Potassium in Animal Nutrition

Potassium has been recognized as an essential nutrient in animal nutrition since its importance was pointed out by Sidney Ringer in 1883. Potassium is essential for life. Young animals will fail to grow and will die within a few days when the diet is extremely deficient in K.

Potassium is the third most abundant mineral element in the animal body, surpassed only by calcium (Ca) and phosphorus (P). Potassium concentrations in cells exceed the concentration of sodium (Na) by 20 to 30 times. Outside the cell the reverse is true. Potassium comprises about 5 percent of the total mineral content of the body.

Muscle contains most of the total K in the bodies of animals (**Table 1**).

Potassium is contained almost entirely within the cells and is the most plentiful ion of the intracellular fluids. Potassium is found in every cell. It is present in tissues and cells only in ionic form (K^+).

Potassium (K) is essential for human and animal life. Potassium is involved in many body functions and is required for proper muscle development. Adequate K is also important for good heart function. The recommended daily allowance (RDA) of K varies depending on species, stage of growth, and level of other dietary minerals.

Functions of Potassium

Potassium functions in the intracellular fluids the same as Na does in the extracellular fluids. The major functions of K in the human and animal body are to:

- maintain water balance
- maintain osmotic pressure
- maintain acid-base balance
- activate enzymes
- help metabolize carbohydrates and proteins
- regulate neuromuscular activity (along with Ca)
- help regulate heartbeat.

Potassium Deficiency

There are several causes of K deficiency: inadequate amounts of K in diet, K losses in digestive secretions caused by vomiting and diarrhea, high intake of Na, increased urination, and stress conditions.

Potassium deficiency may commonly be manifested by depressed growth, muscular weakness, stiffness, decreased feed intake, intracellular acidosis, nervous disorders, reduced heart rate, and abnormal electrocardiograms.

The first sign of K deficiency is reduced feed intake. Many of the other signs stem from reduced feed intake. Potassium must be supplied in the daily ration because it is a mobile nutrient and there are not any appreciable reserves.

Potassium Uptake and Control

Potassium is absorbed in the small intestine. Its availability in digestion is nearly 100 percent. Most K is lost or excreted in urine.

TABLE 1. Concentration and distribution of K in animal body.

Tissue or organ	K, meq/kg	K, %
Muscle	110.0	56.0
Skin	58.6	11.1
Digestive tract	96.6	5.6
Liver	95.0	5.3
Red blood cells	106.0	4.2
Blood plasma	4.2	2.2
Brain	98.6	1.4
Kidney	77.6	0.9
Lung	79.3	0.5
Spleen	130.0	0.4
Heart	77.8	0.4
Bones and other	—	12.6

There is a small amount lost in perspiration. Kidneys play the most important role in maintenance and control of K. Under stress conditions the kidneys tend to excrete more K and conserve more Na.

Proper level of K in the diet is important for all types of animals. Lactating dairy cattle have a high K requirement.

Potassium in Human Nutrition

The usual American diet normally contains adequate K. The RDA is 2,500 milligrams (mg). The usual intake is 2,000 to 4,000 mg per day.

Problems with K intake can occur. Diets low in carbohydrates lower blood K and can cause an irregular heartbeat. Potassium deficiency can become serious due to K depletion in cases of cirrhosis of the liver, diarrhea, vomiting, diabetic acidosis, body burns, and severe protein-calorie malnutrition.

Potassium plays important functions in good cardiac health. Blood pressure is influenced by K. It helps overcome the adverse effect of Na on blood pressure. Sodium can be balanced with K to maintain normal blood pressure.

Potassium in Animal Nutrition

Potassium is especially important in diets of chickens and turkeys during the first 8 weeks. During heat stress, or if there is any diarrhea, the needed levels may be higher. Adequate K in the ration of laying hens assures good egg production, egg weight, and shell thickness. In starter chicks and turkey poults, adequate K increases weight gain, improves feed efficiency, and reduces mortality.

