



**Lecture title: Animal nutrition: Calcium and Phosphorus**

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**Summary:**

**Calcium**

Calcium derives its name from the Latin “calx” meaning “lime.” Calcium is the most abundant mineral element in the animal body. It is an important constituent of the skeleton and teeth, in which about 99 % of the total body calcium is found. Calcium is an essential constituent of living cells and tissue fluids. It is essential for the activity of several enzymes, including those necessary for the transmission of nerve impulses and for the muscle contraction like troponin. It is also concerned in the coagulation of blood. It is essential for eggshell production in laying birds by formation of calcium carbonate and maximum milk production by lactating mammary glands.

The plasma of mammals usually contains 80–120 mg calcium/l, but that of laying hens contains more (300–400 mg/l). Large amounts of the calcium and phosphorus in bone can be liberated by reabsorption. This takes place particularly during lactation and egg production. The ileum is responsible for the absorption of 80% of calcium; it is transported to intracellular organelles by a cytosolic protein called calbindin. Resorption of calcium is controlled by the action of the parathyroid gland. The parathyroid hormone also plays an important role in regulating the amount of the calcium absorbed from the intestine by influencing the production of 1,25-dihydroxycholecalciferol, a derivative of vitamin D. Finally, the hormone stimulates the kidney to resorb urinary calcium.

**Sources of calcium**

- Milk, green leafy crops, especially legumes, and sugar beet pulp are good sources of calcium.
- Animal by-products containing bone, such as fish-meal, are excellent sources.
- Calcium-containing mineral supplements in lactating animals and laying hens, include ground limestone, calcium carbonate and dicalcium phosphate.
- Cereals and roots are poor sources.



It is important to consider the calcium: phosphorus ratio of the diet. The calcium: phosphorus ratio considered most suitable for farm animals other than poultry is generally within the range 1:1 to 2:1. But The proportion of Ca in the diet for laying hens (Ca:P ratio = 13:1) is much higher than that for 3–6week old growing broilers (Ca:P = 2.6:1).

### **Deficiency symptoms**

1. If calcium is deficient in animal feed the following signs appear:
2. In young growing animals, the condition known as rickets is produced which is characterized by enlargement of the joints, lameness, and stiffness.
3. In adult animals, calcium deficiency produces osteomalacia where the bones become weak and are easily broken.
4. In hens, deficiency symptoms are soft beak and bones, retarded growth, and bowed legs; the eggs have thin shells and egg production may be reduced.
5. In dairy cows Milk fever (parturient paresis) is a condition that most commonly occurs shortly after calving. It is characterized by a lowering of the serum calcium level, muscular spasms, paralysis, and unconsciousness.

### **Excess of calcium**

In animals, syndromes of hypercalcemia include:

1. constipation, nausea, and vomiting.
2. reduced feed intake and impaired growth.
3. excessive deposition of calcium in blood vessels to form plaques that lead to the dysfunction of the heart and brain.
4. muscle pain, abdominal pain, and kidney stones

### **Phosphorus**

Phosphorus is highly reactive and, therefore, is not found as a free element on the earth. In animals, phosphorus exists as phosphate. Phosphorus content of the animal body is less than that of calcium content. Whereas 99 % of the calcium found in the body occurs in the bones and teeth, the proportion of the phosphorus in these structures is about 80–85 % of the total,



only 20% of phosphorus present in the soft tissues and fluids. is also covalently bound to sugars, proteins, lipids, vitamins, and other organic molecules. In monogastric animals, the kidney is the primary route of excretion. parathyroid hormone stimulates the release of phosphate from bones, in response to hyperphosphatemia, the secretion of calcitriol and PTH is enhanced to decrease renal reabsorption of phosphate which helps to prevent an excessive elevation of plasma phosphate due to the bone resorption.

### **Functions**

1. Plasma phosphorus diffuses into saliva and in ruminants the large amount of chewing during rumination results in saliva being the major input of phosphorus into the rumen rather than the food.
2. There is a close association between phosphorus and calcium in bone.
3. Phosphorus plays important roles in phosphoproteins, nucleic acids and phospholipids.
4. As well as it is vital role in energy transfer, storage, utilization; and energy metabolism in the formation of sugar-phosphates, adenosine di- and triphosphates.
5. Phosphate is required as part of a coenzyme (e.g., pyridoxal phosphate) or an activator of an enzyme (phosphate-activated glutaminase and  $1\alpha$ -hydroxylase) to improve the efficiency of enzymatic reactions.

### **Sources of phosphorus**

good sources of phosphorus included:

- Milk
- cereal grains
- fishmeal products containing bone
- Much of phosphorus present in cereal grains is in the form of phytates. phytate phosphorus was utilized as well as dicalcium phosphate.
- Phosphorus content in hays and straws is generally very low.

### **Deficiency symptoms**

Phosphorus deficiency has an economical importance. It is usually more common in cattle than sheep, commonly occurs in grazing livestock, it is characterized by:

1. Phosphorus deficiency cause rickets or osteomalacia.



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2. Pica, which is a specifically sign of phosphorus deficiency that the affected animals have abnormal appetites and chew wood, bones, rags and other foreign materials.
  3. Protein deficiency due to reductions in the absorption and synthesis of amino acids.
  4. In chronic phosphorus deficiency, animals may have stiff joints and muscular weakness.
  5. Infertility, with apparent dysfunction of the ovaries causing inhibition, depression, or irregularity of estrous.
  6. In lactating cows reduce milk yield.
  7. In hens, there is reduced egg yield, hatchability, and shell thickness.

### **Excess of phosphorus**

- High phosphorus intake in association with magnesium can lead to the formation of mineral deposits in the bladder and urethra caused urolithiasis (urinary calculi) and blockage of the flow of urine in male sheep and cattle.
- reduced feed intake and impaired growth
- poor digestibility of iron, calcium, magnesium, and zinc