Effect of selenium on breeding and chicks

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Selenium (Se) is known to play a key role in successful fertility and reproduction in all species of animals. Se is a key element in many enzymes, especially those involved in antioxidation, and is crucial for the correct use and recycling of vitamin E. Oxidation causes damage to membranes, DNA and tissues, and is especially important in reproduction.

Neonates and young animals have a higher antioxidant requirement than adult animals, and chicks are no exception. The high levels of lipids in eggs also need adequate protection, and levels of vitamin E are important in developing viable avian embryos.

Protecting fertility

In poultry production, obtaining good hatching percentages from parent and grandparent stock is key to cost effective broiler meat production, in both integrated and non-integrated systems. Research has now demonstrated the importance of adequate intakes of Se to ensure animal performance, as well as longevity and maximal productivity in valuable broiler breeders.

Se is important in fertility of cockerels as it recycles vitamin E. Vitamin E binds free radicals, removing them from interactions with cells and tissues, and thus reducing their harmful effects on vulnerable structures.

A Se-dependent enzyme is required to strip the radicals from the saturated vitamin E molecule and inactive them via a series of chemical reactions, freeing up the vitamin to bind further radicals.

Spermatozoan membranes are particularly sensitive to oxidation damage, which can lead to high sperm abnormalities or, in severe deficiency cases, sterility.

The lipids that make up the membranes require a high level of antioxidant protection, via vitamin E and Se, to maintain the integrity of the membrane structure.

Peroxidation of lipids has been shown to reduce the sperms' ability to produce energy, and, therefore, has a direct impact on motility.

A further Se-dependent enzyme, GSH-Px-4, is found in avian testes, where it appears to be important in sperm maturation, as well as providing antioxidant protection around the energy producing mitochondria in the mid-piece. Certainly, Se-deficient avian spermatozoa have poorly defined mid-pieces when studied microscopically.

Protecting the ova in the hen, as well as supporting the growth and development of a viable embryo during incubation, is strongly linked to adequate antioxidation.

Trials with low antioxidant diets have resulted in significant reductions in the percentag of fertile eggs, which are thought to be linked to both sperm and egg problems.

Deficiencies in either Se or vitamin E can lead to brain abnormalities, cullable behavioural or locomotory problems in progeny.

Broiler breeder hens lose their reproductive capacity with age, in the same manner as other species. They also show lower fertility and producing eggs with poorer hatchability. This may be linked to their reduced ability to retain semen within the sperm storage tubules in their reproductive tract for fertilising ova.

Supplementing older hens with adequate antioxidants can delay the onset of this reduced performance.

Parameter	Control	Sodium selenite	Sel-Plex
Production per hen housed (%)	60[b]	61[b]	68[a]
Unsettable eggs (%)	3.3[a]	1.7[ab]	0.9[b]
Breeders in production (%)	86.7	90.0	100.0
Shell weight 56 wks (g)	8.53	8.44	8.61
Shell weight decline 36-56 wks (g)	0.84[a]	0.80[ab]	0.57[b]
Hatchability (%)	77.9[b]	82.5[a]	83.5[a]
Infertile (%)	13.1[a]	9.9b	9.8b
Hatch of fertile eggs (%)	88.6[b]	91.5[a]	92.5[a]
Total embryonic mortality (%)	5.3[a]	3.7b	3.51[b]
Late embryo mortality (%)	3.6	3.9	3.1
Deformed chicks (No.)	11	5	1

Means not sharing a letter within a row differ significantly

Table 1. Effects of supplementing broiler breeder hens with inorganic or organic forms of selenium on reproductive performance (36-56 weeks old unless otherwise stated) (Renema et al, personal communication).

Sources of selenium

Deficiencies in selenium levels in poultry feed are caused by reductions in the amount of selenium present in feed raw materials – a factor which has been exacerbated in Europe in the last 20 years by declining imports of grain from North America, where soil is not as deficient. Although animals are fed selenium supplements, it is typically in an inorganic salt form, which is not stored in tissues and, therefore, cannot be transferred to either meat or eggs.

