Feeding and managing the modern broiler breeder

Managing the modern broiler breeder provides many challenges, not least of which is ensuring birds reach their genetic potential by providing the correct levels of nutrition.

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Nutrients deposited in eggs by the breeder hen are utilised by the developing embryo and influence growth and development as well as the quality of the hatchling chick in terms of chick size, viability and immune status.

Organic versus inorganic

Embryo development relies on a good supply of high quality energy and nutrients, including minerals needed for antioxidant protection of the young chick. The correct profile and availability of nutrients within the hatching egg needs to be determined in order to ensure optimal feeding of the breeder hen.

The balance of nutrients in the hen's diet can then be transferred in correct amounts to the egg to attain best growth and viability of the resulting broiler chick.

The yolk is the primary source of energy and nutrients for the embryo during development. The energy needs of the embryo throughout the 21-day developmental period of incubation are obtained from polyunsaturated fatty acids (PUFA) derived from the yolk lipids, which are also the source of other compounds needed for the synthesis of membrane phospholipids in the growing tissues of the embryo.

However, PUFA in yolk are very susceptible to oxidative damage from reactive compounds produced in relatively high levels in eggs due to the rapid growth and metabolism of the embryo. Oxidation damages membranes, DNA and tissues, and it can lead to developmental problems in neonatal animals. Hence, the levels of antioxidants deposited within the egg by the dam are important for the production of viable chicks.

An important part of this protective mechanism is provided by antioxidant minerals supplied in a chemically organic form akin to those found in natural feed materials.

Modern technology has made it possible to supply organic minerals as di- and tri-peptide chelates, which are easy to include in the feed matrix and which have higher bioavailability in the animal, from increased, non-competitive absorption in the gut and better storage in organs. Of the antioxidant minerals, selenium plays a key role in ensuring fertility and reproduction in all species of animals.

Selenium is a key element within antioxidant enzymes, which are required to repair DNA damage, hence protecting cells from the harmful effects of free radicals.

It works in harmony with vitamin E to optimise activity and recycle the vitamin, making its use within cells more efficient. Research has shown that trace mineral requirements are higher during reproduction in animals compared to normal maintenance levels in feed.

Given the higher economic value of broiler breeders, commonly cheap inorganic trace minerals (for example oxides and sulphates) are usually fed at higher levels than recommended.

This feeding practise can lead to increased mineral interactions, leading to poor uptake from the gut, worsening the already poor bioavailability of inorganic trace minerals.

Additionally, inorganic minerals can be contaminated with heavy metals such as arsenic and cadmium that can be detrimental to breeder performance and potentially harmful to the developing embryo.

Table 1. Effect of feeding organic Se source (Sel-Plex) to broiler breeder hens on hatch parameters of progeny.

Parameter	Control	Sel-Plex
Body weight (g)	40.41[a]	41.06[b]
Average length (cm)	18.32[A]	18.58[B]
Minimum length (cm)	16.1	17.5
Maximum length (cm)	19.8	20
Correlation BW to length (r)	0.30	0.22

[a,b] Means differ ($p<0.05$), [A,B] Means differ ($p<0.01$)

Inorganic selenium

In an experiment conducted using 24,000 Hubbard Feeds classic broiler breeders to compare the effect of inorganic selenium versus organically derived Sel-Plex (Alltech), the performance of the resulting chicks was measured.

Chicks from the Sel-Plex-fed breeder group had significantly greater body length compared with the control (inorganic selenium) group, indicating that progeny from the Sel-Plex-fed breeder flock were better developed, which is beneficial for future productive performance of broilers.

A significant difference in body weight in favour of the Sel-Plex group was seen, although the correlation coefficient between body weight and length was relatively low. Body weight and body length of the day-old chicks is shown in Table 1.

In conclusion, uniformity of day-old chicks, based on both body weight and body length, was better in those produced by breeder hens supplemented with Sel-Plex compared with those from hens fed inorganic selenium.

The 10% improvement seen in the Sel-Plex group indicated that breeder flock nutrition has an important influence on the uniformity of day-old chicks.

An effective strategy to improve the bioavailability of inorganic mineral sources in broiler breeder diets is to add it 'on top' of existing formulations, or substitute inorganic with organic sources of important trace minerals, such as Bioplex (Alltech).

When breeder diets were supplemented with organic zinc and a combination of organic copper, zinc, manganese and selenium, a

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Table 2. Effect of supplementing organic minerals (Bioplex and Sel-Plex) in broiler breeders on laying performance.

Variables	Bioplex	Control	Difference
Feed intake per bird (kg)	25.51	24.81	+0.70
Hen housed total eggs per bird	83.58	73.92	+9.67
Hen housed hatching eggs per bird	75.89	67.59	+8.29
Feed per hatching egg (g)	336	367	-31

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protective effect on the hens was seen due to increasing cholesterol and triglyceride clearance from plasma and decreasing plasma lipid per oxidation.

