Comments on CFIA's July 2018 proposal

Maximum Nutrient Values in Small Ruminant (Sheep and Goat) Feeds

Submitted by the Animal Nutrition Association of Canada

August 24, 2018

The following comments are submitted by the Animal Nutrition Association of Canada (ANAC) and were developed with a team of Canadian small ruminant nutrition experts from ANAC's nutrition committee. As we considered the recommendations on proposed maximum nutrient levels, we were mindful of the scope as outlined by CFIA in the proposal:

- to determine those nutrient levels that may impact the health and safety of livestock, humans, and environment;
- to determine those nutrient levels that support a nutritional purpose as opposed to a therapeutic purpose; and,
- to determine those nutrient levels that may produce residues in the resulting food that could be harmful to those consuming the products.

ANAC is the national trade association of the livestock and poultry feed industry in Canada. Our 160 members include feed and ingredient manufacturers and distributors, as well as suppliers of a wide range of good and services to the feed industry. Taken together, ANAC's membership represents 90 percent of commercial feed manufactured in Canada.

ANAC and our industry team of small ruminant nutrition experts look forward to discussing our comments with CFIA.

<u>GENERAL COMMENTS</u>

ANAC favours the replacement of Table 4 values with scientifically-supported maximum nutrient values based on the impact to the health and safety of livestock, humans, and the environment.

ANAC and its members recognize that the limits being proposed are intended as maximum levels and do not represent target levels for an optimal diet. The elimination of customer formula feeds in the modernized regulations emphasizes the importance of having levels which accommodate the numerous factors considered during the formulation and manufacture of feed. With that in mind, maximum nutrient levels should be flexible enough to accommodate new developments in the science of animal nutrition that may impact feeding strategies as well as the seasonal and regional variability in nutrient values of agricultural commodities available for use in feed. This is especially true in minor species, where species-specific research is lacking and in the case of small ruminants, recommendations for most nutrients are made based on a very limited number of scientific papers with limited data sets or on beef/dairy data. Forages, in particular, can pose a challenge to meeting some of the maximum levels proposed, especially where there is limited data on certain nutrient content in those forages (e.g. selenium) or where nutrient levels are inherently high or variable (e.g. potassium).

Another consideration for maximum nutrient levels should be the practise of flushing livestock prior to breeding. Flushing refers to increasing the plane of nutrition for both males and females for a brief period of time (i.e. 4-6 weeks) to increase pregnancy rates and tighten the lambing/kidding season, which results in important production and economic benefits for producers. This has been reflected in some of ANAC's recommended levels that follow.

With new policies being adopted to decrease the use of antibiotics in animal feed, the role of nutrition is becoming increasingly important to ensure animal health and well-being. Making use of the additional positive benefits of nutrients and other feed ingredients will be a valuable tool. Nutrients at levels supporting a nutritional purpose and not a therapeutic benefit should be accepted as long as they do not negatively impact the health and safety of animals, humans or the environment.

Below please find ANAC's comments on specific nutrient levels proposed as well as our rationale for the levels we recommend. As in the proposal, our comments on sheep feeds will be discussed followed by goat feeds.

Maximum Nutrient Values in Sheep Feeds

GENERAL COMMENTS

For sheep, ANAC supports the proposed levels of magnesium, sodium, sulfur, iron and vitamin E.

CALCIUM (Ca)

CFIA is proposing a maximum of 1% calcium (Ca) in the total diets of sheep. ANAC recommends a maximum of 2% calcium for all classes of sheep.

Previous research suggests calcium levels greater than 1% reduces dry matter intake (DMI) (Miller 1983) but no data on health or safety concerns associated with feeding elevated levels of calcium are available. NRC 2016 states that the maximum tolerable level of calcium in beef cattle diets is 2%.

A summary of all Canadian (AB, BC, MB, ON, QC, SK) legume forages and pasture and mostly legume forage and pasture samples submitted to Cumberland Valley Analytical Services from July 1, 2012 to August 1, 2017 (n=24238) (Appendix Table 1) indicates a mean calcium content of 1.35% with a standard deviation of 0.31%. Alfalfa forages can contain over 3% calcium. Equi-analytical reported the upper range of Ca in legume hays as 3.936% (accumulated Crop Years: 5/1/2000 - 4/30/2016).). Given the high variability of Ca in forages and the high inclusion rate of forage in sheep diets, a higher calcium maximum level is needed to ensure sufficient flexibility to meet the regulation during normal feeding practices.

PHOSPHOROUS (P)

The CFIA proposed phosphorus (P) maximum value of 0.6% of the diet DM for small ruminants is very restrictive. ANAC recommends that CFIA consider a maximum of 1% of diet DM in small ruminant diets to allow for necessary flexibility to ensure proper nutrition. Good nutrition practices include a 2:1 ratio of Ca to P therefore this would align with our Ca recommendation.

Many creep feeds and grower/finisher rations currently manufactured in Canada contain an elevated level of byproducts, such as wheat millrun, wheat middlings or distillers' dried grains in the pellet formula. These pellets are often used as the sole ration on the farm with phosphorus levels approaching 0.7% to 0.75% on an as-fed basis (or 0.79% to 0.84% DM) due to the naturally high level of phosphorus in byproducts. Restricting the phosphorus to 0.6% in total diet would restrict the pellet to 0.53% as fed (assuming the pellet is at 89% dry matter) and consequently limit the quantity of byproducts that could be incorporated, increasing the amount of waste which would require disposal. This would create a significant increase in the price of these feeds, causing an economic burden to the sheep and goat producers.

POTASSIUM (K)

CFIA is proposing a maximum of 2% potassium in the total diets of all classes of sheep. To account for the high potassium forages that sheep may access, ANAC recommends that the maximum potassium level be increased to 3%.