Feeding organic Se, such as Alltech Inc's yeast derived Sel-Plex, in animal feed not only leads to improved productive performance, but is also in a natural form as part of the protein, which can be transferred to and stored in eggs and meat.

This can prove increased antioxidant protection to gametes and developing chick embryos, and it has been demonstrated to increase fertility and hatchability.

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Fig. 1. Semen volume from broiler breeder cockerels fed supplemental organic selenium (Renema et al, personal communication).

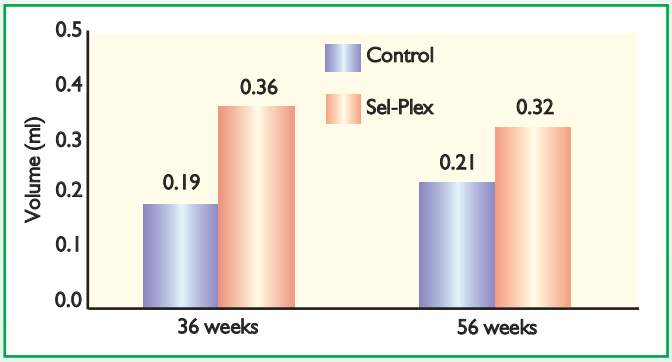
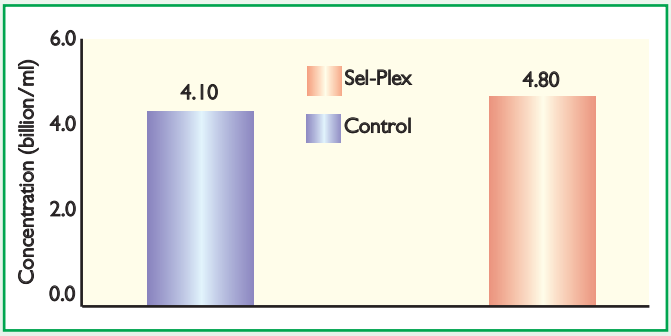


Fig. 2. Sperm concentration in semen from broiler breeder cockerels fed supplemental organic selenium (Renema et al, personal communication).



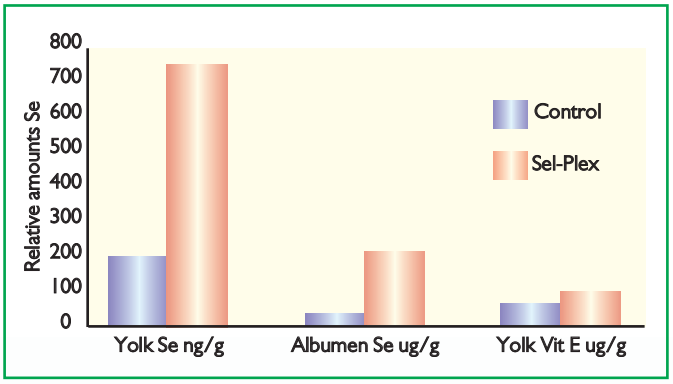


Fig. 3. Effects of supplementing layer feed with organic selenium on egg selenium content.

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However, there are few reported trials where direct measures of antioxidant levels in eggs have been made.

Importantly, organic sources of Se have none of the oxidative toxicity associated with the inorganic forms of Se, such as selenite.

Broiler breeder trials

Trials conducted at the University of Alberta in Canada have investigated the benefits of Se supplementation for breeders in detail. The trials run with female broiler breeders compared a negative (unsupplemented) control diet against one containing inorganic sodium selenite and another with the same amount of organic selenised yeast.

Detailed tests were run to examine fertility and reproductive traits following artificial insemination of the hens from 36-56 weeks of age.

Table 1 shows the effects of supplementing with different forms of selenium on hen parameters.

Hens receiving supplemental Se, particularly in the organic form, had significantly ($P<0.05$) better production and hatchability, with lower embryonic mortality, fewer deformed chicks, and less egg shell loss as they aged.

