Maximising meat quality with selenium

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Antioxidants are important for the maintenance of cell membranes and their correct cell replication, ensuring good, strong tissue growth.

To ensure good growth and proper tissue development, animals must receive a balanced supply of nutrients that include antioxidant vitamins and minerals, such as vitamin E and selenium (Se).

Se can be supplemented in two forms – as inorganic sodium selenite or selenised yeasts such as Alltech Inc's Sel-Plex, which delivers Se in its natural form incorporated in amino acids. Due to its chemical structure, it is not possible to chelate Se.

Previous trials using monogastric species have shown that adding organic Se to the diet can increase growth performance.

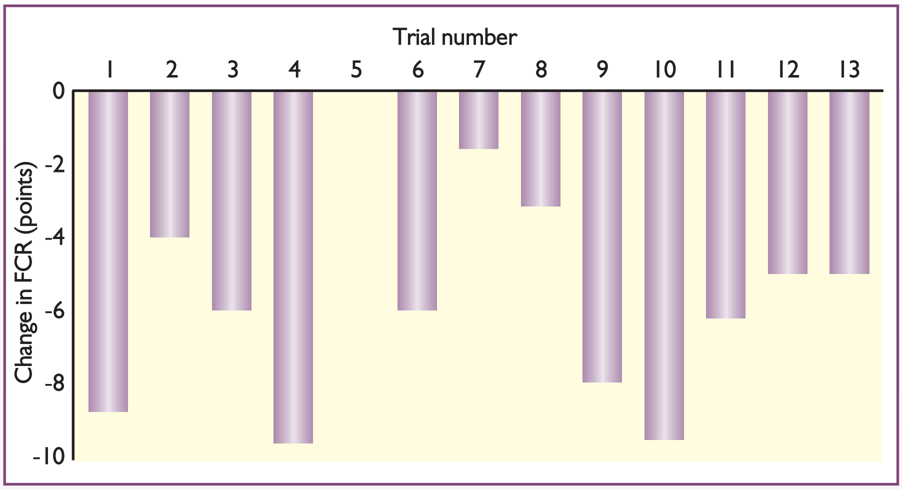


Fig. 2. FCR response in broiler chickens receiving organic selenium supplementation – comparison of 13 performance trials.

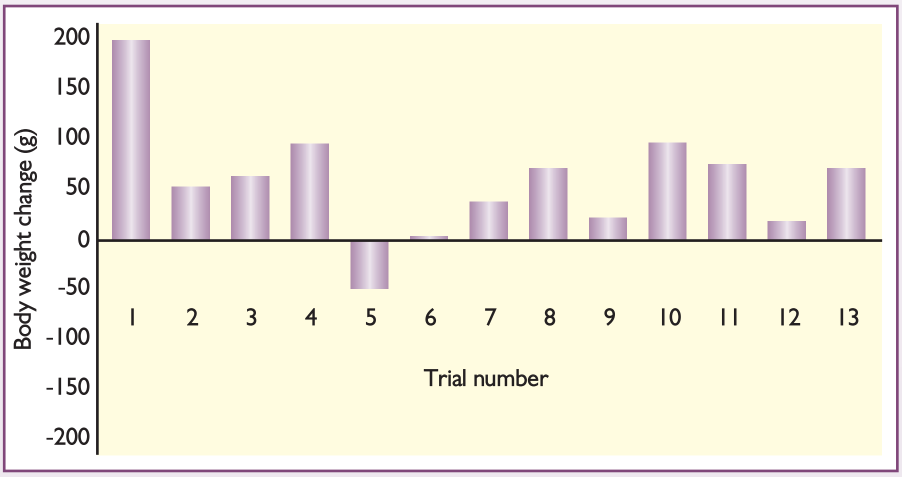
Improved meat quality

More detailed studies have revealed that the improvements in cellular membrane integrity can contribute to better water holding capacity in muscle tissues, leading to juicier meat cuts.

Research trials, published within the last couple of years, have added to this body of data, further demonstrating the benefits of organic Se supplementation on both poultry performance and meat quality. In addition, the potential to increase Se levels in meat offers a major marketing opportunity for the human food market, as Se deficiency has been identified as a key nutritional problem in people, where it contributes to cancer and infertility, as well as a host of minor symptoms and disorders.

Birds challenged with reovirus in a controlled study, showed better weight gain when receiving diets containing 0.3ppm supplemental Se from yeast sources compared to an unsupplemented control or a diet containing inorganic Se to the same level.

