

Toxicology – Animal Mineral Levels

BOVINE Values in ppm Wet Weight

ARSENIC

	Liver	Kidney	Heparinized Blood
Normal	0.004-0.40	0.018-0.40	0.03-0.05
High	1.0-50	1.5-5.0	
Toxic - acute	2.0-15	3.5-38	0.17-6.7
- chronic	7.0-100	5.0-53	

CADMIUM

	Liver	Kidney
Normal	0.02-1.0	0.05-1.5
High	1.4-9.0	5.0-36
Toxic - chronic	50-160	100-250
- acute	> 50	> 200

COPPER

	Liver	Kidney	Serum (No Selenium Supplement)	Serum (Selenium Supplement)
Deficient	0.5-10.0	1.0-5.0	0.02-1.00	0.10-1.20
Marginal	5.0-25.0	3.0-5.5	0.55-1.20	0.30-1.20
Adequate	25.0-100	4.0-6.0	0.8-1.5	0.32-1.20
High	200-550	5.0-7.0	2.5-4.0	0.50-2.50
Toxic	250-800	10-122	4.0-11.0	0.60-10.0

	Liver - Fetal
Deficient	2.0-20
Marginal	20-30
Adequate	30-150
High	200

Toxicology – Animal Mineral Levels (continued)

BOVINE Values in ppm Wet Weight

LEAD

	Liver	Kidney	Heparinized Blood	Hair *	Bone *
Normal	0.1-1.0	0.2-2.0	0.01-0.2	0.5-5	1.0-7.0
High	2-10	3-20	0.30-0.40	3.5-90	30-75
Toxic	5-300	5-700	0.35-32	10-100	30-100
* ppm dry weight					

SELENIUM

	Liver	Kidney	Serum or Plasma	
			(No Supplement)	(Se Supplement)
Deficient	0.02-0.17	0.18-0.40	0.002-0.025	
Marginal	0.12-0.25	0.40-1.00	0.030-0.060	0.020-0.060
Adequate	0.25-0.50	1.00-1.50	0.080-0.300	0.025-0.150
High	0.75-1.25	2.00-2.50	2.5-3.5	0.800-3.500
Toxic - chronic	1.25-7.00	2.50-5.00	3.5-4.1	
- acute	7.00-47.0	1.00-8.00		

ZINC

	Liver	Kidney	Serum
Deficient	<20-40	16-20	0.20-0.40
Marginal	25-40	16-20	0.50-0.60
Adequate	25-100	18-25	0.80-1.40
High	300-500	50-140	2.00-5.00
Toxic	120-500	130-480	3.00-15.0

Toxicology – Animal Mineral Levels (continued)

CANINE Values in ppm Wet Weight

ARSENIC

	Liver	Kidney
Normal	< 0.2	< 0.2
Toxic	> 10.0	> 10.2

CADMIUM

	Liver	Kidney
Normal	0.037	0.12-0.18
High	1.0-7.0	4.0-17.0
Toxic		> 200

COPPER

	Liver	Kidney	Serum
Deficient	< 20	< 5.0	< 0.20
Normal	30.0-100	5.0-15.0	0.20-0.80
Toxic	400-3000	> 20	

LEAD

	Liver	Kidney	Heparinized Blood	Hair *
Normal	0.1-3.5	0.1-2.5	0.01-0.10	0-88
High	3.6-5.0	5.0-10.0	0.30-0.80	0-87
Toxic	50-200	10-50	0.60-7.4	> 88
				* ppm dry weight

ZINC

	Liver	Kidney	Serum
Deficient	< 15	< 8	0.20-2.00
Adequate	30-70	16-30	0.70-2.00
Toxic	369	295	10.0-32.0

Toxicology – Animal Mineral Levels (continued)

EQUINE Values in ppm Wet Weight

ARSENIC

	Liver	Kidney
Normal	< 0.4	< 0.4
High	1.0-5.0	
Toxic	7.0-15	> 10.0

CADMIUM

	Liver	Kidney
Normal	0.01-5.0	0.05-10.0
High	15-30	4.2-100
Toxic	> 80	75-170

COPPER

	Liver	Kidney	Serum
Deficient	< 3.5	< 4.0	0.60-0.80
Adequate	4.0-7.5	7.3-9.3	0.85-2.00
High	1000-1500	30-50	

LEAD

	Liver	Kidney	Heparinized Blood	Brain	Bone*
Normal	0.08-1.4	0.03-1.30	0.04-0.25	0.5	3.0-4.0
High	3.0-5.0	3.0-5.0	0.30-0.60	1.0-5.0	8.9-40
Toxic - chronic	4.0-50	5.0-140	0.33-140	3.0-30	40-350
- acute	10-500	20-200	0.60-2.5		

