Mineral testing

BETA-HYROXYBUTYRATE (BHOB)

Species: Cattle, sheep

Specimens: Serum or plasma

Optimum number of animals to test for mob/herd/flock: 8-10

BHOB, a stable ketone, is commonly used as an indicator of an energy deficit (subclinical and clinical ketosis) and is generally most useful in the transition period from just before calving to mid lactation (just prior to mating) in cattle and in late pregnancy in sheep. It is not a useful test in non-lactating or non-pregnant cattle or sheep and it may be falsely elevated in cows ingesting poor quality silage high in butyrate. In sheep pregnancy toxaemia usually occurs 4-6 weeks before lambing.

Reference interval (cattle): Optimum concentration for milking cows <1.0 mmol/L

Subclinical ketosis (reduced milk production) >1.2 mmol/L

Clinical ketosis >2.0 mmol/L

Reference interval (sheep): Normal <1.0 mmol/L however twin and triplet bearing ewes can have slightly increased BHOB concentrations yet appear clinically normal.

COBALT (B12)

Species: Cattle, sheep, goats, deer, alpaca

Specimens: Serum or liver

Optimum number of animals to test for mob/herd/flock deficiency: 10 (serum) and 5 (liver).

General information about the test: Cobalt is measured indirectly in animals by measuring vitamin B12 a cobalt containing vitamin. Order of susceptibility to cobalt deficiency (high to low) is lambs>adult sheep>calves> kids >fawns>adult goats> cattle>deer.

Serum B12 concentrations can be elevated in lambs by >6 hours of yarding or a concurrent liver disease (e.g. facial eczema). In cattle vitamin B12 analogues produced by some diets can produce sometimes markedly variable and higher than expected results in a group of cows grazing together. This does not appear to occur in sheep.

The liver is the storage organ for vitamin B12.

Reference interval (serum B12): Cattle - adequate >150 pmol/L

Sheep – adequate >500 pmol/L

Alpaca – adequate >70 pmol/L

There are no reference ranges available for deer or goats.

Reference interval (liver B12): Cattle - adequate >220 pmol/kg

Sheep - adequate >375 pmol/kg

There are no reference ranges for deer, alpaca or goats.

COPPER

Species: Cattle, sheep, deer, goats, alpaca

Specimens: Serum, plasma (EDTA or Heparin) or liver.

Number of animals to test for mob/herd/flock deficiency: 10 (serum, whole blood) and >10 (liver).

General information about the test: Copper is stored in the liver so measurement of plasma, ferroxidase or serum copper do not give an estimation of the liver reserves until they are very low <4.5 umol/L (serum or plasma) or ferroxidase <7 U/L.

Ferroxidase is a copper containing enzyme which deteriorates over time so using old or haemolysed serum samples can affect results. However it does correlate with serum copper if fresh samples are used.

Reference ranges for copper were established using plasma samples whereas most samples taken are serum. In cattle a significant amount of copper is sequestered during the clotting process which is not currently accounted for with the current reference ranges and could lead to misdiagnoses of copper deficiency.

Although plasma copper also measures the copper which would have been retained in the clot if serum copper had been measured there appears to be no clinical advantage in using plasma copper over serum copper as the reference ranges have been adjusted and both are equally poor indicators of liver stores but can give an indication if copper deficiency is the cause of the current problem.

Serum (live animal) and kidney (dead animal) are the samples to test for copper toxicity. Serum copper >40 umol/L and a kidney copper >150 umol/kg indicate toxicity. Liver coppers >4000 umol/kg in liver biopsies or liver taken at slaughter plants from normal cattle indicate the potential for copper toxicity.

Reference interval (serum Cu):	Cattle - adequate >7 umol/L
	Sheep - adequate >8 umol/L
	Deer - adequate >8 umol/L
	Goat - adequate >11 umol/L
	Alpaca - adequate >5 umol/L
Reference interval (plasma Cu):	Cattle - adequate >9 umol/L
Reference interval (ferroxidase):	Cattle - adequate >14 IU/L
Reference interval (liver Cu):	Cattle - adequate >95 umol/kg
	Sheep - adequate >65 umol/kg
	Deer - adequate >100 umol/kg

IODINE

Species: Cattle, sheep

Specimens: Serum, plasma or urine (sheep only).

