Poultry health through nutrition

Organic selenium has proven to be superior to inorganic forms. Organic Se from yeast is approved for use in animal nutrition in most countries and is beneficial to bird health and performance.

By Dr Peter Spring*, *Zurich, Switzerland*

The role of selenium (Se) in animal and human nutrition has been explained in the May issue of World Poultry. It highlighted the facts that Se is an essential trace nutrient, deficient in many European soils, crops and feed materials, and administered in the EU as a feed supplement in the form of inorganic Se (sodium selenite or selenate). Se yeasts are superior sources of selenium compared to selenite and selenate, because they supply Se in organic forms, mimicking the endogenous forms of Se that occur in plants, grasses, cereal grains and oilseeds. Organic Se from yeast is approved for use in animal nutrition in most of the world, including the USA, Latin America, Asia and Australasia, but not yet in the EU.

The first EU Se yeast feed additive application (Sel-Plex® 2000, Alltech, based on a specific strain of *Saccharomyces cerevisiae* CNCM I-3060) was submitted in 2005 and received a positive opinion from the EFSA (European Food Safety Authority) in April 2006. At the time of writing (August 2006), the product is under discussion in Comitology (the EU Commission and 25 member states), with authorisation expected during the autumn of 2006. In a new European culture where antibiotic growth promoters are prohibited, and coccidiostats and therapeutic antimicrobials face future restrictions on use, there is a strong focus on optimising hygiene, husbandry and nutrition to improve bird performance. This article summarises the health and production benefits of organic Se in poultry.

Inorganic versus organic selenium

Many research studies published in the past decade have demonstrated that sodium selenite, the commonest form of Se used in poultry feeds since the 1960s, is not an ideal source of Se, being less effective and more toxic than organic Se. Birds have adapted their digestion and metabolism to natural, organic forms of Se, probably over millennia of evolution *(Figure 1)*. The Se yeast mentioned above contains a number of organic Se molecules, and the Se profile is very similar to endogenous Se in crops and major feed materials. Around 60% of the organic Se in Sel-Plex® 2000 is selenomethionine, which can be stored in body tissues as a reserve and used when needed, especially to support anti-oxidant defence systems, known to be important for optimum bird health and performance.

Figure 1 shows that wild birds eating an all-natural diet lay eggs that have much higher yolk Se than domestic layers fed a basal commercial diet. When commercial layer diets are supplemented with approximately 0.5 ppm Se from Se yeast, the highest Se concentration permitted in EU feeds, egg yolk Se increases five-fold, but is still modest in comparison with most wild avian species. Such data suggest that current Se application rates in commercial poultry may still be too low for optimum Se status, even when organic Se is used as the supplement. Nevertheless, organic Se from yeast is still the best Se supplement for poultry diets in terms of efficacy and cost/benefit.

Importance of improved selenium status

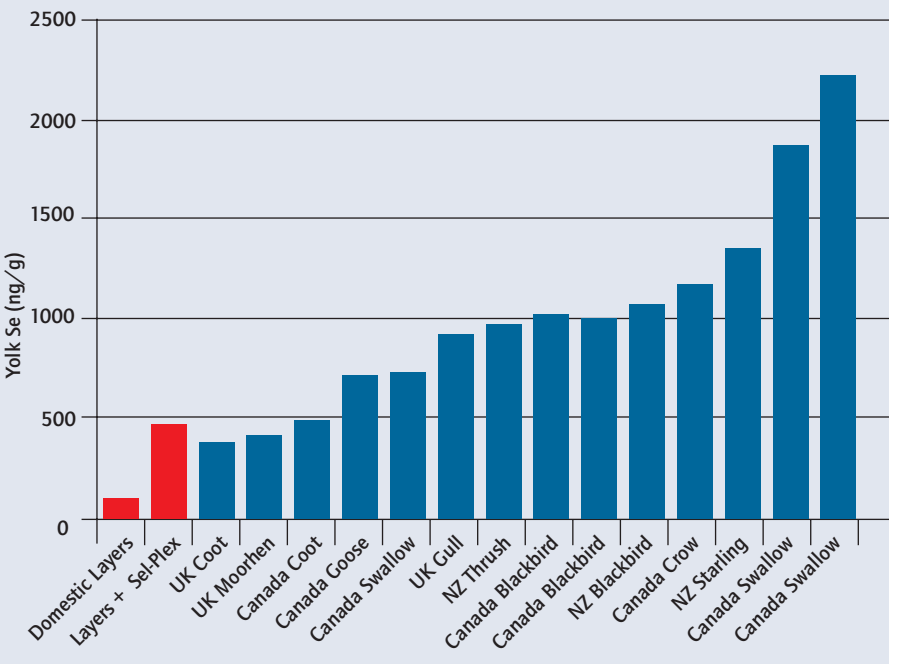
Optimum Se status is important for several reasons:

