The nutrient requirements of horses: historical perspectives

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INTRODUCTION

The Sixth Revised Edition of the “Nutrient Requirements of Horses” was published in 2007. Like other publications in the “the nutrient requirement series,” the Nutrient Requirements of Horses is a project of the National Research Council (NRC), which was created as the working arm of the National Academy of Science (NAS). NAS was established by the U.S. Congress in 1863 as a non-profit, non-governmental organization that could examine and report on scientific subjects. In 1928, NAS created the Committee on Animal Nutrition (CAN) as a standing committee of accomplished animal nutritionists with broad expertise from academia, government and industry. A primary role of the committee was to appoint subcommittees to produce and revise publications on the recommended nutrient allowances for domestic animals, the first of which dealt with poultry (NAS-NRC, 1944). The “Recommended Nutrient Allowances for Horses” was released in 1949, as the 6th publication in the series (following poultry, swine, dairy cattle, beef cattle, and sheep). The 1949 publication was updated and renamed “The Nutrient Requirements of Horses” in 1961 and since then there have been revisions in 1966, 1973, 1978, 1989, and 2007.

Since the original publication on the “Recommended Nutrient Allowances of Horses” was published, the size of the committee on horse nutrition increased from three members (1949), to five or six members (1966 through 1989), to eleven members in 2007. Perhaps not surprisingly, the length of the document as well as the number of topics covered has increased as well. About 100 yr after the formation of the National Academy of Science, the National Academy of Engineering and the National Academy of Medicine were formed. Today, the National Academies of Science, Engineering and Medicine (NASEM) work together in order to provide evidence-based information on a variety of topics. The Committee on Animal Nutrition was disbanded in the mid-2000s, but the NRC has continued to convene committees to revise publications in the nutrient requirement series. The National Animal Nutrition Program (NAMP), which is a national research support program of the USDA, currently provides input to the NRC on topics related to animal nutrition.

THE STUDY PROCESS

The publications in the Nutrient Requirement Series are generated following a defined process. Initially, NASEM determines the need for a study and the anticipated costs. A proposal with statement of task and budget is then approved by the NRC. Publication of the 6th revised edition of the Nutrient Requirements of Horses was made possible by significant support from external sources. Likewise, recent revisions of other publications in the series have relied heavily on external funding. The funds for each project support the travel of committee members and NRC staff to meetings, software development, technical editing of the publication, and publishing costs. The committee members are not paid. Once a project is approved and funded, the committee is selected. Many factors are considered when the committee is assembled, including range of expertise, possible conflict of interest, and a balance of perspectives (NASEM, 2021). The work of the committee includes gathering information in public meetings, from outside parties and through the review of scientific literature. Once the report has been developed, it is sent for independent review, and reviewers’ comments are addressed.
before the report is approved for publication. The Sixth Revised Edition of the Nutrient Requirements of Horses was reviewed by 13 individuals. After a publication is complete, the committee members are dismissed.

DETERMINING NUTRIENT REQUIREMENTS

A variety of methods have been used by the horse committee to estimate the nutrient requirements of horses. Some requirements have been estimated from review and summary of animal responses to different amounts of a nutrient. For example, in 1989, the committee reviewed data from nine studies to estimate the crude protein requirements for growing horses. Using those studies, they concluded that weanlings and yearlings should receive 50 and 45 g of crude protein, respectively, for each megacalorie of digestible energy. Several committees embraced the concept of nutrient-calorie ratios, particularly for working horses. In the 1973 and 1989 publications, the crude protein requirement for working horses was increased in proportion to the increase in digestible energy requirement above maintenance.

Factorial methods that partition nutrient needs into maintenance and production (growth, lactation, pregnancy, and work) components have also been common. Prior to 1989, the protein requirements of growing horses were determined using factorial methods that calculated the maintenance and growth requirements separately and considered the digestibility of protein in different diets. In addition, the factorial method employed to calculate the growth component considered composition of gain, rate of gain, and the efficiency of protein deposition. To arrive at the assumptions used in the factorial method, the committee utilized data from horses or cattle.

In the absence of research studies with horses, estimates for some nutrients were extrapolated from other species. Other estimates were derived from practical experience. For example, in the 1978 NRC, cobalt recommendations were based on the observation that horses consuming low cobalt pastures did not exhibit any health issues. When new information on a nutrient requirement was not available, most committees carried previous recommendations forward in the next edition.