* ppm dry
weight

Toxicology – Animal Mineral Levels (continued)

EQUINE Values in ppm Wet Weight

SELENIUM

	Liver	Kidney	Serum
Deficient	0.14-0.20	0.14-1.10	0.008-0.053
Marginal	0.20-0.30	0.35	0.053-0.120
Adequate	0.30-1.00	0.70-2.00	0.140-0.250
High			0.350-1.000
Toxic - chronic	10.0		1.400-2.000
- acute	> 2.5	> 2.0	

ZINC

	Liver	Kidney	Serum
Deficient			< 0.50
Adequate	40-125	20-50	0.60-1.70
High	160-500	65-150	1.60-3.50
Toxic	1300-1900	295-580	1.00-3.50

Toxicology – Animal Mineral Levels (continued)

PORCINE Values in ppm Wet Weight

ARSENIC			
	Liver	Kidney	Heparinized Blood
Normal	0.003-0.20	0.03-0.10	0.01
CADMIUM			
	Liver	Kidney	
Normal	0.04-5.0	0.15-0.99	
High	3.0-30.0	2.0-50	
Toxic	> 13	> 270	
COPPER			
	Liver	Kidney	Serum
Deficient	0.30-1.02	2.0-4.0	0.09-0.40
Marginal	4.0-7.0	4.0-7.0	0.40-1.50
Adequate	5.0-25.0	7.0-10.0	1.30-3.00
High	15-200	12.0-25.0	1.70-3.00
Toxic	150-15000	300-1200	4.5-77
SELENIUM			
	Liver	Kidney	Serum
Deficient	0.03-0.10	0.40-0.77	0.005-0.060
Marginal	0.12-0.25	0.77-1.10	0.060-0.100
Adequate	0.40-1.20	1.50-2.90	0.140-0.300
High	1.50-12.0	3.00-18.0	0.400-0.800
Toxic	3.00-120	3.80-90.0	0.500-2.360
ZINC			
	Liver	Kidney	Serum
Deficient	9.6-25		0.18-0.25
Marginal	25-35		0.40-0.80
Adequate	40-90	15-30	0.70-1.50
High	> 200		
Toxic	500-3100	190-367	1.40-2.80

Toxicology – Animal Mineral Levels (continued)

OVINE Values in ppm Wet Weight

ARSENIC

	Liver	Kidney	Heparinized Blood
Normal	0.01-0.20	0.01-0.30	0.01-0.08
High	4.0-8.0	1.0-6.0	0.04-0.50
Toxic	10.0-50.0	10.0-40.0	5.0-14.5

CADMIUM

	Liver	Kidney
Normal	0.02-1.40	0.06-0.48
High	2.0-20.0	4.0-12.0
Toxic	50-600	50-400

COPPER

	Liver	Kidney	Serum
Deficient	0.50-4.0	3.0-4.0	0.10-1.00
Marginal	5.0-20	4.0-5.0	0.40-1.00
Adequate	25-100	4.0-5.5	0.70-2.0
High	100-500	4.0-10	1.00-5.00
Toxic	250-1000	18-260	3.3-20

LEAD

	Liver	Kidney	Heparinized Blood	Brain	Bone (Tibia)*
Normal	0.03-0.80	0.10-0.80	0.02-0.25	0.1-0.5	1.0-3.0
High	5-25	5-100	0.70-0.90	1.2-2.0	10-40
Toxic	10-100	5-200	1.0-5.0		> 70
					* ppm dry weight

Toxicology – Animal Mineral Levels (continued)

OVINE Values in ppm Wet Weight

SELENIUM

	Liver	Kidney	Serum
Deficient	0.01-0.10	0.046-0.600	0.006-0.030
Marginal	0.15-0.25	0.70-1.10	0.030-0.060
Adequate	0.25-1.50	0.90-3.00	0.080-0.500
High	2.00-10.0	4.00-6.00	
Toxic	15.0-30.0	6.00-15.00	> 3.0
Toxic – injected (IM)	3.6-18.2	3.39-8.70	

ZINC

	Liver	Kidney	Serum
Deficient	20-30	15-30	0.22-0.45
Marginal			0.40-0.80
Adequate	30-75	20-40	0.80-1.20
High	100-400	50-1000	4.0-5.0
Toxic	> 400	240-1600	30.0-50.0

NOTE:

- Tissue mineral levels are quoted from Mineral Levels in Animal Health, Diagnostic Data by Robert Puls, 3rd printing, 1990.
- Conversion of units between wet and dry weight:

$$\text{Units in dry weight:} \quad \frac{\% \text{ dry matter}}{100} = \text{units in wet weight}$$

$$\text{Units in wet weight:} \quad \frac{100}{\% \text{ dry matter}} = \text{units in dry weight}$$