- Anti-oxidant defence systems – enabling birds to detoxify free radicals, especially important under stress conditions
- Appropriate immune responses
- Resistance to viral attacks
- Optimum male and female fertility
- Adequate Se reserves to enable the transfer of Se to chicks via the yolk sac – thus ensuring that chicks hatch with sufficient Se for early anti-oxidant defence and other key biochemical and metabolic requirements.

By optimising selenium status key

Improvement of Se status through organic selenium enhances bird health and performance

Figure 1 - Yolk Se concentrations (ng/g) in 14 wild bird species, in comparison with commercial laying hens fed a basal diet (no Se supplement) or a diet supplemented with Sel-Plex™ 2000 at 0.5 ppm Se (Pappas et al, 2006a)



selenium-containing enzymes and proteins are influenced. *Table 1* summarises current knowledge on those molecules, their functions when known, and avian responses to improved Se status.

Enhanced maternal selenium transfer

The improved transfer of Se from breeders to chicks is demonstrated in recent work by researchers at the Avian Science Research Centre in Scotland. Broiler breeders were fed either a control basal wheat-barley diet (0.03 ppm Se) or the same diet supplemented with Sel-Plex® 2000 (0.42 ppm Se). Progeny of these breeders were raised to four weeks of age on diets not supplemented with Se. Liver and breast muscle from chicks were tested for GSH-Px activity. GSH-Px is the key Se-containing enzyme in the anti-oxidant defence system and this study examined the ability of breeders to transfer Se to chicks via the yolk sac. Breeders fed organic Se produced chicks with significantly higher GSH-Px activity in both breast muscle and liver at every sampling up to three weeks post-hatch, and up to four weeks post hatch in breast muscle. *Figure 2* shows the liver GSH-Px data.

US scientists confirmed these findings, this time using white and brown layer breeders fed corn-soy basal diets, and

Table 1 - Selenoenzymes, selenoproteins, functions and health/performance benefits

Enzyme/Protein	Function (if known)	Health/Performance Benefits
Glutathione peroxidases:		
Cytosolic GSH-Px	All involved in the removal and.	
Gastro-intestinal GSH-Px	detoxification of hydrogen peroxide and lipid hydroperoxides	Improved disease resistance Improved male and female fertility
Plasma GSH-Px		Lower incidence of broiler ascites
Phospholipid hydroperoxidase GSH-Px	GSH-Px is a major intracellular antioxidant	Lower tendency to PSE (pale soft exudative meat) Lower post-mortem drip loss
Thioredoxin reductases:		Improved keeping quality of meat & eggs
Thioreoxin reductase (TrX)	Intracellular antioxidants	
Mitochondrial TrX	Important in DNA synthesis and apoptosis*	
Iodothyronine deiodases:		
Type I (liver, kidney, thyroid)	Regulate conversion of inactive thyroid hormone (T4) to active	More efficient broiler growth Earlier feathering
Type II (brain)	thyroid hormone (T3)	Improved flock uniformity
Type III (inactivating other selenoenzymes)		
Selenophosphatase synthetase-2	Involved in synthesis of selenoproteins	?
Methionine sulphoxide reductase B	Involved in protection and repair of proteins oxidised by free radicals	?
Selenoprotein P	Possibly an extracellular antioxidant in plasma	?
Other selenoproteins:		?
Selenoprotein W	Present in muscle and heart	?
Selenoproteins P12, R, T, X, N, etc	Functions not yet defined	?