Trials run with male breeders, by the same research group, investigated the effect of feeding organic Se, on sperm quality and other fertility characteristics (Figs. 1 and 2). Cockerels fed the organic selenium diet showed clear improvements in both semen volume and sperm density, which would have a major impact on their fertility.

Improvements in chick viability and survival with increased antioxidant supply to the parent stock can be related to the higher levels of antioxidant expressed in the egg. Organic selenium is known to pass into the egg, as is vitamin E, where it can prevent oxidative damage.

Trials examining these potential benefits to chicks have shown that hens fed with 0.8ppm Sel-Plex had higher levels of selenium in their eggs than hens receiving sodium selenite. Commercial hens received organic selenium in feed, and their eggs were collected at two weekly intervals from the start of supplementation for 12 weeks.

Eggs were assessed for selenium and vitamin E level, and MDA (malondialdehyde, a final lipid peroxidation product) as a measure of improvements in antioxidant status. Eggs were assessed for peroxidation immediately at lay and then after one and two weeks of storage. They were also kept at 37°C for three hours to simulate poor storage and assessed for MDA.

Supplementation with organic selenium resulted in eggs containing nearly 75% of the recommended daily intake for an adult human, and therefore supplying an increased level of antioxidation and stability to a chick embryo (Figs. 3 and 4)

The significantly lower peroxidation levels and higher Se content observed for eggs from Sel-Plex fed layers would be linked to improved hatchability and fertility in breeder eggs.

Experiments run in 2006 examined the role of organic selenium in improving the quality of day old broiler chicks from commercial parent stock receiving diets formulated with organic selenium. Some 48,000 breeders were fed either inorganic or organic forms of selenium at a level of 0.3ppm from 20-45 weeks of age.

Hatched chick quality characteristics were recorded from the trial (Table 2).

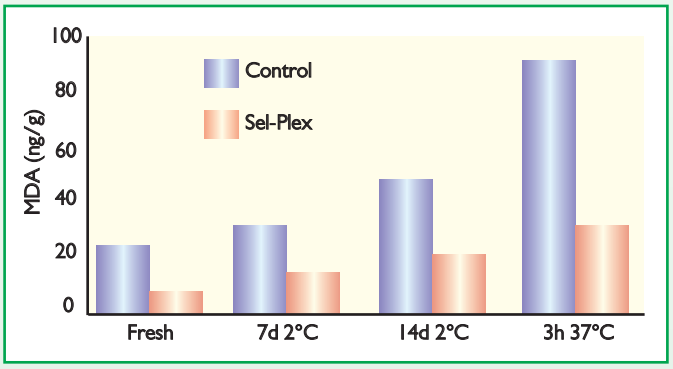
Chick parameter (day old)	Control	Sel-Plex
Body weight (g)	40.67[a]	41.06[b]
Body length (cm)	18.32[a]	18.58[b]

Means not sharing a letter within rows differ significantly.

Table 2. Impact of organic selenium fed to broiler breeders on progeny characteristics (Nollet et al., unpublished).

Chicks from parents receiving the supplemented feed were significantly larger and heavier than those from the control flock of breeders. This size and weight advantage can be related to better survival and productive performance.

Fig. 4. Peroxidation levels (MDA) of eggs from layers supplemented with organic selenium.



Conclusions

Selenium, in combination with vitamin E, forms an intrinsic part of the antioxidant protection system in chickens. The sensitivity of gametes and developing embryos in ovo to free radical oxidative damage makes fertility and incubation an area of prime concern for correct antioxidant nutrition.

The form of selenium used is important for ensuring the transfer and storage of adequate antioxidant in the egg and developing chick.

Organic selenium has been demonstrated to give superior transfer and protection relative to inorganic forms, such as sodium selenite.

Recent research has shown that, when supplemented appropriately with organic selenium, benefits in fertility, hatchability, chick survival and size can be observed for broiler breeders.

For both breeder and meat broiler producers, ensuring a reliable supply of healthy, strong chicks is essential for the continued production of affordable poultry meat. ■