Fig. 1. Response of weight gain in broiler chickens receiving organic selenium supplementation – comparison of 13 performance trials (adapted from Edens and Gowdy (2003), Arruda et al., (2002), Anciuti et al., (2004), Choct et al., (2004), Bonaspetti (personal communication, 2005).



Positive effect demonstrated

When performance trials were compared, 11 out of 13 showed a positive effect on weight gain and 12 on FCR due to organic Se supplementation.

On average, broilers fed Sel-Plex put on 58g more weight with more than five points improvement in FCR compared to the unsupplemented control (Figs. 1 and 2).

Researchers investigating the effect of wasting diseases, such as reoviruses, have discovered that increasing the levels of

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Table 1. Effect of supplementation and form of Se on body weight of broilers challenged with reovirus (Edens and Read-Snyder, 2007).

	Se (ppm)	23 day body weight (g)
Control	0.02	755
Inorganic sodium selenite	0.3	740
Organic Sel-Plex	0.3	801

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organic Se in the diet helps the bird to better cope with the disease challenge.

Improved Se tissue retention

The application of organic Se in feed can also be expressed in animal products, through the meat, milk and eggs. Many countries, in both Europe and Asia, now sell high selenium products into the human food sector.

Trials published in 2007 by Chinese researchers have investigated the transfer of organic selenium yeast products into the meat of Lohman laying hens. In a replicated trial using 700 sixty-eight week old hens, the effects of varying levels and two forms of dietary Se was investigated over a 28 day feeding period. At the end of the trial, two hens per replicate were used to determine levels of Se in eggs and tissue. The results for the most commonly consumed tissue, breast muscle and liver (Table 2) showed significant ($P<0.05$) increases in Se concentrations in hens receiving organic Se.

Se Source	Added Se in diet (mg/kg)	Breast muscle Se (mg/kg)	Liver Se (mg/kg)
Control	0	0.135[a]	0.582[a]
Sodium selenite	0.2	0.137[a]	0.612[b]
	0.5	0.140[ab]	0.634[c]
	1.0	0.149[b]	0.690[d]
Organic Sel-Plex	0.2	0.149[b]	0.623[bc]
	0.5	0.161[c]	0.661[e]
	1.0	0.182[d]	0.722[f]

[a-f]Means within column with no common superscript differ significantly ($P<0.05$)

Table 2. Effect of dietary source and level on Se breast muscle and liver concentrations.

Whilst only the highest level of inorganic Se from sodium selenite gave any significant increase in breast meat Se concentration, providing Se in an organic form increased concentrations in line with dietary levels.

For the liver analysis, organic forms of Se resulted in consistently higher levels expressed in tissue for each level added in the diet, compared to supplementation with the inorganic form.

Water holding capacity

Improved membrane integrity is linked to better osmotic regulation and control, reducing the amounts of water lost from the tissue as either oedema (in living animals) or drip-loss (in meat). Water holding capacity is an important characteristic of meat, as it determines the level of exudative water loss in packaging and during cooking, and the juiciness of the meat.

Trials conducted at the University of Novi Sad examined the influence of higher breast muscle Se concentration in relation to its protective antioxidant effect on cell membranes.

Peric et al. used 2,400 day old Cobb 500 broilers in a replicated trial to evaluate how feeding different forms and levels of Se impacts drip loss. After a 42 day growing period, broilers were slaughtered and the drip-loss from breast meat was monitored, by difference, at 24 and 48 hours post-mortem (Table 3).

Average drip-loss was significantly reduced ($P<0.01$) for the muscle removed from broilers fed organic Sel-Plex compared to those fed inorganic selenite. Lower inclusions of Sel-Plex resulted in less drip-loss even compared to higher levels of selenite, which demonstrates the pro-oxidant potential of inorganic Se on tissue.

