Unlocking muscle growth potential with phytase

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Exogenous phytases have been used commercially since the early 1990s as a successful tool for reducing the environmental impact of industrial livestock production and improving poultry and swine profitability. These cost-saving and sustainability benefits derive from the ability of phytase to liberate phosphorus from phytate. The breakdown of this poorly digestible compound improves animals’ phytate-phosphorus retention and reduces the need to use inorganic phosphorus sources in the diet.

The hydrolysis of phytate also delivers several additional physiological benefits that extend beyond phosphorus alone. These include the retention of amino acids, trace minerals, calcium and energy, which has led to feed phytase ‘super-dosing’. The resulting performance improvements reported, particularly with DSM’s RONOZYME® HiPhos, are over and above what would be expected based on additional phosphorus release and the reduction of anti-nutritive effects. However, the exact cause of these enhanced benefits was not until recently fully understood.

New research conducted by DSM has revealed important new insights into the ‘extra-phosphoric’ (EPE) effects of phytase, particularly on the role of myo-inositol.

The role of myo-inositol

Myo-inositol is a cyclical sugar alcohol that forms the core of the phytate molecule. Phytase together with endogenous phosphatases can liberate phosphate groups from phytate to increase the levels of circulating plasma myo-inositol (Figure 1).

Figure 1: Formation of myo-inositol in the small intestine after quick degradation of IP6 to lower IP esters in the upper digestive tract.
Myo-inositol is known to have the property to increase insulin sensitivity which can help in the distribution of blood glucose to the different organs and in particular to skeletal muscles, which will influence protein accretion and by that have a growth promoting effect. Laboratory results suggest that baseline plasma myo-inositol concentrations in broilers are around 30 mg/l and in pigs around 5-10 mg/l. The addition of a suitable phytase can increase these levels with beneficial effects.

Benefits to broilers

Although glucose metabolism is different in poultry and pigs, both have shown improved performance in response to oral doses of myo-inositol. Trials have shown that higher doses of phytase improve weight gain and feed conversion ratio, as well as calcium, phosphorus and sodium retention.

In a recent study, broiler chicks were fed either a diet containing insufficient (NC) or sufficient (PC) levels of available phosphorus and calcium. RONOZYME® HiPhos was then added at 1000, 2000 and 3000 FYT/kg to both diets. The supplementary phytase improved body weight gain and FCR effects of the NC diet and of the PC diet and plasma myo-inositol levels were also measured and remained elevated after three to four weeks. Myo-inositol concentration increased in both cases mirroring the effects on performance and by that strengthening its role.

‘Extra-Phosphoric Effects’ (EPE) in pigs

A number of trials have also been carried out in pigs to demonstrate the performance response to increasing doses of RONOZYME® HiPhos when matrix values are applied. It is clear that a high dose of RONOZYME® HiPhos can improve pig and piglet performance over and above that of the positive control diet, beyond feed cost savings.

By increasing the phytate degradation efficiency, RONOZYME® HiPhos has been shown to increase levels of myo-inositol in pigs and poultry. A study compared the EPE performance improvements with myo-inositol levels in piglets. A PC diet was compared with a matrix control diet (MC) and the MC diet containing either a 1000 or 2000 FYT dose of RONOZYME® HiPhos. The energy, Ca & P levels in the MC were adjusted according to the respective matrix values for RONOZYME® HiPhos at 1000 FYT dose. The piglets fed the MC1000 and MC2000 diets showed improvements in daily weight gain (DWG) and FCR above that of the PC (Figure 2). A clear response to the addition of RONOZYME® HiPhos was also seen in the level of plasma myo-inositol and this followed the performance response.

Figure 2: Higher doses of RONOZYME® HiPhos increased the DWG and FCR of piglets
Latest findings

Phytase has been demonstrated to improve growth performance, meat breast weight, amino acid digestibility and plasma myo-inositol concentration in broilers. New research recently presented by DSM demonstrates the potential interactions between phytase supplementation, growth performance and host gene expression to identify potential associated biomarkers.

The addition of RONOZYME® HiPhos at 1000 FYT/kg to the negative control (NC) restored the body weight gain at the level of the positive control (PC) in parallel with an increase of the plasma myo-inositol concentration driven by muscle growth as illustrated by the positive effect on the breast muscle (filet) weight increase.

The most impacted pathways via myo-inositol stimulation in animals fed RONOZYME® HiPhos are those controlling the formation of muscle tissue via the calcium/calmodulin-dependent kinase and IGF pathways (Figure 3).

**Figure 3:** Gene expression in skeletal muscle cells

Myo-inositol can be related to both metabolic pathways affected in broilers’ muscle due firstly its involvement in the intra-cellular enzyme activity and secondly as an insulin sensitivity enhancer. In spite of differences in the gastro-intestinal tract physiology and metabolism between weaned piglets and broilers, phytase supplementation had similarly increased plasma myo-inositol in both species which may influence muscle development and partly explain the better growth.

The results highlighted the importance of IP3 and myo-inositol (end products of phytic acid degradation by phytase) for improving muscle growth through the specific biomarkers potentially related to phytase supplementation that have been identified in the muscle.

Research will now focus on confirming these results in other species besides better understanding other mechanisms involved in the extra phosphoric effects (EPE) resulting from high doses of microbial phytase.