Forages generally contain 1% to 4% potassium (NRC, 2016). Since sheep receive a large forage portion as part of their diet, it will be extremely difficult and often impossible to stay below the 2% proposed maximum based on current feeding programs.

Ruminants grazing pastures over 3% potassium will need increased magnesium levels as decreased magnesium absorption has been reported (NRC, 2016). No other adverse effects have been reported for higher potassium intake.

COBALT (Co)

CFIA is proposing a reduction of maximum cobalt (Co) levels to 1 mg/kg of diet dry matter, which is too restrictive. ANAC requests that the limit remains at 10 mg/kg of complete feed (added), which is the current level in Table 4 and well within the MTL for cattle, sheep, chicks, and rats of 25 mg/kg DM (NRC, 2005).

A robust dataset does not exist for Co levels in commodities and forages. As such, enforcing total dietary limits will be difficult; this also pertains to iodine and selenium. Data is not readily available and analytical testing would place an impractical and undue burden on industry as a result of the costs and time delays of such tests. To enable industry to comply with the new regulations, transparency will be imperative with regards to the forage values being used by CFIA inspectors. To this end, ANAC has convened a committee of animal nutrition experts from across the country to develop reference values for forages that account for regional variability in Canada.

The maximum value proposed appears to be consistent with the European Food Safety Authority (EFSA) decision regarding the possibility of cobalt II ion posing a health concern for feed mill personnel. However, there is no data to show reducing cobalt levels in feed to such a restricted level as 1mg/kg improves human health considerations. Furthermore, Workplace Hazardous Materials Information System (WHMIS) regulations address the handling, training and communication of chemical hazards in relation to worker safety. The WHMIS regulations also control other more concentrated and more hazardous chemicals used in the feed industry.

Additionally, cattle with decreased DMI, such as dry cows and heifers, may suffer from a deficiency of vitamin B12. Cobalt can increase the rumen production of vitamin B12 and so sufficient cobalt is required to meet the vitamin B12 requirements of the animal.

Feedlot nutritionists have recognized more and more the value of increased dietary inclusion of cobalt on ruminal bacterial activity and animal performance, as demonstrated by the progression of inclusion rates from a 2007 survey to a 2015 survey (Vasconcelos & Galyean, 2007). Some nutritionists are supplementing up to 5 mg Co/kg DM for receiving diets and up to 3 mg Co/kg DM for finishing diets.

Finally, in the US there is no upper limit on the amount of cobalt that can be used in feed. Certain chelated mineral packs containing high cobalt levels and showing beneficial effects are currently used in Canada and the US; however, Canadian usage would be restricted or potentially eliminated with CFIA's proposed levels. Cobalt supplementation as low as 1 mg/kg would put Canadian producers at a severe competitive disadvantage to their American counterparts.

COPPER (Cu)

CFIA is proposing a maximum of 15 mg/kg copper in the total diets of all classes of sheep. ANAC recommends a maximum of 25 mg/kg.

The MTL for copper is 40 mg/kg for ruminants and 15 mg/kg for sheep (NRC 2005). However, the MTL assumes normal molybdenum (Mo) and sulfur (S) concentrations of 1-2 mg/kg and 0.15-0.25%, respectively (NRC 2005). NRC 2016 reports that "the antagonistic action of Mo on Cu metabolism is exacerbated when S is also high". Spears (2003) reviewed that S has a greater impact of Cu absorption than Mo, on its own or in combination with Mo and regardless of form (inorganic (i.e. sulfate) or organic (i.e. methionine)). Iron (Fe) and zinc (Zn) are also known to antagonize Cu absorption (NRC 2016).

ANAC is acutely aware of concerns regarding copper toxicity in sheep and understands 25 mg/kg will be a maximum and not a target level for formulation. Nutritionists will typically not approach this limit and would only do so in very specific scenarios and with extreme caution, which is how this is currently handled with customer formula feeds. Flexibility is required in the event of high sulfate levels in water or high molybdenum levels in forage, which are not controllable.

Forage and water sources frequently contain tremendously variable and often elevated levels of Mo and Fe. A summary of a variety of Canadian (AB, BC, MB, ON, QC, SK) forage and pasture samples submitted to Cumberland Valley Analytical Services from December 1, 2012 to December 1, 2017 indicates a mean Mo content of 1.95 mg/kg with a large standard deviation of 1.14 mg/kg (n=535) (Appendix Table 1). Fe content averaged 303 mg/kg (n=33549) with a large standard deviation of 386 mg/kg.

From the same laboratory, a summary of 86 water samples submitted from Western Canada (BC, AB, SK, MB) had an average S content of 258 mg/L with a standard deviation of 360 mg/L. The highest reported S level in this set of samples was 1874 mg/kg. NRC (2016) considers water high in S at 500 mg/L. The current proposal to regulate nutrients considered nutrient contribution from feedstuffs only. However, water can be a major source of mineral antagonists. Sulfate in water is considered an anti-quality factor (Beede 2006). Iron is also known to interfere with Cu absorption; the highly soluble form of Fe in water can cause a greater interference with Cu absorption than the less soluble form of iron from feedstuffs (Beede 2006). A summary of 88 water samples submitted from Western Canada (BC, AB, SK, MB) had an average Fe content of 1.11 mg/L with a standard deviation of 1.81 mg/L. The highest reported Fe level in this set of samples was 7.76 mg/kg.