** Apoptosis = Controlled cell decline and death, part of normal tissue metabolism and cell turnover.*

EU registration and consumer benefits

The advantages of feeding Se yeast illustrated in this article have been confirmed through published research and experience from around the world. Sel-Plex, 2000 is expected to be the first Se yeast approved within the EU. This is the second article in a series of articles on selenium. Further articles in this series, to appear in future issues of World Poultry, will discuss the EU registration requirements and illustrate the benefits of organic Se throughout the food chain, including consumers of poultry products derived from birds supplemented with Se yeast.

including a selenite group. *Figure 3* illustrates that, whereas layer breeders fed sodium selenite hatch chicks with improved GSH-Px status in comparison with layers fed a low Se basal diet, layers fed Se yeast produce chicks with a better capacity to maintain GSH-Px activities in the critical first weeks of life. By three weeks of age, chicks from layer breeders fed Se yeast (0.3 ppm Se) had significantly higher GSH-Px activity in both brain and liver, in comparison with control chicks (low Se diet) and chicks from layer breeders fed sodium selenite (0.3 ppm Se).

Optimum fertility and reproductive performance

Research over the past decade indicates that replacing selenite with an equivalent Se dose from Se yeast produces improvements in broiler and layer breeder fertility and reproductive performance, including parameters such as egg production, embryo viability, hatchability and number of live chicks hatched per breeder. The latest research in minor avian species, such as geese *(Figure 4)* and guinea-fowl *(Figure 5)* add to the large body of experience and published data in commercial layer and broiler breeders, demonstrating the benefits of Se yeast supplementation in relation to male and female fertility and reproductive performance. *Figure 4* shows that treatment effects were significant in relation to egg weight and day-old gosling weight. Treatment also produced significant effects on eggshell thickness and Haugh Units (data not shown), with organic Se consistently better than either selenite or controls.

Optimal selenium nutrition is also critical for the male bird. Male guinea fowl have shown significant improvements in spermatozoa concentration and activity, when fed diets supplemented with Se yeast in comparison to selenite. Most fertility parameters were superior, even when the Se yeast provided a lower Se dose than selenite *(Figure 5)*.

Faster feathering

Improved, faster feathering in broilers supplemented with Se yeast instead of selenite is a consistent, statistically significant, research finding and under commercial conditions may lead to several health, welfare and product quality benefits, such as:

- reduced vent pecking and related injuries
- improved insulation against extreme temperature conditions
- better protection of the skin and reduced incidence of breast blisters
- lower carcass condemnations due to skin injuries and imperfections.

Selenium status remains critical for a growing bird's health and performance throughout the entire production cycle.

Figure 2 - Effect of Se yeast in maternal diet on GSH-Px activity (U/g) in chick livers (Pappas et al, 2006b)

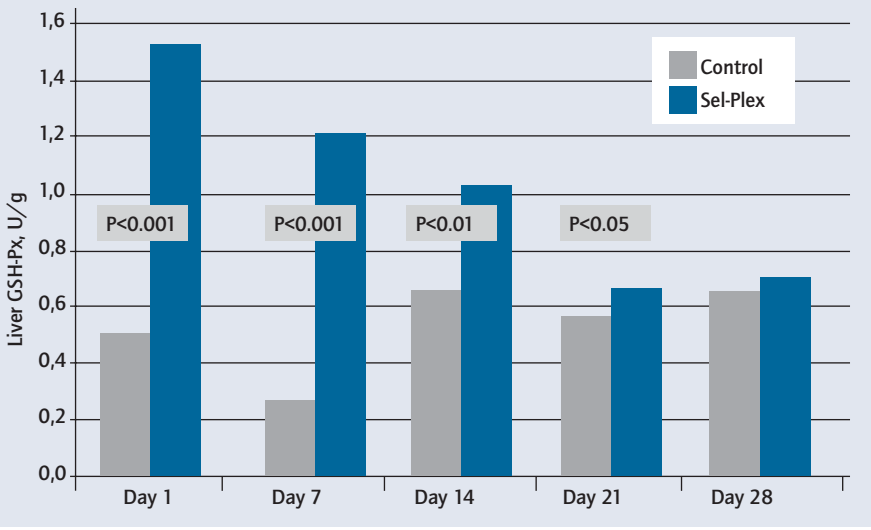


Figure 3 - Chick tissue GSH-Px activity (U/g), combined results from white and brown layer breeders (Ao et al, 2006)

