Managing post-weaning stress in piglets: nutritional considerations

Weaning, at whatever age, is a considerable challenge to the young piglet and represents a critical period in its life. It is also the period that establishes its future growth and development, since it is well known that both the body weight at weaning and performance in the immediate post-weaning period influence its subsequent growth and development, all the way through to slaughter. The overriding objective at weaning should, therefore, be to ensure as rapid a growth rate as possible through good nutrition, management and health status, as well as the reduction of stress.

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Indeed, weaning is perhaps one of the most stressful periods in the life of the pig. As such, issues of welfare and physical stressors are not the only stresses that should be reduced: so should the physiological and metabolic stressors associated with changing circumstances, high levels of performance, limited body reserves and considerable mobilisation of body tissue, not to mention inadequate feed and nutrient intake immediately after weaning. Nutrition can play an important role in helping to alleviate metabolic and physiological distress.

Role of minerals

Minerals and vitamins are fundamental in combating stress and may need to be increased if the metabolic function and the antioxidant status of the animal are not to be compromised. This is especially true for sows after their second litter of piglets.

A study by Newton and Mahan (1995) showed that there is considerable depletion of minerals from the sows' bodies, and the higher the litter size, the greater the rate of mobilisation will be.

This will, of course, influence the mineral status of the piglets, as demonstrated by Damgaard Poulsen (1993).

One way to overcome this depletion is to include organic rather than inorganic minerals in the diet of the sow and her piglets. The total replacement of inorganic minerals with organic minerals (Alltech's Bioplex) in the diet of the sow has been shown to substantially improve litter size and the number of piglets weaned per sow per year.

It also has a major impact on the mineral composition of both colostrum and milk, as well as that of the piglet at birth and weaning (Table 1). Of particular interest are the trace elements selenium, zinc and copper, which influence antioxidant status and immune function.

	Inorganic	Organic	Increase (%)	Source
Newborn piglet				
Liver Fe (mg/kg)	219	278	27	Egeli et al. (1998)
Liver Fe (mg/kg)	1779	2171	22	Bertechini et al. (2012)*
Blood Hb (g/dL)	9.16	11.16	22	Bertechini et al. (2012)*
Blood Fe (mcg/dL)	174	228	31	Bertechini et al. (2012)*
Blood Se (mg/L)	0.060	0.092	53	Svoboda et al. (2008)
Blood Se (mg/g)	0.140	0.159	14	Quesnel et al. (2008)
Loin Se (mg/kg)	0.116	0.200	72	Mahan (1994)
Colostrum				
Colostrum Se (mg/L)	0.093	0.188	202	Mahan (2000)
Colostrum Se (mg/L)	0.095	0.168	77	Peters & Mahan (2004)
Colostrum Se (mg/L)	0.242	0.323	33	Quesnel et al. (2008)
Colostrum Se (mg/L)	0.205	0.270	32	Yoon & McMillar (2006)
Milk				
Milk Se (mg/L)	0.036	0.105	292	Mahan (2000)
Milk Se (mg/L)	0.056	0.101	80	Peters & Mahan (2004)
Milk Se (mg/L)	0.042	0.087	107	Quesnel et al. (2008)
Milk Se (mg/L)	0.060	0.098	63	Yoon & McMillar (2006)
Milk Fe (mg/L)	773	1014	31	Bertechini et al. (2012)*

*Values at 2 kg/T inclusion rate

Table 1. Comparison of organic and inorganic minerals in pigs.

Selenium (Se)

Selenium has proven to be an important dietary antioxidant, and Mahan and Kim (1996) demonstrated that there is a rapid decline in blood serum and tissue levels of selenium and vitamin E after weaning. This may be due to the low feed intake of the piglets as well as the levels of the minerals in the diet and the availability of the mineral in question.

It is relevant and important to consider the source of selenium, as both tissue and loin levels were higher when organic selenium from selenium yeast (Alltech's Sel-Plex) rather than inorganic selenium (sodium selenite) was provided in the diet (Table 1). This helps to reduce the metabolic and antioxidant stress on the animals, resulting in enhanced performance, higher immune status and, ultimately, higher health status.

Several studies have shown that, when selenium yeast is included in the diet, it better supports pre-weaning and post-weaning survivability, as compared to the same level of inorganic sodium selenite.

Zinc (Zn)

Zinc is an essential micronutrient for piglets, and a deficiency results in parakeratosis. Moreover, zinc is involved in many critical functions in the bodies of piglets and is fundamental for optimising protein synthesis and growth, cell proliferation and differentiation, as well as antioxidant defence. It is, therefore, essential for lean tissue growth and health.

However, distinctions need to be made between the physiological need for zinc, which has been estimated at 9mg available zinc per day, and the high levels commonly provided in the diets of piglets to combat scouring and diarrhoea post-weaning (2,500-3,000mg of zinc from zinc oxide).

The level of zinc needed in the diet to meet the physiological needs after weaning will depend on the feed intake of the animal and the form and availability of the source of zinc.

In this respect, an interesting study has been carried out by Hill et al. (2014) in which they compared the effects of different levels (0, 25, 50, 75 and 100mg of zinc per kilograms diet) and sources (organic Bioplex and inorganic sulphate) of zinc on the performance and metabolic responses of piglets post-weaning.

Although performance was only slightly higher when zinc was provided in the form of Bioplex ($p > 0.05$), the results showed that the bioavailability of zinc from the organic source was greater than that from inorganic zinc, indicating that it better serves the metabolic and physiological functions of the piglet in the post-weaning period (Table 2).