The large standard deviations for Mo, Fe, and S in the forage and water analyses summarized above illustrates the geographical variation that exists across the country. While a maximum of 15 mg/kg copper in sheep diets is realistic and safe under normal circumstances, in scenarios where Mo is >2 mg/kg and S is >0.25%, higher levels of copper may be required. Sulfur in particular can high detrimental to Cu absorption; when dietary sulfur increases from 0.2-0.4%, copper absorption decreases by 50% (Suttle 1991). Further, increasing S intake in sheep can increase Mo retention (Grace and Suttle 1979). A survey of Saskatchewan water sources in 2017 indicated that 60.1% of dug out sources were >1000 mg/kg S, while 52.8% of well water samples were >1000 mg/kg (Feist 2017). Assuming an average water consumption of 10 L (8-12 L/d depending on environment, breed, and physiological status (CSF 2002)), a water source at 250, 5000, and 1000 mg/L S would contribute 0.093%, 0.185%, and 0.370% S to the total diet from water alone.

Central Saskatchewan Case Study: In 2016, a flock of 500 ewes was diagnosed with severe copper deficiency, manifesting as thin, poor-doing animals (other potential causes for poor condition and performance were ruled out). Average serum copper was 0.533 ppm (normal range 0.7-2.0 ppm) and liver copper levels were as low as 7.4 ppm (normal range 25-100 ppm). Forage tests showed average molybdenum of 2.60 mg/kg; water sample results indicated 458.2 mg/L sulfates. To correct this deficiency, a custom premix was manufactured with 1,500 mg/kg copper and fed at 25 grams per day from October 2016 until April 2017; total dietary copper during this time was approximately 25 mg/kg DM.

In addition to variability in forages and water, sheep are widely known to have significant age and breed variation to copper requirements (NRC 2007); British, medium wool and texel breeds have the lowest copper requirements, fine wool type sheep are intermediate, and hair sheep have the greatest tolerance to copper (Neary 2002). Older animals are less efficient at absorbing copper than young and growing sheep (ARC 1980).

The impact of mineral interactions on Cu absorption is difficult to predict (NRC 2016) and geographical variation exists for inert dietary antagonists (Mo, S, Fe, Zn). The maximum level of copper in sheep diets needs to offer flexibility for these interactions and for scenarios where these antagonists are present in levels outside the range considered normal (1-2 mg Mo/kg and 0.15-0.25% S; NRC 2005). Ruminants already have a substantially lower rate of Cu absorption compared to non-ruminants (Underwood and Suttle 1999). Normal practice for Cu fortification in sheep diets will continue to be carefully monitored by the feed industry given the susceptibility of sheep to Cu toxicity given that Cu is a valuable aid in maintaining weight gain and stimulating appetite during periods of stress caused by moving, vaccination, temperature changes, and castration.

<u>IODINE (I)</u>

CFIA is proposing a maximum of 1.3 mg/kg iodine for lactating sheep, and 2 mg/kg for non-lactating. ANAC does not feel such a drastic decrease is warranted by the available data and recommends that the maximum allowable limit for iodine be set at 10 mg/kg for non-lactating sheep and 2.5 mg/kg for lactating, and that these levels be based on an “as added” basis for the reasons below. It has been accepted that the maximum tolerable iodine level in cattle is 50 mg/kg DM (NRC, 2005). Iodine has been fed at levels exceeding 50 mg/kg without adverse effects in calves and lactating beef cows (NRC, 2016). A limit of 10 mg/kg of diet dry matter would be well within the MTL for dairy cattle and would allow flexibility to deal with specific on-farm situations.

As per Table 4, sheep and goat feeds may contain 10 mg/kg iodine. A 75 kg ewe consuming 5% of her body weight in dry matter per day at 25% forage dry matter could be consuming 28 mg of iodine per day or 7.5 mg/kg DMI. With the removal of Table 4, maximum levels should be based on evidence of a risk to environment, food safety or animal safety. To date, ANAC is not aware of any issues involving safety that would suggest such a drastic decrease in the current allowed maximums is necessary. Concerns with high milk iodine levels have been traced back to environment and iodine-based teat dips.

It is recognized that feeding excess iodine can result in high milk iodine levels. Borucki Castro et al. (2011), looked at milk iodine concentrations from 501 dairy farms across Canada. The study found that feed iodine levels of 1.2 ppm correlated with milk iodine at 146 µg/kg, and feed at 1.81 ppm correlated with milk at 487 µg/kg. In Europe, dietary iodine levels of 2.5 mg/kg DM resulted in iodine at 420 µg/L in raw milk and 305 µg/L in pasteurized milk (Norouzian and Azizi, 2013).

There must be flexibility built in for diets that contain ingredients high in goitrogens that interfere with iodine and the synthesis of thyroid hormones (NRC, 2001). Dietary iodine levels need to be increased when goitrogens are present.

Enforcing total dietary limits will be difficult, particularly with regards to nutrients such as cobalt, iodine and selenium where data is not readily available and analytical testing would place an impractical and undue burden on industry as a result of the costs and time delays of such tests. To enable industry to comply with the new regulations, transparency will be imperative with regards to the forage values being used by CFIA inspectors. To this end, ANAC has convened a committee of animal nutrition experts from across the country to develop reference values for forages that account for regional variability in Canada. We request that CFIA consider “added” levels of iodine at this time, with the possibility of moving to total levels once more data becomes available.

<u>MANGANESE (Mn)</u>

CFIA is proposing a maximum of 150 mg/kg manganese (Mn) in total diet for all classes of sheep and goats. The maximum tolerable limit (MTL) for manganese for ruminants is 2,000 mg/kg (NRC 2005), although levels twice as high have been fed with no ill effect (Watson et al. 1973, Wong-Valle et al. 1989). Additionally, the Small Ruminant NRC 2007 states that manganese is low in toxicity even at elevated levels. ANAC proposes a Mn maximum of 300 mg/kg of total diet dry matter for all classes of sheep and goats.