Optimum number of animals to test for mob/herd/flock deficiency: 3-5 (serum, plasma) or 10 pooled urines (sheep only).

General information about the test: Inorganic iodine is very stable compound. Inorganic iodine measures the iodine intake of the animal over the previous 2-3 days and the effect of oral or parenteral treatment with iodine supplements. It does not measure the reserves of iodine which are only in the thyroid gland.

Serum thyroxine is not a useful test to detect iodine deficiency in farm animals.

Reference intervals (serum, plasma, urine):

Cattle - adequate >40 umol/L

Sheep - adequate >40 umol/L (large goitres (60 grams) have been found in neonatal lambs produced by ewes with serum iodine <10 umol/L)

Horse - serum iodine measured in low numbers of normal horse suggest that their normal range may be much lower compared with other grazing animals i.e. 10-30 umol/, so serum thyroxine may perhaps be a more useful test in this species.

There are no reference ranges available for deer, alpaca or goats.

MAGNESIUM

Species: Cattle and sheep

Specimens: Serum or eye fluid (in recently dead cows or sheep)

Optimum number of animals to test for mob/herd/flock: 8-10

General information about the test: Magnesium is a stable element. Magnesium deficiency occurs most frequently in dairy and beef cattle in the late winter and spring period. This deficiency can be due to a combination of low magnesium and high potassium in spring pasture, the application of slurry to pasture and nutritional stress. A variety of clinical signs may be observed in a deficient herd from peracute (found dead) to chronic (unthrifty cows with an udder oedema). An increased incidence of milk fever and reduced milk yield can indicate subclinical hypomagnesaemia in a herd. Wet cold days and the pasture is wet and lush may precipitate attacks as cows will have lower intakes of pasture. Clinical hypomagnesaemia also occurs in sheep – the causes are similar to those seen in cattle.

Reference intervals: Cattle - supplied with results

Sheep - adequate 0.74 -1.15 mmol/L

Eye fluid - adequate > 0.60 mmol/L

NON-ESTERIFIED FATTY ACIDS (NEFA)

Species: Cattle

Specimens: Serum or plasma

Optimum number of animals to test for mob/herd/flock: 8-10

Collection protocol: Samples need to be submitted chilled and tested within 2 days of collection.

General information about the test: NEFAs are useful for detecting cows in negative energy balance (when body fat is being mobilised) 2-14 days before calving and perhaps colostrum cows. Avoid testing cows that are on the point of calving. Outside these times it has limited use. Diurnal variation in serum concentrations of NEFA can occur and their lowest concentration is reached 4-5 hours after feeding so blood for testing should collected just before feeding to obtain peak concentrations.

Reference interval (cattle): Optimum concentration for milking cows <1.0 mmol/L, although some studies have found that normal values for cows in positive energy balance can be as low as <0.2 mmol/L.

PHOSPHORUS

Species: Cattle

Specimens: Serum or (soil/ pasture)

Optimum number of animals to test for mob/herd/flock deficiency: 8-10

General information about the test: Serum phosphorus can be elevated by haemolysis, aging of the sample, azotaemia, enteric disease, milk fever and anorexia. Phosphorus deficiency is commonly seen in dairy cattle a month either side of calving and the usual signs are anaemia and haemoglobinuria. This

syndrome is called post parturient haemoglobinuria (PPH). Deficiencies can occur under drought conditions and where pasture phosphates are low due to recent conversions from sheep farms where the requirements for phosphates are much lower.

Reference interval: Cattle - adequate >1.4 mmol/L

Note: In PPH, anaemic cattle commonly have serum phosphorus levels <0.8 mmol/L.

SELENIUM

Species: Cattle, sheep, horse, alpaca, deer, goats

Specimens: Serum, whole blood (EDTA or heparin) or liver.