REPORTING AND APPLYING NRC REQUIREMENTS

In 1949, the recommended daily intakes of total digestible nutrients, digestible protein, calcium, and phosphorus were described for maintenance, pregnancy, lactation, work, and growth. In 1961, requirements for digestible energy, total protein, carotene, and vitamin A were added and recommendations were expressed as both amounts per day and as concentrations in the daily ration. The 1966 and 1973 versions of the document followed a similar format, except that total digestible nutrients and carotene were removed from the tables. A table containing adequate levels of ten minerals (in addition to calcium and phosphorus) and five vitamins (in addition to vitamin A) was added to the 4th revised edition (NRC, 1978). Recommendations for total digestible nutrients reappeared in the 4th revised edition and then were removed in the 5th revised edition (NRC, 1989). In the most recent revision (NRC, 2007), tables with recommended nutrient concentrations were removed and requirements were only expressed as amounts per day. In general, the characteristics defining horses within each physiological class have become more specific over time.

The publications in the Nutrient Requirement Series were intended to be used by animal nutritionists, livestock feeders, and the feed industry (NRC, 1949). Since their inception, the publications have been used to identify rations with nutrient deficiencies or excesses and to formulate rations (NRC, 1998). All of the versions of the Nutrient Requirements of Horses up until the 6th revised edition contained tables with example rations or with suggested forage:concentrate ratios for various types of horses. The 6th revised edition contains chapters on ration formulation, feed analysis, and feeding management and behavior but does not make specific feeding recommendations. However, the 6th revised edition of the Nutrient Requirements of Horses included an internet-based program that allowed comparison of nutrient needs to nutrients provided by the feeds in the ration. Another purpose of publications in the Nutrient Requirement Series is to identify gaps in knowledge and research priorities (NRC, 2012).

CHANGES IN ESTIMATED REQUIREMENTS

With increasing research on nutrient requirements in horses and the application of different methods (factorial, summary), it would be expected that some recommendations might change in the 58 yr since the Recommended Nutrient Allowances of Horses was published in 1949 and the most recent edition of the Nutrient Requirements of Horses (NRC, 2007). Horse body weight has been expressed in pounds only, in both pounds and kilograms and in kilograms only. For the purposes of requirement comparisons in this discussion, horse body weight is described in both pounds and kilograms.

In general, the estimated digestible energy (DE) requirements for horses in a given physiological class have remained relatively consistent (< 20% variation from high to low) over the various editions of the Nutrient Requirements of Horses. The maintenance DE allowance for a 1300 lb (590 kg) average, idle mature horse suggested in the 3rd edition (NRC, 1973) was 18.5 Mcal/day and the current estimate is 19.6 Mcal/day (NRC, 2007). The DE estimates for 1300 lb (590 kg) horses in moderate work have remained relatively consistent, with estimates between 33 Mcal/d (NRC, 1973) and 28 Mcal/d (NRC, 2007). For weanlings (6 mo; mature weight of 1300 lb/590 kg), DE was estimated at 16 Mcal/d in the 2nd and 3rd editions, 17 Mcal/d in the 4th and 5th editions, and at 18 Mcal/d in the 5th and 6th editions. The DE needs of horses were not reported in The Recommended Nutrient Allowances of Horses (NRC, 1949), and the DE requirements for mature, idle horses were not listed in the tables of the 1st or 2nd editions of the Nutrient Requirements of Horses.

Crude protein (CP) requirements were not presented for any class of horse in the 1949 publication, and CP requirements for maintenance were not presented in 1961 or 1966. Figure 1 shows that the NRC recommendations for CP for maintenance and growth have been relatively stable over time, but the recommendations for working horses have varied widely. The methods used to derive the CP requirements for working horses also varied. In 1978, CP requirements for work were considered to be similar to requirements for maintenance, based on the concept that protein was not an important energy substrate (NRC, 1978). More recently CP requirements were considered to be higher than maintenance due to increased lean tissue mass, increased sweat
loss, and increased protein turnover during exercise (NRC, 2007). The highest CP requirements for working horses resulted from maintaining a consistent nutrient-calorie ratio; so as DE requirements were increased above maintenance, CP intakes were increased proportionately (NRC, 1973; NRC, 1989).

The recommended intakes for calcium have also varied considerably over time, both for working horses and growing horses (Figure 2). The calcium requirements of mature horses in moderate work have increased approximately 50% (NRC, 1978) and 100% (NRC, 2007) compared to initial recommendations (NRC, 1949). Marked changes in the recommendations for growing horses occurred between the 2nd and 3rd revised editions of the Nutrient Requirements of Horses (NRC, 1966 and NRC, 1973, respectively). The 3rd revised edition did not explain the rationale for the more than 100% increase in calcium compared to the previous edition. Compared to the changes in calcium, the changes in phosphorus recommendations have been much more moderate for both working and growing horses.