Manganese is critical for metabolism, growth and development, and reproduction (NRC 2007). NRC 2001, which calculated Mn requirement by factorial method, underestimated Mn requirements by as much as 35% (Weiss and Socha 2005). Manganese absorption is low (estimated at 5% for solid diets) and is not stored in the body to the same extent as other trace minerals (NRC 2007). Further, Mn absorption can be antagonized by high iron, calcium, potassium, and magnesium (Hanson et al. 2006, Cooper et al. 2014).

Forage and water sources contain tremendously variable levels of Mn. A summary of a variety of Canadian (AB, BC, MB, ON, QC, SK) forage and pasture samples submitted to Cumberland Valley Analytical Services from December 1, 2012 to December 1, 2017 indicates a mean Mn content of 51.3 mg/kg with a large standard deviation of 48.7 (n=20,481) (Appendix Table 2). From the same laboratory, a summary of 21 water samples submitted from Western Canada (BC, AB, SK, MB) had an average Mn content of 0.28 mg/L with a standard deviation of 0.47 mg/L. The highest reported Mn level in this set of samples was 2.12 mg/kg.

Human health risk is mainly by inhalation (Levy and Nassetta 2003), although excessive amounts in drinking water can also lead to negative health affects (Kondakis et al. 1988). Manganese consumed in excess of animal requirement is excreted almost exclusively in the feces (NRC 2007), which has not been documented to be a source of environmental contamination. Citing worker, rather than consumer, safety as a reason for this decrease is a duplication of efforts under the Workplace Hazardous Materials Information System (WHMIS), that cover the Canadian workplace. WHMIS regulations address the handling, training and communication of chemical hazards in relation to worker safety. The WHMIS regulations also control other more concentrated and more hazardous chemicals used in the feed industry.

SELENIUM (Se)

CFIA is proposing to change the Se level from 0.3 mg/kg (added) to 1 mg/kg (total) for sheep. ANAC recognizes that CFIA would like to monitor total dietary Se levels; however, lack of data on selenium makes this impractical. To that end, ANAC suggests a maximum of 1 mg Se/kg DM (added) for all classes of sheep for the reasons outlined below.

The maximum tolerable level for Se in cattle is 5 mg/kg DM (NRC 2005). No Se toxicity was reported in several studies where total dietary concentrations exceeded 2 mg/kg DM (Davis et al. 2006a, b, 2008; Neville et al. 2008; Juniper et al. 2008; Taylor 2005; Taylor et al. 2009; Hintze et al 2002; Lawler et al 2004). The absorption rate of Se in ruminants is estimated to be 29% (Meschy 2010); this is substantially lower than the estimated 80% absorption rate for monogastric animals (Mehdi and Dufrasne 2016) and should be accounted for when considering maximum tolerable levels in ruminant diets.

CFIA has indicated that they will use NRC values for Se content in forages in the determination of total dietary Se. Using these values, it is plausible that the proposed maximum level of 0.5 mg/kg of total diet would limit total Se content of the diet to a level that is lower than the current Table 4 maximum of 3 mg per day. There has been no reported negative effect of including Se at this level. Further, discrepancies exist in the reported Se levels between NRC 2016 and NRC 2001 including but not limited to barley grain, corn distiller dried grains with solubles, corn grain, corn silage, oat grain, and soybean meal. Limited data exits for Se content in Canadian forages, although geographical differences are known to exist (Campbell 1995; Hintze et al 2002; Miltimore et al 1975).

Selenium has a critical role in reducing oxidative stress, improving immune function, and reproduction (NRC 2001, NRC 2016). In field settings with larger ruminants, inadequate Se manifests as retained placentas, weak and still born calves, and increased somatic cell counts; poor calf health and increased susceptibility to infectious disease is commonly reported (Enjalbert et al. 2006; Reffett et al. 1988; Droke and Loerch 1989). In parts of Western Canada where soils are deficient in selenium and white muscle disease is more prevalent, higher levels of selenium are often added to beef cattle diets. Selenium deficiency is considered to be a greater risk than toxicity (Eisler 1985).

Various international bodies have set recommended human dietary selenium intake levels ranging from 20 to 70 micrograms per adult per day (EMA 2015). Although animal products – fish, edible organs, dairy products and eggs – are estimated to provide 50% of the total dietary selenium intake in humans (CCME 2009), there appears to be little risk of exceeding the human MTL of 300 ug per day even if animals are supplemented with feed exceeding the 0.5 mg/kg. An American study fed cattle 4.5 micrograms of selenium per kg of body weight resulting in a mean concentration of 18 ug per liter of milk; a Swedish study estimated daily consumption of 1.5 liters of milk per day results in an intake of 22 ug per person per day; sheep supplemented with 3 mg/kg of Selenium DMI had a resulting muscle Se level of 0.08 mg per kg (EMA 2015).

Feeding selenium to livestock is deemed to have negligible impact on the environment (EFSA 2016, Reilly 1996).

ZINC (Zn)

CFIA has proposed a maximum of 150 mg/kg of diet DM, for all classes of sheep. ANAC proposes that the maximum level for zinc be set at 250 mg/kg of diet DM for all classes of sheep. This level would be more closely aligned with the level for all classes of beef and dairy cattle proposed in CFIA's consultation summary and is also under the MTL for sheep.

The maximum tolerable level for Zinc as outlined the Mineral Tolerance of Animals (NRC, 2005) is 500 mg/kg for all classes of animals. Within this reference it is written "Zinc is relatively nontoxic to birds and mammals. Rats, pigs, poultry, sheep, cattle and humans exhibit considerable tolerance to high intakes of Zinc."