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Zinc source	Basal	Organic Zn				Inorganic Zn				Combination
Zn level (mg/kg)	0	25	50	75	100	25	50	75	100	25+10
Feed intake (g/d)	534	542	552	578	540	574	537	552	563	555
Growth rate (g/d)	318	370	378	397	366	387	362	365	373	378
Feed: gain (g/g)	1.74	1.43	1.46	1.50	1.47	1.48	1.48	1.67	1.51	1.47
Liver content (mg/liver)	19.1	22.6	36.7	43.7	58.3	27.9	33.6	43.7	49.9	36.1
Metallothionein conc. duodenum (mg/g tissue)	30.2	33.3	34.6	37.8	50.1	30.5	32.0	40.6	40.6	33.7

Table 2. The effects of source and level of zinc on the performance and metabolic function in nursery pigs (Hill et al, 2014).

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Based on their results, Hill et al. (2014) concluded that the zinc requirements of modern piglets may be higher than originally thought.

Organic minerals appear to be managed differently from inorganic minerals in the body and better support the needs of the piglet in the face of changing dietary and environmental circumstances immediately post-weaning.

They suggested that, to maximise growth, health, well-being and antioxidant defence, the modern high-performing and sensitive piglet post-weaning should be provided with 75mg of zinc per kg of diet from organic sources.

These results confirm earlier findings, such as those of Carlson et al. (1999) and Mullan et al. (2002), in relation to both animal performance and metabolic significance.

Copper (Cu)

Copper is an essential nutrient for optimising growth and performance, as well as the development of immunity and health. It plays an important role in the synthesis and activation of several oxidative enzymes necessary for normal metabolism.

The National Research Council (2012) calculated that piglets post-weaning have a copper requirement of 2.81mg per day, corresponding to a dietary requirement of 6mg/kg. In practice, diets contain higher levels than this, and including 100mg of copper per kg diet – or even higher values – is commonplace in many countries to enhance growth and performance.

However, at these high levels, there is the possibility of interference with other nutrients that can reduce their bioavailability. For example, high levels of dietary copper may reduce the absorption of iron and indirectly result in anaemia.

One way to avoid this is to include organic rather than inorganic sources of copper in the diets of newly weaned piglets.

For example, Veum et al. (2004) fed young, weaned piglets diets supplemented with increasing levels of organic copper (Bioplex Cu at 0, 25, 50, 100 and 200mg of copper per kg diet) and 250mg of copper per kg diet as copper sulphate ($CuSO_4$).

Feed intake was highest at 25 and 50mg of copper per kg diet from the organic source.

Growth rate increased up to 50mg of copper per kg diet, with no further increases above this level; feed efficiency was not affected by dietary treatment. Rates of absorption of both copper and zinc were considerably higher from the organic sources of copper, leading to reduced mineral excretion rates.

The results of these and other studies suggest that providing 50-100 milligrams of copper per kilogram to piglets from organic (Bioplex) copper results in a similar performance to feeding 150-250 milligrams of copper per kilogram from $CuSO_4$, with considerably reduced rates of copper excretion.

Mineral supply

Although iron and manganese are important, they are not discussed in this article. However, providing them in organic form is recommended. Indeed, the total replacement of all inorganic minerals by lower levels of organic minerals is highly recommended for piglets post-weaning.

Dietary ingredients

After weaning, piglets require a good intake of a highly digestible diet to optimise performance. The choice of ingredients to supply these essential nutrients is critical, as certain dietary ingredients provide not only nutrients, but may also include proactive compounds that improve health, well-being and performance.

NuPro (yeast-derived protein [YDP], Alltech) is a source of digestible nutrients that also provides other proactive properties, such as nucleotides, inositol and glutamine. These support intestinal function, promote gut integrity, support the immune response and stimulate appetite, resulting in optimised health and performance well above the value of their nutrient content.

From a meta-analysis of 38 studies comparing YDP with a range of highly digestible ingredients normally included in piglet diets, there was a 5.3% improvement in growth rate and a 3.4% better feed conversion efficiency (Fig. 1). This improvement resulted in piglets weighing 1kg heavier some four weeks after weaning. The increase in performance suggests that the response to YDP is above the sum of its nutrient content, and it is interesting to speculate why this occurs. Studies have shown that intestinal health is improved, and there is a concomitant increase of beneficial bacteria.

There is also an enhancement of immune function as well as the healing of any gut wall damage. The physiological stress associated with weaning may be reduced, since the concentration of the acute-phase protein haptoglobin in the blood of piglets post-weaning was reduced. Absorptive capacity of the gut may be increased, as it has been shown that the villus height to crypt depth ratio is increased, which results in enhanced nutrient utilisation.

The overall response measured from several studies was a 10% increase in the ratio (range 1.5-27.6%). All of these factors contribute to better gastrointestinal health and immune function, enhanced digestive competence and reduced metabolic distress, in turn resulting in better growth, feed conversion efficiency and overall performance.

Conclusions

Weaning is a very sensitive and stressful period in the life of the pig, with consequences that last until slaughter. Ensuring that the nutritional requirements of the animals are met by providing the most available nutrients and proactive ingredients in the diet to reduce metabolic and physiological distress is fundamental to ensuring optimum growth, feed efficiency, health and profitable piglet production. ■

References are available from the author on request

Fig. 1. Improvement in ADG and FCR with yeast derived protein.