Previous research conducted in Australia has reported similar findings for reduced drip loss in breast meat from broiler chicks

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Selenium source	Level of Se in feed (ppm)	Drip loss after 24 hours g	Drip loss after 24 hours % of breast wt	Drip loss after 48 hours g	Drip loss after 48 hours % of breast wt
Selenite	0.3	1.38 ± 0.16^{b}	0.91 ± 0.09^{b}	1.82 ± 0.15^{b}	1.13 ± 0.07^{b}
Selenite + Sel-Plex	0.2 0.1	1.42 ± 0.14^{b}	0.91 ± 0.08^{b}	2.08 ± 0.14^{b}	1.25 ± 0.08^{b}
Selenite Sel-Plex	0.1 0.2	1.11 ± 0.14^{ab}	0.79 ± 0.08^{ab}	1.52 ± 0.10^{ab}	1.05 ± 0.09^{ab}
Sel-Plex	0.3	0.95 ± 0.11^{a}	0.60 ± 0.06^{a}	1.36 ± 0.15^{a}	0.84 ± 0.11^{a}

$^{a-b}$Means within column with no common superscript differ significantly (P<0.05)

Table 3. Influence of sodium selenite and organic selenium (Sel-Plex) on breast meat drip loss of broiler chickens (Peric et al., in press).

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fed organic forms of Se compared to selenite.

Further work, by the same research team, has looked at the effect of supplementing breeders on their progenies' meat quality characteristics.

In a large scale trial (24,000 Hubbard breeder hens), two treatment diets were compared; a control (0.3ppm sodium selenite) versus a diet where all the selenite was replaced by organic Se (Sel-Plex).

The treatments were compared in a cross over design of breeders and progeny, to give four treatments; selenite in breeder and progeny diets, selenite in breeder and organic Se in progeny diets, organic Se for both breeder and progeny diets, and organic Se in breeder and selenite in progeny diets.

Progeny were compared in a trial using replicated randomised pens. Table 4 shows the impact on meat quality for the progeny.

The lowest drip-loss was achieved when organic Se was included in both the broiler and the breeder diets.

Selenium source	Bird group	Drip loss after 24 hours g	Drip loss after 24 hours % of breast wt	Drip loss after 48 hours g	Drip loss after 48 hours % of breast wt
Selenite	Breeder Progeny	1.1	0.56^{b}	1.72	0.91^{b}
Selenite Sel-Plex	Breeder Progeny	0.81	0.46^{b}	1.31	0.77^{b}
Sel-Plex Selenite	Breeder Progeny	1.04	0.56^{b}	1.60	0.90^{b}
Sel-Plex	Breeder Progeny	0.54	0.31^{a}	1.02	0.64^{a}

$^{a-b}$Means within column with no common superscript differ significantly (P<0.05)

Table 4. The impact on meat quality for the progeny.

Although the effect of organic Se on progeny from supplemented breeder hens has not been studied as much as growing broiler chickens, Pappas et al., (2005) has recently shown that Se status of chicks hatched to hens fed organic Se has higher Se status in breast meat tissues during the first four weeks post-hatch (Table 5).

This data agrees with previous findings reported by Paton et al., (2002) and Surai (1999). The reduction in drip loss is thought to be due to the pro-oxidant effect of sodium selenite (inorganic Se) being detrimental to cell membranes, causing higher levels of cellular loss, observed as drip loss.

As organic Se, such as Sel-Plex, exerts a more powerful antioxidant effect on the birds' cellular and tissue structures, cell membranes are afforded more protection, causing less exudative losses from meat.

Table 5. Effect of supplementing breeder hens with organic forms of Se on the Se status of their chicks (Pappas et al., 2005)

Se concentration	Maternal diet Control (no added Se)	Organic Se (0.02%)
Egg yolk (ng/g)	85.3^{a}	515.6^{b}
Albumen (ng/g)	29.9^{a}	248.7^{b}
Shell membrane (ng/g)	131.5^{a}	854.0^{b}
At hatching		
Residual yolk (ng/g)	99.4^{a}	1273.0^{b}
Se yolk sac membrane(ng/g)	162.4^{a}	1194.4^{b}
GSH-Px activity liver (mU/mg)	30.0^{a}	94.0^{b}

$^{a-b}$Means within rows with no common superscript differ significantly (P<0.05)

Conclusions

The body of evidence supporting the use of organic forms of Se in poultry, not only for performance benefits but also for improved meat quality, continues to grow in its complexity and elucidation of practical benefits in commercial poultry rearing.

The data resource has now reached a point whereby producers can confidently use proven organic forms of Se to completely replace the sodium selenite commonly used in animal feeds.

Organic Se from yeast has been shown in numerous trials to improve animal growth and efficiency, especially under stressful commercial conditions, demonstrating a healthy return on investment.

This combined with the latest evidence showing reduced drip losses in packaged meat and the opportunity to market value added Se enriched meat in a competitive retail sector offers excellent opportunities for producers who are looking to maintain their commercial edge. ■

References are available from the author on request.