Beyond nutritional considerations, the EU on July 20, 2016 lowered the zinc maximum to 180 mg/kg for calves (from 200 mg/kg) and 120 mg/kg (from 150 mg/kg) for all other classes in an effort to reduce zinc excretion in the environment. This reduction is expected to reduce zinc excretion by 20% (EFSA, 2014). However, there is no supporting data at this time to substantiate the effectiveness of this decision.

VITAMIN A

The maximum vitamin A levels proposed by CFIA are 16,000 IU/kg DM for Lambs for Rearing (≤2 months old) and 10,000 IU/kg DM for Sheep for Fattening (≥2 months old). This is a decrease from the current Table 4 maximum of 75,000 IU/day for all classes. To ensure maximum flexibility, ANAC recommends a maximum proposed level of 65,000 IU/kg DM for Lambs for Rearing (≤2 months old) due to low dry matter intake and 25,000 IU/kg DM for Sheep older than two months, including ewes and rams). This recommendation is based on the assertion that forages have no vitamins. The presumed safe level for vitamin A in sheep diets is 45,000 IU/kg diet (NRC 1987).

An informal survey of ANAC Nutrition Committee members indicates that current vitamin A levels in feed used in the industry without any negative effects are as follows:

Animal Class	Range (IU/kg feed as fed)
Milk Replacers	50,000 – 60,000
Lamb Starters/Creeps	10,000 – 23,500
Lamb Growers	8,000 – 20,000
Lamb Finishers	7,000 – 14,000

The maximum levels proposed by CFIA do not encompass the current feeding practices in the animal feed industry, which are made possible through the use of consultant and customer formula feeds, and a reduction could be detrimental to animal health and production in Canada.

VITAMIN D

The maximum vitamin D levels proposed by CFIA are 2,200 IU/kg DM for all classes. This is a decrease from the current Table 4 maximum of 7,500 IU/day for all classes. To ensure maximum flexibility, ANAC recommends a maximum level of 11,000 IU/kg of diet DM for sheep under two months and a maximum of 5,500 IU/kg of diet DM for all other classes (to accommodate flushing). No safety, environmental, animal or human health effects have been reported at the current Table 4 limit. The presumed safe level for vitamin D in sheep is 25,000 IU/kg diet when exposure is less than 60 days and 2,200 IU/kg diet when exposure is greater than 60 days (NRC 1987). With concern regarding prolonged feeding of elevated vitamin D, it may be advisable to provide recommended maximum limits based on animal class.

An informal survey of ANAC Nutrition Committee members indicates that current vitamin D levels in feed used in the industry without any negative effects are as follows:

Animal Class	Range (IU/kg feed as fed)
Milk Replacers	4,000 – 10,600
Lamb Starters/Creeps	1,000 – 3,500
Lamb Growers	1,200 – 2,700
Lamb Finishers	1,000 – 2,500

Thus, the maximum levels proposed by CFIA do not encompass the current feeding practices in the animal feed industry. Furthermore, the sheep rearing industry is moving towards an indoor rearing model which will increase the dietary vitamin D requirements to compensate for the loss of vitamin D3 synthesis by the skin when exposed to the sun.

Maximum Nutrient Values in Goat Feeds

GENERAL COMMENTS

For goats, ANAC supports the proposed maximum levels of magnesium, sodium, sulfur, copper, iron, and vitamin E.

CALCIUM (Ca)

CFIA is proposing a maximum of 1% calcium in the total diets of goat. ANAC proposes a maximum of 2% calcium for all classes of goat.

Previous research suggests calcium levels greater than 1% reduces dry matter intake (DMI) (Miller 1983) but no data on health or safety concerns associated with feeding elevated levels of calcium are available.

A summary of all Canadian (AB, BC, MB, ON, QC, SK) legume forages and pasture and mostly legume forage and pasture samples submitted to Cumberland Valley Analytical Services from July 1, 2012 to August 1, 2017 (n=24238) indicates a mean calcium content of 1.35% with a standard deviation of 0.31%. Given the high variability of Ca in forages and the high inclusion rate of forage in goat diets, a higher calcium maximum level is needed to ensure sufficient flexibility to meet the regulation during normal feeding practices.

PHOSPHOROUS (P)

The CFIA proposed phosphorus maximum of 0.6% of the diet DM for small ruminants is very restrictive. ANAC recommends that CFIA consider a maximum of 1% of diet DM in small ruminant diets to allow for necessary flexibility. Good nutrition practices include a 2:1 ration of Ca to P so this will align with our Ca recommendation.

Many creep feeds and grower/finisher rations currently manufactured in Canada contain an elevated level of byproducts, such as wheat millrun, wheat middlings or distillers' dried grains in the pellet formula. These pellets are often used as the sole ration on the farm with phosphorus levels approaching 0.7% to 0.75% on an as-fed basis (or 0.79% to 0.84% DM) due to the naturally high level of phosphorus in byproducts. Restricting the phosphorus to 0.6% in total diet would restrict the pellet to 0.53% as fed (assuming the pellet is at 89% dry matter) and consequently limit the quantity of byproducts that could be incorporated. This would cause a significant increase in the price of these feeds, becoming an economic burden to the sheep and goat producers.

POTASSIUM (K)

CFIA is proposing a maximum of 2% potassium in the total diets of all classes of goat. To account for the high potassium forages that goats may access, ANAC recommends that the maximum potassium level be increased to 3%.

Forages generally contain 1% to 4% potassium (NRC, 2016). Since goats receive a large forage portion as part of their diet, it will be extremely difficult and often impossible to stay below the 2% proposed maximum.