Maternal nutrition can affect embryonic development by the deposition of nutrients in the egg. Supplementing organic minerals in the feed increased triglyceride delivery and decreased lipid per oxidation product retention in the yolk, which can be linked to improved growth performance of chicks. Moreover, the combination of organic copper, zinc, manganese and selenium appeared to be much more effective than that of organic zinc. Hence, these findings suggest that the use of organic minerals in breeders' diets has beneficial effects on growth and development of the resulting progeny.

Trials carried out in the U.S. by Swamy et al. (2008) confirmed these findings where breeders were supplemented with Bioplex and Sel-Plex, which resulted in improved performance (Table 2).

This improvement was attributed to greater bioavailability of organic trace minerals compared with inorganic sources, thus increasing the mineral status and tissue reserves of the bird, leading to improved hatching egg production and feed efficiency. When Bioplex Poultry Pak was added on top of the existing breeder diet, which already contained inorganic minerals, the resulting performance improvement provided a competitive edge in terms of profitability for farmers.

Additional advantages of the extra eggs realised in the organic mineral-fed birds in the early part of life (up to 44 weeks of age) was further supported by fewer shell quality problems, better fertility and better hatchability.

An area that organic minerals could positively affect reproductive efficacy is cockerel nutrition. This is because gametes are very sensitive to oxidative damage, leading to poor fertility and fewer settable, fertile eggs.

In an experiment conducted by Klecker and Zeman (2005), young cockerels fed diets containing 50% of the added selenium, manganese and zinc in an organic form (Bioplex) showed significant improvements linked to fertility.

Bioplex manganese/zinc and Sel-Plex significantly increased blood testosterone, particularly when Sel-Plex was added (Fig. 1), and fertility, measured as settable hatching eggs, improved with organic supplementation (Fig. 2).

Hatchability of eggs from cockerels aged 27 weeks, which is usually low at this age, was positively affected not only by application of Bioplex manganese and zinc, but particularly with the addition of Sel-Plex ($P<0.01$).

In ovo feeding

Epigenetics studies cellular and physiological phenotypic trait variations that are caused by external or environmental factors that switch genes on and off and affect how cells 'read' genes during critical developmental periods.

This allows an animal to metabolically or physiologically adapt to specific dietary or environmental conditions.

In poultry, epigenetic programming occurs at two critical periods: during gametogenesis, when breeding stock are adolescents; and during egg formation, when nutrients are consumed by the embryo via amniotic fluid and yolk, which occurs from setting until the first few days after hatch.

The amount of selenium in the egg that is derived from the hen's diet is limited because the maximum level of dietary selenium supplementation is only 0.3 parts per million.

This is due to historical issues with the toxicity of inorganic selenium sources, whereas it is now known that organic forms are typically 10 times less toxic, although feeding restrictions have yet to be modified

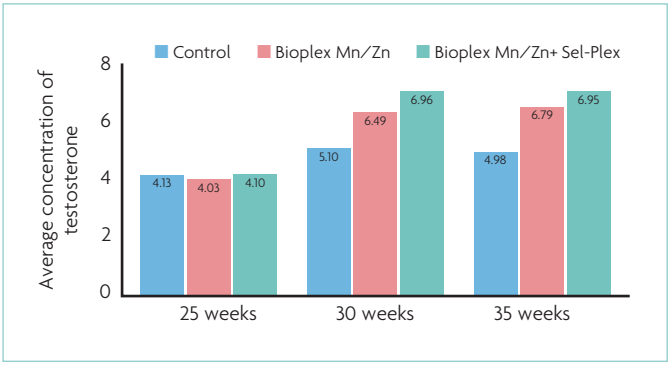


Fig. 1. Average concentration of testosterone in blood serum (nmol/l) from cockerels fed either inorganic (control) or organic minerals in feed.

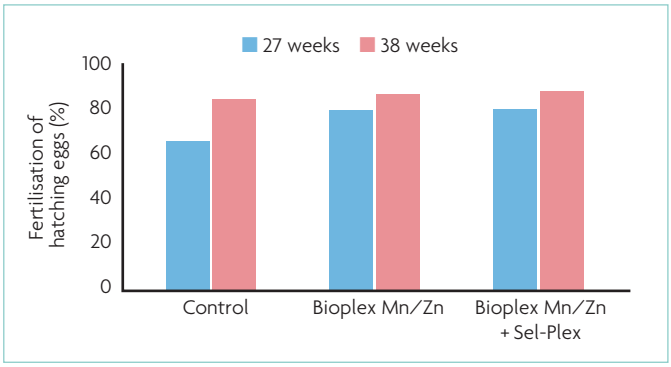


Fig. 2. Fertilisation of hatching eggs (%) from cockerels fed inorganic (control) or organic minerals.

to take relative toxicity into account. To get around such limitations, other methods of getting nutrients into hatching eggs have been devised.

One way of introducing extra nutrients to the incubating embryo is through in ovo injection.

Studies have shown that this method, supplying higher levels of carbohydrates, proteins, vitamins, amino acids and vaccines, can enhance growth, development of the embryo, improve energy status, promote early gut development and improve immune status, alleviating certain stresses at hatching.

In a study using in ovo injection of organic selenium (as Selenomethionine), data showed greater tissue selenium accumulation in the chick than injecting the same amount of selenium as inorganic selenate. Such increases in selenium in tissue reserves are physiologically useful for the bird during times of stress, where extra antioxidants may be required.