Number of animals to test for mob/herd/flock deficiency: 5 (liver, serum or whole blood)

Sample collection (liver): Necropsy sampling - take entire caudate lobe. Refrigerate or freeze;

Biopsy sampling – take >50 mg of liver – remove any blood clots at the time of collection and refrigerate. Special collection tubes are available at no charge on request.

General information about the test: Selenium is not stored for any length of time in tissue - depletes rapidly after dosing. Serum selenium is very stable as is whole blood selenium. Liver or whole blood can be used to diagnose selenium toxicity: >30,000 nmol/kg (or/L) indicates toxicity. However recently dosed animals (<24-48 hours) can have liver concentrations of selenium up to 30,000 nmol/kg.

Serum selenium measures current intake and approximates liver concentration.

Whole blood selenium and glutathione peroxidase (GPx) correlate after steady state reached 3 months after dosing. GPx is less stable than whole blood selenium so should be measured within 24-48 hours after collection if kept at room temperature or within a week if stored at 4°C. GPx can be used to assess selenium status of stock if they have been grazing the same soil type and no selenium supplementation for three months.

As with serum selenium, liver selenium measures current intake as selenium is not stored in any tissue.

Reference intervals (serum Se):
Cattle - adequate >140 nmol/L
Sheep and deer – no reference ranges at present

Reference intervals (whole blood Se):
Cattle - adequate >250 nmol/L
Sheep - adequate >250 nmol/L
Horse - adequate >1600 nmol/L
Alpaca - adequate >350 nmol/L
Deer and goats - no reference range at present

Reference intervals (GSHPx):
Cattle - adequate >2 kU/L
Sheep - adequate >3 kU/L
Deer, horse, alpaca and goats - no reference range at present

Reference intervals (liver Se):
Cattle - deficient <600 nmol/kg
Sheep - deficient <250 nmol/kg
Deer - outbreaks of myopathy (WMD) have been recorded in young fawns with a liver selenium of <600 nmol/kg.
Alpaca, horse and goats - no reference range at present

SODIUM

Species: Cattle

Specimens: Urine (or pasture/ diet)

Optimum number of animals to test for mob/herd/flock deficiency: 8-10

In lactating dairy cattle sodium requirements are high. Deficiency signs are reported to include poor conception rates, irregular oestrus cycles and poor milk yield. Because of homeostatic mechanisms the measurement of serum sodium gives erroneous results. The measurement of the potassium (mmol/L):sodium (mmol/L) ratio in urine appears to overcome these problems.

Reference interval:

A median K:Na ratio of <15 suggests a sodium deficiency in a mob of cattle.

Reference:

Eicher et al. Evaluation of biochemical methods for estimating the sodium intake of dairy cows. *Veterinary Record.* 153:358-362, 2003

ZINC

Species: Cattle, sheep

Specimens: Serum or liver (serum preferred)

Optimum number of animals to test for mob/herd/flock deficiency: 6-10 (serum) and 4 (liver).

General information about the test:

There are no significant mobilisable stores of zinc in the body. High levels of calcium, soil, copper and sulphur in the diet can reduce zinc availability to the animal. Do not test sick animals or cows within two weeks of calving as initial values can double within 24 hours.

Reference interval (serum):	Adequate 9-20 umol/L Potentially toxic >27 umol/L Facial eczema control* 18-34 umol/L
Reference interval (liver):	Adequate 460-1150 umol/kg Toxic - 1760-10,200 umol/kg

*Please note that serum zinc levels for facial eczema prevention are general guidelines as clinical and subclinical sporidesmin toxicity can still occur with serum zinc values within this range depending on level of toxin challenge, other trace element intake e.g. Copper and other host or environment factors. Also note that zinc toxicosis can potentially occur with serum zinc levels at the upper end of this range.

References:

Smith BL. Controlling facial eczema in sheep using zinc salts. *Proceedings 17th annual seminar. Society of Sheep and Beef Cattle Veterinarians* NZVA pp 227-233. 1987.

Dawson C, Laven RA. Failure of zinc supplementation to prevent severe facial eczema in cattle fed excess copper, *New Zealand Veterinary Journal*, 55:353-355, 2007.