Ruminants grazing pastures over 3% potassium will need increased magnesium levels as decreased magnesium absorption has been reported (NRC, 2016). However, no other adverse effects have been reported.

<u>COBALT (Co)</u>

CFIA is proposing a reduction of maximum cobalt levels to 1 mg/kg of diet dry matter, which is too restrictive. ANAC requests that the limit remains at 10 mg/kg of complete feed, which is the current level in Table 4 and well within the MTL for cattle, sheep, chicks, and rats of 25 mg/kg DM (NRC, 2005).

A robust dataset does not exist for Co levels in commodities and forages. As such, enforcing total dietary limits will be difficult; this also pertains to iodine and selenium. Data is not readily available and analytical testing would place an impractical and undue burden on industry as a result of the costs and time delays of such tests. To enable industry to comply with the new regulations, transparency will be imperative with regards to the forage values being used by CFIA inspectors. To this end, ANAC has convened a committee of animal nutrition experts from across the country to develop reference values for forages that account for regional variability in Canada.

The maximum value proposed appears to be consistent with the European Food Safety Authority (EFSA) decision regarding the possibility of cobalt II ion posing a health concern for feed mill personnel. However, there is no data to show reducing cobalt levels in feed to such a restricted level as 1mg/kg improves human health considerations. Furthermore, Workplace Hazardous Materials Information System (WHMIS) regulations address the handling, training and communication of chemical hazards in relation to worker safety. The WHMIS regulations also control other more concentrated and more hazardous chemicals used in the feed industry.

Additionally, cattle with decreased DMI, such as dry cows and heifers, may suffer from a deficiency of vitamin B12. Cobalt can increase the rumen production of vitamin B12 and so sufficient cobalt is required to meet the vitamin B12 requirements of the animal.

Feedlot nutritionists have recognized more and more the value of increased dietary inclusion of cobalt on ruminal bacterial activity and animal performance, as demonstrated by the progression of inclusion rates from a 2007 survey to a 2015 survey (Vasconcelos & Galyean, 2007). Some nutritionists are supplementing up to 5 mg Co/kg DM for receiving diets and up to 3 mg Co/kg DM for finishing diets.

Finally, in the US there is no upper limit on the amount of cobalt that can be used in feed. Certain chelated mineral packs containing high cobalt levels and showing beneficial effects are currently used in Canada and the US; however, Canadian usage would be restricted or potentially eliminated with CFIA's proposed levels. Cobalt supplementation as low as 1 mg/kg would put Canadian producers at a severe competitive disadvantage to their American counterparts.

<u>IODINE (I)</u>

CFIA is proposing a maximum of 1.3 mg/kg DM iodine for lactating sheep and goats and 2 mg/kg DM for all other classes of sheep and goats. ANAC recommends that the maximum allowable limit for iodine be set at 10 mg/kg for non-lactating goats and 2mg/kg for lactating, and that these levels be based on an "as added" basis for the reasons below.

As per the current Table 4, sheep and goat feeds may contain 10 mg/kg iodine. A 75 kg doe consuming 5% of her body weight in dry matter per day at 25% forage dry matter could be consuming 28 mg of iodine per day or 7.5 mg/kg DMI. With the removal of Table 4, maximum levels should be based on evidence of a risk to environment, food safety or animal safety

The MTL for iodine for ruminants is 50 mg/kg (NRC 2005), although levels twice as high have been fed with no ill effect (McCauley et al. 1973, Paulikova et al. 2002). Iodine is a critical component of thyroid hormones and therefore is essential for digestion and metabolism, reproduction and fetal development, growth, immunity, and thermoregulation (NRC 2005). Several authors (Meschy 2000, Caple et al. 1983, Lamand 1981) have indicated that goats have a higher iodine requirement than sheep. Additionally, cattle, sheep, and goats reduce thyroid hormone production in the summer months (ARC 1980), resulting in an increased requirement for iodine at that time. Iodine has a relatively wide difference between requirements and toxicity, making toxicity rare (NRC 2005, NRC 2007).

The presence of goitrogenic compounds increases the requirement for iodine. NRC 2007 estimated the iodine requirement for goats be increased if significant brassicas (canola, kale, turnips, cabbage, etc.) or cyanogenetic plants (i.e. white clover) are present in the diet. The primary impact of iodine deficiency is neonate mortality (Sargison and West 1998). Plant proteins tend to be marginal sources of iodine compared to animal protein sources (NRC 2007).

The analysis of iodine is extremely difficult and costly (NRC 2005). As such, no robust dataset for the iodine content of feedstuffs (i.e. forages and grains) exists. Further, Great Lakes regions and western Canadian regions are known to be iodine deficient (NRC 2007). To enable industry to comply with the new regulations, transparency will be imperative with regards to the forage values being used by CFIA inspectors. To this end, ANAC has convened a committee of animal nutrition experts from across the country to develop reference values for forages that account for regional variability in Canada. We request that CFIA consider "added" levels of iodine at this time, with the possibility of moving to total levels once more data becomes available.

MANGANESE (Mn)

CFIA is proposing a maximum of 150 mg/kg manganese (Mn) in the total diets of all classes of sheep and goats. The MTL for manganese for ruminants is 2,000 mg/kg (NRC 2005), although levels twice as high have been fed with no ill effect (Watson et al. 1973, Wong-Valle et al. 1989). Additionally, the Small Ruminant NRC 2007 states that manganese is low in toxicity even at elevated levels. ANAC proposes a Mn maximum of 300 mg/kg of total diet dry matter for all classes of sheep and goats.

