Book review

Minerals in Animal and Human Nutrition 2nd Edn

By L.R. MCDOWELL.
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In the Preface to this 2nd Edition the author writes *"The purpose of this book is to provide, as both a college textbook and a reference source, a comprehensive text that contains current information on mineral nutrition":* and further *"It is hoped that this book will be of worldwide use and will continue as the first edition, to be used as a textbook and an authoritative reference book for use by research and extension specialists, in the animal, poultry, and veterinary sciences fields and for feed manufacturers, teachers, students, and others"*.

The text on offer is on a scale to match these lofty aims. Any purchaser will receive a document containing 644 pages of text, tables, photos and references. Across the 19 chapters of this book, the reader is confronted by over 4000 references with some chapters, for example Ch 2 — Calcium and Phosphorus, citing over 400 references in 60 pages of text. This does not make for easy reading and there are obvious instances where descriptive passages literally resemble litanies of 'facts' without any easily discernible theme unifying them.

The opening chapter deals effectively with the history of mineral nutrition and the concept of 'essentiality'. It also introduces the concept of 'Apparent Beneficial Intake' for elements such as Fluorine (F), which historically have been studied because of their toxicity. The incidence of mineral deficiencies/toxicities is considered on a global basis but, as emerges throughout the book, only passing reference is made to Australia. Most attention is directed to continental USA, Latin and South America and, to a lesser degree, Asia and Africa. Sections dealing with mineral analyses (sample preparation/digestion and instrumental techniques) and attendant problems are brief overviews. The reference (p.19) to near infrared reflectance spectroscopy (NIRS) for mineral analyses seems at odds with current knowledge.

Chapters 2 –14, inclusive, deal in depth with the established macro and trace minerals: calcium (Ca) and phosphorus (P); sodium (Na) and chlorine (Cl); potassium (K); magnesium (Mg); sulphur (S); iron (Fe); copper (Cu) and molybdenum (Mo); cobalt (Co); iodine (I); manganese (Mn); zinc (Zn); selenium (Se); and fluorine (F).

Each mineral is examined across a framework that involves in-depth consideration of its History, Chemical Properties and Distribution, Metabolism (including hormonal control where applicable), Physiological Functions, Requirements, Natural Sources, Deficiency, Supplementation and Toxicity as pertinent to monogastrics, ruminants, laboratory animals, humans and sometimes fish. One unfortunate outcome from such an exhaustive approach is the problem of repetition. This is an ongoing problem throughout the text. It is well demonstrated in Ch 2 in relation to discussion of onset of rickets and osteomalacia in both ruminants and monogastrics. The two conditions are discussed under a multitude of headings but the outcome is always the same. Either the diet is low in Ca and/or P and/or Vitamin D or the bioavailability of P to monogastrics is reduced by phytates. This can make for tedious reading.

Despite this concern, Ch 2 presents a comprehensive review on the roles of Ca and P in animal production. There is an extensive coverage of milk fever (hypocalcaemia), including a useful discussion, albeit brief, on CAD (cation–anion difference) manipulation of prepartum diets. From a purely local (Australian) viewpoint, it's a pity that much of the basic and applied research on P supplementation across northern Australia is not adequately cited. Reference to *Tropical Grasslands* Vol 24, No 3, September 1990 would benefit all readers. The P-supplementation strategies presented for extensively grazed cattle are not new for Australian conditions. **Recommendations for the use of animal by-products ('tankage' or meat scraps; meatmeal/bloodmeal/bonemeal) and 'broiler litter' as good sources of Ca and P totally contravene Australian law.**

Chapter 3 provides a realistic review of current knowledge with respect to Na metabolism and the widespread nature of salt deficiency. The risk of Cl deficiency is restricted to semi-purified diet experiments and is unlikely to be demonstrated under 'natural' conditions. Likewise Ch 4 deals effectively with K metabolism. Although the consensus opinion is that 'natural' deficiency is unlikely under extensive grazing, an interesting scenario is developed where K intake from matured pasture and/or hay could be inadequate for maximum production due to leaching of K from plant material by rain/weathering. Likewise the use of K supplements to alleviate heat stress in lactating dairy cows is pursued.

Chapter 5 — Mg, demonstrates another distraction to the reader, *i.e*., inconsistent poor editing. In a discussion on absorption of Mg from the digestive tract, the following sequence of text occurs (p.153, para 1, lines 1–5):

"For ruminant animals the major Mg absorption site is the reticulorumen portion of the digestive tract (Grace and MacCrae, 1972; Emanuelle *et al.,* 1991; Robson *et al*., 1997). In monogastrics the rate for mature animals is much higher, from 30 to 60% (Meyer 1976). Whittemore and Manson (1995) suggest a lower absorption rate for the growing pig to be 26%. Guenter and Sell (1974) ……..". It is impossible to determine what the relationship is between these two statements, the one dealing with 'site' the other with 'rate'. Either some interlinking statement relating to 'rate' for ruminant animals has been omitted or as stated earlier, references appear as unrelated litanies of 'facts'. Not withstanding editorial glitches, Ch 5 presents a good overview on grass tetany (hypomagnesaemia), its aetiology and treatment/prevention strategies. It is pointed out that

this is a disease more often associated with temperate rather than tropical pastures.

