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ARE YOUR FISH HEALTHY? BLOOD CHEMISTRY PROFILES MAY PROVIDE THE ANSWER

Veterinary reference ranges of normal blood chemistry values have been determined for several mammals to assess the overall health of individuals; however, similar profiles do not exist for fish. Such profiles would be useful to aquaculture specialists by providing evidence that the fish are in good condition and therefore healthy before releasing to the wild or selling as food. We report here information on our research to determine normal blood chemistry values as fish health indicators for various species.

DRY CHEMISTRY METHODOLOGY PROVED USEFUL

A desktop Kodak Ektachem DT60 analyzer was used for several clinical tests on fish serum; two additional modules, the DTSC and DTE, measure enzymes and electrolytes, respectively. We adapted 12 clinical tests to measure fish blood serum on this analyzer. All reactions needed for a single test take place within a multilayered, dry chemical slide that contains a bar code that enables the DT60 analyzer, the DTSC and the DTE modules to identify which test will be run. Only 10 μ L of sample is needed and a slide is used once for each test and discarded. A profile for one fish can be completed in about 20 min. The 12 analytes measured were glucose, total protein, amylase, alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), calcium, magnesium, creatine kinase (CK), triglycerides (TRIG), sodium (Na^+), and potassium (K^+).

BLOOD CHEMISTRY RANGES VARIED

Two species of fish ($n = 50$ each) were sampled for this project—channel catfish (*Ictalurus punctatus*) and tilapia (*Tilapia nilotica*); both are important to the aquaculture industry. Fish were anesthetized and whole blood was sampled through the caudal peduncle using a 3-cc syringe

with a 21-gauge needle; blood serum was frozen for analysis. Hematocrit (packed red blood cells [%]) was also measured at the time of sampling. The average, standard deviation, coefficient of variation, and ranges for all tests are reported in the Table. Ranges overlapped and were similar for glucose and total protein; for all remaining tests the distributions were distinctly different. For example, amylase was detectable in channel catfish serum but was below analyzer range for tilapia. To measure triglycerides and creatine kinase in catfish serum, a fourfold dilution of the serum was necessary. Both species were hatchery-reared and considered to be in healthy condition. Since the frequency distributions differed for ten of the tests, we anticipate that different species of fish might have different "normal" ranges and, therefore, not all be the same.

HEALTH INDICATORS LOOK PROMISING

The use of blood chemistry profiles as indicators of good health should be pursued, especially because of the accuracy, speed, and relative inexpense of this automated method. We are working on obtaining blood profiles of other fish species (e.g., lake trout, *Salvelinus namaycush*). We attempted to prioritize blood chemistry parameters in the event cost became an issue: glucose and total protein should always be included in a profile, and hematocrit should be measured. The three tests we consider the lowest priority would be amylase, Ck, and Alkp.

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Table. Summary of clinical chemistry profiles for Channel Catfish and Tilapia (n = 50 each).

Test Unit Analyzer Range	Glucose (mg/DL) (20-450)	Total protein (g/DL) (2.0-11.0)	Amylase (μ/L) (4-900)	Alt/Gpt (μ/L) (3-950)	Ast/Got (μ/L) (4-950)	Alkp (μ/L) (20-1500)	Calcium (mg/DL) (3-15)	Magnesium (mg/DL) (0.2-6.0)	Ck (DTSC) (u/L) (20-1600)	Trig (mg/DL) (25-400)	Na+ (mmol/L) (92-215)	K+ (mmol/L) (1.0-11.0)	Hematocrit (%RBC)
Channel catfish													
Average	82.8	3.2	103.0	8.1	54.6	43.2	68.5	2.4	**		39.8		46.8
S.D.	26.6	0.4	34.1	8.7	35.6	20.8	42.6	1.4			31.1		3.5
CV (%)	32.2	13.9	33.1	107.4	65.3	48.3	62.1	56.3			78.0		7.5
Range	36-160	2.2-4.3	35-220	<3-22	<4-196	<20-77	9.1-14.8	2.4-4.1		180-1,160	97-133	<1.0-2.1	37.0-53.5
Tilapia													
Average	77.4	2.9	*	50.6	63.6		7.8	3.5	414.1	125.3	135.4	1.5	40.3
S.D.	29.3	0.8		30.9	79.7		6.4	0.5	1,052.1	98.2	10.0	0.7	4.5
CV (%)	37.8	27.3		61.1	125.4		81.4	13.3	254.1	78.4	7.4	48.8	11.2
Range	32-136	2.0-3.7		17-159	<4-417	<20-84	10.8->15	2.4-4.2	194-4,528	31->400	109-157	<1.0-4.2	35.0-46.5

* Below analyzer range.

** Above analyzer range.