Manganese is critical for metabolism, growth and development, and reproduction (NRC 2007). NRC 2001, which calculated Mn requirement by factorial method, underestimated Mn requirements by as much as 35% (Weiss and Socha 2005). Manganese absorption is low (estimated at 5% for solid diets) and is not stored in the body to the same extent as other trace minerals (NRC 2007). Further, Mn absorption can be antagonized by high iron, calcium, potassium, and magnesium (Hanson et al. 2006, Cooper et al. 2014).

Forage and water sources contain tremendously variable levels of Mn. A summary of a variety of Canadian (AB, BC, MB, ON, QC, SK) forage and pasture samples submitted to Cumberland Valley Analytical Services from December 1, 2012 to December 1, 2017 indicates a mean Mn content of 51.3 mg/kg with a large standard deviation of 48.7 (n=20,481) (Appendix Table 2). From the same laboratory, a summary of 21 water samples submitted from Western Canada (BC, AB, SK, MB) had an average Mn content of 0.28 mg/L with a standard deviation of 0.47 mg/L. The highest reported Mn level in this set of samples was 2.12 mg/kg.

Human health risk is mainly by inhalation (Levy and Nassetta 2003), although excessive amounts in drinking water can also lead to negative health affects (Kondakis et al. 1988). Manganese consumed in excess of animal requirement is excreted almost exclusively in the feces (NRC 2007), which is not been documented to be a source of environmental contamination. Citing worker, rather than consumer, safety as a reason for this decrease is a duplication of efforts under the Workplace Hazardous Materials Information System (WHMIS), on which ANAC collaborates with Health Canada. This redundancy would be counter to the objectives of the Cabinet Directive on Regulation as it would unnecessarily increase the administrative burden on businesses, promote inefficiencies, and create unpredictability as two separate government branches attempt to regulate the same business function.

SELENIUM (Se)

CFIA is proposing to change the Se level from 0.3 mg/kg (added) to 1.0 mg/kg (total) for goats. ANAC recognizes that CFIA would like to monitor total dietary Se levels; however, lack of data on selenium makes this impractical. To that end, ANAC suggests a maximum of 1 mg Se/kg DM (added) for all classes of goats for the reasons outlined below.

The maximum tolerable level for Se in cattle is 5 mg/kg DM (NRC 2005). No Se toxicity was reported in several studies where total dietary concentrations exceeded 2 mg/kg DM (Davis et al. 2006a, b, 2008; Neville et al. 2008; Juniper et al. 2008; Taylor 2005; Taylor et al. 2009; Hintze et al 2002; Lawler et al 2004). The absorption rate of Se in ruminants is estimated to be 29% (Meschy 2010); this is substantially lower than the estimated 80% absorption rate for monogastric animals (Mehdi and Dufrasne 2016) and should be accounted for when considering maximum tolerable levels in ruminant diets.

CFIA has indicated that they will use NRC values for Se content in forages in the determination of total dietary Se. Using these values, it is plausible that the proposed maximum level of 0.5 mg/kg of total diet would limit total Se content of the diet to a level that is lower than the current Table 4 maximum of 3 mg per day. There has been no reported negative effect of including Se at this level. Further, discrepancies exist in the reported Se levels between NRC 2016 and NRC 2001 including but not limited to barley grain, corn distiller dried grains with solubles, corn grain, corn silage, oat grain, and soybean meal. Limited data exits for Se content in Canadian forages, although geographical differences are known to exist (Campbell 1995; Hintze et al 2002; Miltimore et al 1975).

Selenium has a critical role in reducing oxidative stress, improving immune function, and reproduction (NRC 2001, NRC 2016). In field settings with larger ruminants, inadequate Se manifests as retained placentas, weak and still born calves, and increased somatic cell counts; poor calf health and increased susceptibility to infectious disease is commonly reported (Enjalbert et al. 2006; Reffett et al. 1988; Droke and Loerch 1989). In parts of Western Canada where soils are deficient in selenium and white muscle disease is more prevalent, higher levels of selenium are often added to beef cattle diets. Selenium deficiency is considered to be a greater risk than toxicity (Eisler 1985).

Various international bodies have set recommended human dietary selenium intake levels ranging from 20 to 70 micrograms per adult per day (EMA 2015). Although animal products – fish, edible organs, dairy products and eggs – are estimated to provide 50% of the total dietary selenium intake in humans (CCME 2009), there appears to be little risk of exceeding the human MTL of 300 ug per day even if animals are supplemented with feed exceeding the 0.5 mg/kg. An American study fed cattle 4.5 micrograms of selenium per kg of body weight resulting in a mean concentration of 18 ug per liter of milk; a Swedish study estimated daily consumption of 1.5 liters of milk per day results in an intake of 22 ug per person per day; sheep supplemented with 3 mg/kg of Selenium DMI had a resulting muscle Se level of 0.08 mg per kg (EMA 2015).

Feeding selenium to livestock is deemed to have negligible impact on the environment (EFSA 2016, Reilly 1996).

<u>ZINC (Zn)</u>

CFIA has proposed a maximum of 150 mg/kg of diet DM, for all classes of goats. ANAC proposes that the maximum level for zinc be set at 250 mg/kg of diet DM for all classes of goats. This level would be more closely aligned with the level for all classes of beef and dairy cattle proposed in CFIA's consultation summary, as well as what ANAC is proposing for sheep, and is well within the MTL.

The maximum tolerable level for Zinc as outlined in the Mineral Tolerance of Animals (NRC, 2005) is 500 mg/kg for all classes of animals. Within this reference it is written "Zinc is relatively nontoxic to birds and mammals. Rats, pigs, poultry, sheep, cattle and humans exhibit considerable tolerance to high intakes of Zinc."

