

**IFP**

INORGANIC FEED PHOSPHATES

Phosphorus: a vital source of animal nutrition

Phosphorus is one of the most important minerals in animal nutrition. It is the second most abundant element in an animal's body after calcium, with 80% of phosphorus found in the bones and teeth, with the remainder located in the body fluids and soft tissue.

Average total content of phosphorus and calcium in adult animals			
		Calcium	Phosphorus
Laying hen	(2kg)	22g	13g
Sheep	(50kg)	550g	280g
Fattening pig	(100kg)	750g	460g
Dairy cow	(600kg)	7000-9600g	3600-5000g

Sources: V.I. Georgievskii, Mineral Nutrition of Animals, Butterworths, 1982 H.J. Oslage, Zeitschrift Tierphysiologie, Tierernährung, Futtermittelkunde, 1964

Phosphorus plays a key metabolic role and has more physiological functions than any other mineral. These functions involve major metabolic processes such as:

- Development and maintenance of skeletal tissue: by far the greatest proportion of phosphorus is devoted to maintaining and supporting the skeleton, where it is co-precipitated with calcium in the form of hydroxyapatite. The skeleton acts not only as a support system but also as a reservoir of calcium and phosphorus from which the rest of the body can draw. It undergoes a continuous process of absorption and release of calcium and phosphorus, particularly during animal pregnancy and lactation and, for hens, during the laying period
- Maintenance of osmotic pressure and acid base balance: together with other minerals, phosphorus has a major role in the maintenance of osmotic pressure, buffer capacity and acid-base balance
- Energy utilisation and transfer: phosphorus plays a vital part in energy regulation. Certain phosphates, such as ATP (adenosine triphosphate), are universal accumulators and donors of energy; they are present in all body cells and ensure both the storage of energy and its utilisation. ATP is of prime importance in muscular activity during which chemical energy is converted into mechanical energy
- Protein synthesis, transport of fatty acids, amino acid exchange: phosphorus compounds are involved, directly or indirectly, in all major physiological functions. Phosphorylation is responsible for intestinal absorption, glycolysis and direct oxidation of carbohydrates, renal excretion, transport of lipids, exchange of amino acids, etc. Phosphorus is also a component of a large number of co-enzymes



- Growth and cell differentiation (DNA): phosphorus forms part of the structure of nucleic acids, which are carriers of genetic information and regulate protein biosynthesis and immunity.
- Appetite control, efficiency of feed utilisation, and fertility.

Phosphorus requirements

An adequate supply of phosphorus, in a form that can be absorbed by the animal and is available for storage or use to support these physiological processes, is essential if optimal livestock health and productivity are to be achieved. This is often referred to as biologically “digestible” or “available” phosphorus (cf. definitions p. 17).

In addition, an animal’s phosphorus requirement cannot be looked at in isolation, since both calcium and vitamin D are closely linked with it in many of the metabolic processes. For example, accretion of phosphorus in the animal’s bones is also affected by the presence of calcium and vitamin D.

Consequently, in addition to adequate phosphorus levels, the calcium to phosphorus ratio (Ca:P), as well as suitable levels of vitamin D, are critical to balanced nutrition.

Phosphorus deficiency

Without an adequate supply of phosphorus, an animal will suffer from a phosphorus deficiency, the consequences of which are varied, but in all cases affect the animal’s physical well being, as well as its economic performance. The initial effect is a fall in blood plasma phosphate levels, followed by the response mechanism of calcium and phosphorus being withdrawn from the animal’s bones. Apart from a generally lower resistance to infection, this often results a loss of appetite and a reduction in live weight gain due to impaired feed efficiency.

Deficiency symptoms become more pronounced when conditions for animal husbandry are not ideal. For specific species, these include:

- Laying hens: reduced egg yield, as well as a reduction in shell thickness and hatchability; often accompanied by “cage layer fatigue syndrome” and osteomalacia. Maintaining a correct Ca:P ratio is essential to ensure that the skeleton of the bird develops sufficiently to support optimum egg yield.
- Broilers: leg weakness and bone breakage, as well as tibial dyschondroplasia, osteomalacia and rickets. Bone breakage causes major problems during both production and processing, affecting meat quality; birds developing rickets result in total economic loss.
- Sows: reduced fertility, posterior paralysis (“Downer Syndrome”) and osteomalacia, leading to a shorter animal life cycle and reduced productivity.
- Fattening pigs: reduced growth rates and feed efficiency. Development of rickets results in total loss, while bone breakage during transport and processing affects meat quality and results in economic loss.

Optimum calcium: phosphorus ratios		
	Ca:P	Ca:vP
Laying hens	4.1 – 5.8	11.4 – 12.3
Broilers, chickens, pullets	1.2 – 1.5	2.2 – 2.3
Piglets, sows and fattening pigs	1.2 – 1.5	2.9 – 3.0
Dairy cow (600kg; 35kg milk/day)	1.15 – 1.4	–
Sources: V.I. Georgievskii, Mineral Nutrition of Animals, Butterworths 1982 Centraal Veevoeder Bureau (CVB), The Netherlands, 2004.		

- Cattle: lower feed utilisation and intake, reduced fertility, irregular or suppressed ovulation, and lower conception rates. Other symptoms include reduced milk yield, lameness, stiffness of gait and, in severe instances, enlarged and deformed joints and bones.

Phosphorus allowances

Phosphorus requirements for most animals have been well established. However, translating these into daily allowances is more complicated, taking into account a number of factors. These include:

- Variations in the levels of animal performance.
- Differences between animal breed and strain.
- Variations within a flock or herd.
- Variations in the composition of feed material.

In providing required levels of phosphorus, the primary concerns of the livestock producer are animal welfare and productivity, in order to ensure the proper development of the animal and the best economic return. In addition, environmental considerations to ensure the lowest possible environmental impact are increasingly being taken into account.