Swine K requirement is higher for young pigs than for older ones. It ranges from about 0.33 percent (dry matter basis) in rations of small pigs weighing up to 8 lb, to 0.19 percent in rations of pigs weighing more than 180 lb (**Table 2**). The K requirement for gestating and lactating sows is 0.20 percent. Potassium requirement increases in diets with higher Na and chloride (Cl) levels.

Ruminants have a higher K requirement than nonruminants. Potassium is essential for rumen microorganisms. The single most consistent effect of suboptimal K in the ration of ruminants is decreased feed intake.

Lactating dairy cattle, particularly high-producing cows, require the highest levels of dietary K. Under heat stress, their optimal level of dietary K can be as high as 1.9 percent, but the normal National Research Council (NRC) recommendation is 1.0 percent of dietary dry matter (**Table 2**).

Less K (0.65 percent) is recommended for dry cows, calves and heifers. During the last three to four weeks before calving, excessive K in the dry cow diet can increase the incidence of milk fever and retained placentas. This can lead to reduced milk production during the subsequent lactation. The maximum amount of K desirable in the dry cow diet depends on the use of anionic salts and

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TABLE 2. Recommended K level, % in dry ration.

Animal	Recommended level[1]
Beef cattle	0.6-0.7
Dairy cattle	0.65-1.0
Sheep	0.5
Swine	0.19-0.33
Horses	0.25-0.45
Poultry:	
Starting chicks	0.30
Laying or breeding hens	0.40
Turkeys	0.6-0.8

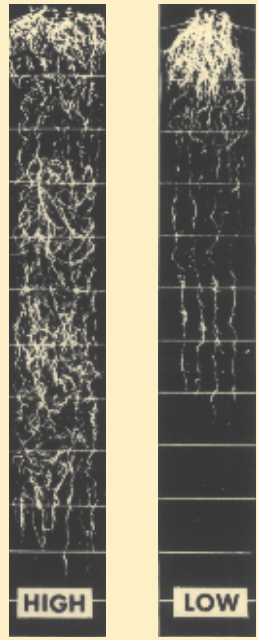
[1]National Research Council of National Academy of Science.

Higher K levels clearly help get crops through periods of stress. Many observations show the need to plan a strong K soil fertility program to make crop yields more certain in an uncertain environment. BC

Effective Water Use

Potassium helps crops use water more effectively. The positive benefits of adequate K fertility are:

- **Deeper roots.** Potash helps plant roots penetrate to access deeper soil water, as illustrated at right.
- **Faster closing of the crop canopy**. When the crop canopy closes, the ratio of transpiration to evaporation increases, which means more of the water available is used by the crop.
- **Greater osmotic gradient**. The more K inside the plant cell, the more strongly it can attract water from the soil – and better control its water loss.
- **Earlier maturity**. Adequate K helps ensure plants will get through the critical pollination period earlier – before drought.



Soil Fertility

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other factors, but generally forage K should be less than 2.5 percent. Cool-season forages tend to contain more K than warm-season grasses. Thus, problems of excess occur less frequently in southern than in northern regions.

The RDA of beef cattle is about 0.5 to 0.7 percent of dry ration (**Table 2**). Several studies have been reported with weight gains of steers on rations containing optimum levels of K. In Texas and Tennessee, elevating K levels to 1.4 percent of dietary dry matter helped reduce the stress of shipping calves and lambs to feedlots.

Grass tetany and wheat pasture poisoning are metabolic diseases of lactating cattle. These occur most frequently in animals grazing cool-season forages in which magnesium (Mg) concentration or availability is low (less than 0.2 percent). High levels of K, unbalanced with Mg, can increase risk of grass tetany. Milliequivalent ratios of K/(Ca+Mg) above 2.2 in forage dry matter are considered hazardous. Grass tetany risk is reduced by feeding Mg supplements. Also, fertilizing with phosphorus (P) can enhance plant uptake of Mg. BC

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