Beyond nutritional considerations, the EU on July 20, 2016 lowered the zinc maximum to 180 mg/kg for calves (from 200 mg/kg) and 120 mg/kg (from 150 mg/kg) for all other classes in an effort to reduce zinc excretion in the environment. This reduction is expected to reduce zinc excretion by 20% (EFSA, 2014). However, there is no supporting data at this time to substantiate the effectiveness of this decision.

<u>VITAMIN A</u>

The maximum Vitamin A levels proposed by CFIA are 16,000 IU/kg DM for Kids for Rearing (≤2 months old) and 10,000 IU/kg DM for Goats for Fattening (≥2 months old). This is a decrease from the current Table 4 maximum of 40,000 IU/day for all classes. To ensure maximum flexibility, ANAC recommends a maximum proposed level of 65,000 IU/kg DM for Kids for Rearing (≤2 months old) due to low dry matter intake and 25,000 IU/kg DM for Goats (≥2 months old). No safety, environmental, animal or human health effects have been seen at the current Table 4 limit. The presumed safe level for vitamin A in goats is 45,000 IU/kg diet (NRC 1987).

An informal survey of ANAC Nutrition Committee members indicates that current vitamin A levels in feed used in the industry are as follows:

Animal Class	Range (IU/kg feed as fed)
Milk Replacers	50,000 – 60,000
Kid Starters/Creeps	16,000 – 16,500

Goat Growers	10,000 – 14,650
Goat Finishers	10,000 – 11,000

The maximum levels currently proposed by CFIA do not encompass the current feeding practices in the animal feed industry.

VITAMIN D

The maximum Vitamin D levels proposed by CFIA are 2,200 IU/kg DM for all classes. To accommodate current practices using consultant and customer formula feeds, ANAC recommends the maximum proposed level of vitamin D remain as the current Table 4 limit of 5,500 IU/kg of diet DM, which would accommodate common practices such as flushing. No safety, environmental, animal or human health effects have been seen at the current Table 4 limit. The presumed safe level for vitamin D in goat is 25,000 IU/kg diet when exposure is less than 60 days and 2,200 IU/kg diet when exposure is greater than 60 days (NRC 1987). With concern regarding prolonged feeding of elevated vitamin D, it may be advisable to provide recommended maximum limits based on animal class.

An informal survey of ANAC Nutrition Committee members indicates that current vitamin D levels in feed used in the industry are as follows:

Animal Class	**Range (IU/kg feed as fed)**
Milk Replacers	4,000 – 10,600
Kid Starters/Creeps	2,100 – 3,000
Goat Growers	1,700 – 3,000
Goat Finishers	2,500 – 3,000

The maximum levels currently proposed by CFIA do not encompass the current feeding practices in the animal feed industry.

APPENDICES

Appendix I: Cumberland Valley Analytical Services findings regarding calcium in forage materials

CUMBERLAND VALLEY ANALYTICAL SERVICES

Laboratory services for agriculture ... from the field to the feed bunk.

Feed Codes: ALFALFA MEAL,ALFALFA PELLETS,LEGUME FORAGE,MML FORAGE,MML PASTURE

# of Samples: 26513

Date Range: 11/1/2012 To 12/4/2017

Region: Canadian

MINERALS	AVERAGE	# OF SAMPLES	ST DEV	COV	-1 SD	+1 SD
Calcium (%DM)	1.35	26361	0.31	23	1.04	1.66

Appendix II: Cumberland Valley Analytical Services findings regarding manganese in forage materials

CUMBERLAND VALLEY ANALYTICAL SERVICES

Laboratory services for agriculture ... from the field to the feed bunk.

Feed Codes: BARLEY FORAGE,BROME ,CLOVER,CORN SILAGE,FESCUE,FORAGE,GRASS FORAGE,GRASS MIXED SPECIES,LEGUME FORAGE,MEADOW GRASS,MIXED FORAGE,MMG FORAGE,MMG PASTURE,MML FORAGE,MML PASTURE,OAT FORAGE,OATS AND PEAS,ORCHARD GRASS,PASTURE,PEA FORAGE,REEDS CANARY GRASS ,RYE FORAGE,SMALL GRAIN SILAGE,TIMOTHY FORAGE,TRITICALE FORAGE,WESTERN HAY,WHEAT FORAGE

# of Samples: 83245

Date Range: 12/1/2012 To 12/1/2017

Region: Canadian

MINERALS	AVERAGE	# OF SAMPLES	ST DEV	COV	-1 SD	+1 SD
Ash (%DM)	8	82572	3.23	40.4	4.77	11.2
Calcium (%DM)	0.77	82110	0.51	66.2	0.26	1.28
Phosphorus (%DM)	0.28	82107	0.08	28.6	0.2	0.36
Magnesium (%DM)	0.22	82101	0.08	36.4	0.14	0.3
Potassium (%DM)	2.14	82074	0.93	43.5	1.21	3.07
Sulfur (%DM)	0.21	46690	0.07	33.3	0.14	0.28
Sodium (%DM)	0.08	20481	0.11	138	-0.03	0.19
Chloride (%DM)	0.51	3955	0.36	70.6	0.15	0.87
Iron (PPM)	303	51375	386	128	-83.3	689
Manganese (PPM)	51.3	20481	48.7	94.9	2.63	100
Zinc (PPM)	27.2	20483	18.6	68.2	8.65	45.8
Copper (PPM)	8.21	20483	13.9	169	-5.68	22.1
Molybdenum (PPM)	1.95	535	1.14	58.5	0.81	3.09
Selenium (PPM)	0.68	18	1.09	160	-0.41	1.77
DCAD (meq/100gdm)	60.7	3926	29	47.8	31.7	89.7