From a ruminant nutrition point of view, Ch 6 focuses on the microbial utilisation of sulphur; the consequences of ruminal sulphide production on trace element availability — most notably Cu through the formation of insoluble copper sulphide and soluble but biologically unavailable copper thiomolybdates; and the importance of the nitrogen:sulphur ratio, particularly when feeding non-protein N. None of these issues is particularly new but none the less they are dealt with adequately. The author concludes that diet S content is still the most accurate assessment of S status. He also cites evidence that beef cattle will tolerate water sulphate levels up to 2500ppm. This is 2.5 times the current Australian 'best practice' recommendation of 1000ppm.

Iron is discussed in Ch 7. Iron deficiency would not generally be of concern to the grazing ruminant except perhaps under conditions of acute parasitaemia.

Copper and molybdenum are reviewed in Ch 8. As mentioned for S, the interaction(s) between Cu, S and Mo to form thiomolybdates is well covered. There is a brief but interesting discussion of copper's role at the cellular level in the immune system. Diagnosis of Cu deficiency on the basis of plasma/blood Cu content and Cu-dependent enzymes is regarded as sensitive and accurate. The various supplementation strategies suggested to correct deficiency situations are consistent with current Australian practice(s). What are not adequately dealt with are those 'nil response to treatment' situations, which abound in the literature.

Ch 9 deals with cobalt. This is one of the clearest and more concise chapters in the book. If any criticism is warranted, it is in relation to the analyses necessary to determine Co (Vit B_{12}) status. Analyses at the part per billion (10^{-9}) range are fraught with difficulty and samples are so easily contaminated. It's a pity these difficulties are more-or-less glossed over. Another editing problem is that Table 9.2 — Cobalt sample concentrations in healthy and deficient sheep and cattle (p. 294) — has no units of measurement, *i.e*., ppm or µg/g.

Ch 10 reviews iodine metabolism in a concise manner and deals effectively with simple goitre (I deficiency) and secondary goitre induced by goitrogens (I antagonists). How high doses of potassium iodide prevent the iodination of tyrosine by iodine in the thyroid, thus leading to goitre, is not adequately covered.

Manganese is reviewed in Ch 11. Normally Mn deficiency is a disease affecting poultry (porosis). A similar tendon-related condition has been reported in grazing cattle when pasture Mn levels are lowered following draining and liming of acidic, waterlogged soils.

Ch 12 presents a very detailed and extensive discussion of zinc metabolism and physiology. There is a very interesting section detailing zinc's role at a cellular level in the transcription and translation of the genome. Based on extensive pasture analyses (Zn <40 ppm), the author proposes that marginal Zn deficiency is more common than thought and mineral licks ought to incorporate Zn. Plasma Zn levels are not good indicators of Zn status.

Ch 13 contains an extensive and very complex discussion on selenium metabolism. Several monochrome photos are included to illustrate various pathologies associated with Se deficiency. Without true colour contrast they are of doubtful value, as is a complex table (Table 13.4) which purports to depict Se and Vitamin E deficiency diseases as influenced by various dietary factors. Some explanation is needed. Se deficiency can be diagnosed with reasonable confidence and status should be determined before any supplementation is undertaken. Given the occurrence of seleniferous (high Se) soils across various parts of northern Australia, this would seem good advice.

Fluorine metabolism and its associated toxicity are discussed at length in Ch 14. Suggested permissible daily F intakes for breeder versus slaughter cattle are similar to current Australian recommendations. Toxic fluoracetate levels are found in plants worldwide. Australian concerns with heartleaf and georgina gidgee are not mentioned nor is the use of sodium fluoracetate in baits for feral pest control.

Ch 15 deals with elements (aluminium, arsenic, cadmium, lead and mercury) historically considered only for their toxicity. Now, some are identified as essential for some species under dietary regimens involving purified diets and specialised housing. Ch 16 concentrates on chromium (Cr), essential for effective glucose utilisation and other newly discovered or emerging trace elements (*e.g.* boron, silicon and nickel). Of interest are the beneficial responses to Cr amino acid chelates by lactating cattle and young cattle entering feedlots.

Chapters 17, 18 and 19 concentrate on the practical aspects of mineral supplementation. Ch 17 — Natural Sources of Minerals — is something of a 'grab bag' of themes. It critiques the contributions from forage and pasture, water and soil to total mineral intake. The author highlights the well 'known' variability in laboratory analyses for most minerals (**inter-laboratory variations >25%**). He then relies upon the same mineral determinations to support arguments of 'widespread deficiencies', while at the same time concluding: "There are gross errors in even the most widely accepted feed tables: some…". These problems are not new, it's just difficult to see what the author is trying to achieve! Criteria for bioavailability, utilisation of saline waters (TDS > 5000ppm) and management of pica and geophagia are useful.

Ch 18 provides a straight-forward discussion on determination of Maximum Tolerance Levels for minerals and factors influencing mineral availability/toxicity. Much of the availability/toxicity data is repeated from individual chapters.

Ch 19 focuses on methods for formulating/delivering mineral supplements. Indirect (via fertiliser) and direct (via water, free choice licks and intraruminal boluses) methods are reviewed. There are useful inclusions on: organic (chelated) trace minerals; bioavailability of different chemical forms of the same element; and calculations for free-choice mineral supplement formulation. This information would be of

use where mineral licks/supplements are being compounded from first principles.

The book concludes with extensive appendices covering mineral requirements for different classes and species of livestock, feed composition tables and various chemical data. In most cases, information is drawn from NRC tables.

In summary, this is a comprehensive text on mineral metabolism. It offers an extensive reference base relative to studies carried out in the Americas but it does not cover contemporary Australian, New Zealand, United Kingdom and European studies particularly well. Readability is diminished at times by both style and lack of editorial precision. It should be considered as a useful adjunct to a resource library but would be of limited benefit to producers.

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