DEFINING REQUIREMENTS

Initially the daily nutrient intakes recommended for horses were defined as “adequate under practical situations” (NRC, 1949). Subsequently, the values appearing in the “Nutrient Requirements of Horses” were intended to present actual requirements instead of allowances that included safety margins (NRC, 1961; NRC 1966; NRC 1973; NRC, 1978; NRC, 1989; NRC, 2007). Maintenance requirements for mature horses were not provided in 1961 or 1966. Values are amounts per horse per day using a mature body weight of 1300 lb (590 kg).
committee members’ experience (NRC 1989). The 5th and 6th revised editions also mentioned several factors associated with horse-to-horse variability as well as the importance of understanding the variation in the availability of nutrients from different feeds in order to apply the recommendations appropriately.

In human nutrition, there has been an evolution in the terms and methods used to describe nutrient intakes. The Recommended Dietary Allowance (RDA) for a nutrient was set at a level intended to meet the needs of healthy people and serve as a guide for providing adequate nutrition (NRC, 1941). Although the first RDAs for humans were determined by literature review and consensus (NRC, 1941), they are now determined using the estimated average requirement (EAR) plus two standard deviations, covering about 97% of the population (Institute of Medicine, 2008). The term “adequate intake” (AI) has been applied when information about the EAR is absent or inconclusive (Institute of Medicine, 2008). The AI is expected to provide adequate intakes for most healthy humans. The tolerable upper intake level (UL) is the highest intake rate with no risk of adverse health effects (Institute of Medicine, 2008). The Institute of Medicine now uses a framework referred to as dietary reference intakes (DRI), which utilizes the RDA, EAR, AI, and UL. For example, the EAR, RDA, and UL for calcium intakes by adult men and women (19–50 yr) were reported to be 800, 1000, and 2500 mg per day, respectively (Institute of Medicine, 2011). Because data for infants were insufficient to define an EAR or RDA, the calcium intakes for infants were expressed at an AI (Institute of Medicine, 2011).

As equine nutrition evolves, the creation of a system similar to the RDIs may be useful. One advantage to the RDI system is the separation of recommendations based on scientific studies with defined response variables and recommendations believed to be adequate based on practical diets and observations. Designating the equine requirements primarily determined from practical experience might highlight those areas in need of additional research. As human nutritionists learn more about how to assess health risks associated with high or low intakes of nutrients or other dietary components, equine nutritionists may be able to apply those same methods to reduce the risk of diseases such as metabolic syndrome and osteoarthritis in horses.

LITERATURE CITED

Institute of Medicine. 2008. The development of DRIs 1994-2004: Lessons learned and new challenges. Workshop summary. Natl. Acad. Press, Washington DC.

Institute of Medicine. 2011. Dietary reference intakes for calcium and vitamin D. Natl. Acad. Press, Washington DC.

NASEM. 2021. About us. Study Process. [accessed August 2, 2021] https://www.nationalacademies.org/about/our-study-process.

NRC. 1941. Recommended dietary allowances. Natl. Acad. Sci., Washington DC.

NRC. 1944. The recommended nutrient allowances for swine. Natl. Acad. Sci., Washington DC.

NRC. 1949. The recommended nutrient allowances for horses. Natl. Acad. Sci., Washington DC.

NRC. 1961. The nutrient requirements of horses. Natl. Acad. Sci., Washington DC.

NRC. 1966. The nutrient requirements of horses. 2nd rev. ed. Natl. Acad. Sci., Washington DC.

NRC. 1973. The nutrient requirements of horses. 3rd rev. ed. Natl. Acad. Sci., Washington DC.

NRC. 1978. The nutrient requirements of horses. 4th rev. ed. Natl. Acad. Press, Washington DC.

NRC. 1989. The nutrient requirements of horses. 5th rev. ed. Natl. Acad. Press, Washington DC.

NRC. 1998. The first 70 years. Natl. Acad. Press, Washington DC.

NRC. 2007. The nutrient requirements of horses. 6th rev. ed. Natl. Acad. Press, Washington DC.

NRC. 2012. The nutrient requirements of swine. 10th rev. ed. Natl. Acad. Press, Washington DC.