary carotenoids. The top shrimp received no dietary carotenoids, while the darker animal below did receive carotenoids. Photo by Don Lightner.

Although it is generally believed that the nutritional characteristics and quality of most commercial aquafeeds is satisfactory, this is not always the case. It is imperative that farmers keep good records on feed use and species health/mortality (including the occurrence of morphological deficiency signs). Moreover, whenever economically feasible, it is strongly recommended that farmers undertake periodic spot checks on new batches of feed to monitor feed quality, including label declarations.

However, equally important as the aquafeed itself, is the need for farmers to employ good on-farm feed management protocols concerning feed storage and feed use on the farm. All too often it is believed that a “high-quality” feed works by itself. It does not. It must be properly managed. There is no substitute for good on-farm feed and water management to ensure that all the nutritional attributes of feed are transferred in their entirety to the cultured target species.

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