Yolk sac injection of less than 40 microgrammes of selenium at 10 days of incubation was not toxic to the embryo and did not produce teratogenic effects.

The results of these studies indicated that injection of selenium into the yolk of incubating eggs may be useful for enhancing selenium status during embryonic and early post-hatch development.

Thus, the improvement in selenium status using this method in conjunction with dietary selenium supplementation of breeder hens would be much greater than only using dietary supplementation.

The role of MOS in fertility and hatchability

Restrictions on the use of antibiotics due to consumer and media concern regarding the promotion of resistance from overuse in feeds for animals, including poultry, has increased the interest in natural alternatives.

Mannan-oligosaccharides (MOS) is a yeast cell wall-derived oligosaccharide that binds certain bacteria in the gut and influences the immune system by 'presenting' specific bacteria types to the gut-associated lymphatic tissue. It is known from studies on gene regulation that specific carbohydrates, such as MOS, are important in switching on certain immunological functions.

This explains why supplementation with β-glucans has been observed to raise immunoglobulin in blood, intestines and milk, including promoting the transfer of maternal antibodies to progeny.

The use of Bio-Mos and Actigen in diets for breeders is of particular interest because it promotes beneficial gastrointestinal microflora and has the ability to maintain optimal immune function.

Previous experiments have suggested that MOS can give significant improvements in antibody response and hatchability in chicks from supplemented broiler breeders.

Bio-Mos can be fed to one-day old chicks in pre-starter and starter diets. However, there are few trials examining the influence of Bio-Mos supplementation on breeder performance and on their progeny.

Trials conducted in commercial breeder flocks in Ireland and the U.S. showed that breeders receiving Bio-Mos consistently laid more eggs, which resulted in larger numbers of progeny.

Furthermore, Bio-Mos improved hatchability, fertility and immune function in broiler breeder flocks, making each hen more profitable for the producer.

Feeding trials in broiler breeders conducted in India have shown that Bio-Mos improved hatchability and fertility characteristics of eggs from supplemented parent stock, and that antibody responses in breeders fed Bio-Mos were significantly higher (Fig. 3).

In the hens fed Bio-Mos, significant improvements in hatchability and decreased infertile eggs and dead-in-shells were reported. In cockerels, significantly higher sperm density was noted in the birds fed Bio-Mos-supplemented diets. From the immune function point of view, significantly higher Infectious bursal disease titre was observed in Bio-Mos-fed birds compared to unsupplemented controls.

Maternal performance and immune function

Other research investigated the relationship between maternal performance and immune function in broiler breeders and the impact on their progeny.

The aim of the trial was to examine the benefits of Bio-Mos supplementation on the performance of broiler breeder hens, egg quality and hatchability and subsequent performance of chicks. Data was collected to examine any 'carry-over' effects of supplementing Bio-Mos in the breeders to their progeny and to evaluate starter diet supplemented with Bio-Mos on performance, immune status and economic payback.

In terms of hatchability, the number of viable chicks increased and infertile, dead and non-viable chicks were reduced in eggs from breeders fed the MOS-supplemented diet. This may be a reflection of the significantly higher yolk weight recorded for eggs from Bio-Mos-fed hens.

Egg quality was improved, whereby researchers used the ratio of albumen to yolk as an indicator of the viability of the chick at hatch. Eggs from hens fed Bio-Mos had significantly less white ($P<0.05$) and more yolk compared to eggs from the control flock.

An important outcome of the trial was the higher number of eggs produced by hens fed Bio-Mos during the experimental period, which was not related to an increase in feed intake, leading to an improvement of laying efficiency and savings of 9g of feed per egg.

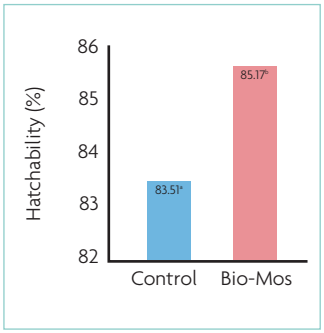
This had a direct impact on the economics of production for the experimental flock.

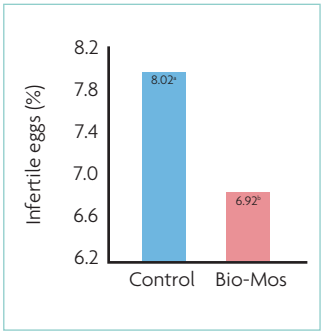
When broilers were vaccinated against Newcastle disease, the effects of adding Bio-Mos to either the parent breeder feed or directly in the starter feed on immune system responses were measured.

The highest antibody titres against Newcastle disease were recorded for birds that were sourced from Bio-Mos-supplemented breeder flocks, which also received Bio-Mos in starter diets from one to 14 days post-hatch.

The addition of Bio-Mos and Actigen to the diets of breeders can have a significant impact on overall reproductive performance in fertility and hatchability, as well as subsequent chick growth, viability and immune function. ■

Fig. 3. Influence of feeding Bio-Mos on productive parameters of broiler breeders.





References are available from the author on request