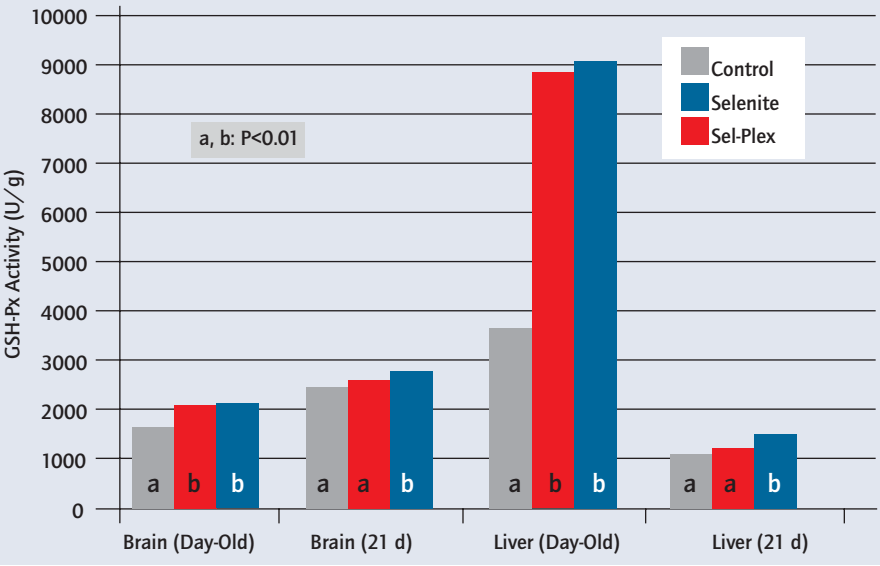


Table 2 - Contribution of Se yeast to improved broiler performance (Deniz *et al.*, 2005)

Observation	Control Basa No supplement	Basal + Sodium selenite (0.3 ppm Se)	Basal + Sel-Plex 2000 (0.3 ppm Se)
Body weight at 42 days (g)	1899	1960	1984
Feed intake (g)	3647	3756	3712
FCR (feed/gain)	1.96[a]	1.95[a]	1.90[b]

Notes: Basal diets contained approximately 0.12 ppm endogenous Se.
[a, b]: Values in the same row with no common superscript are significantly different (P<0.05).

Figure 4 - Effect of replacing inorganic with organic Se in geese (Tverdohlebov et al, 2006)

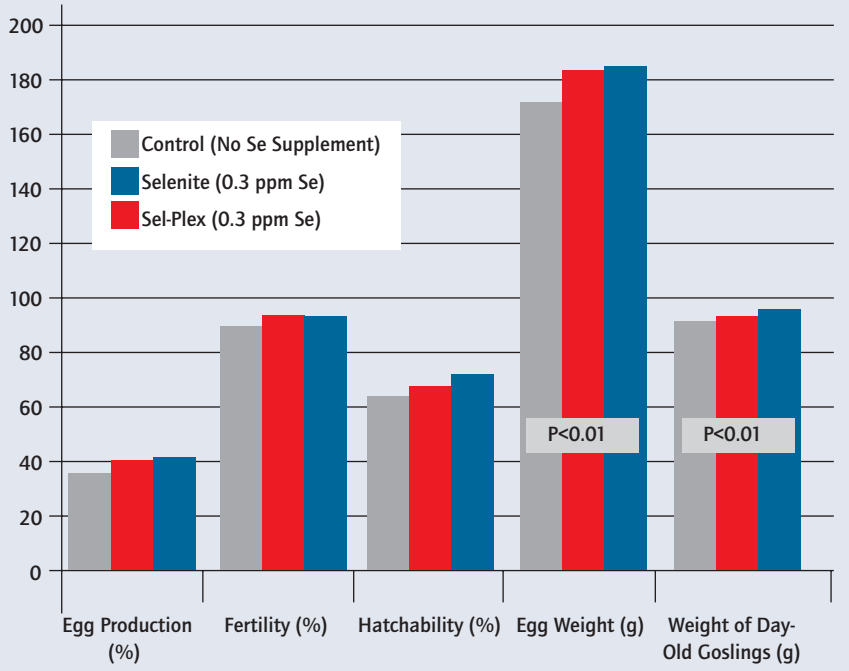
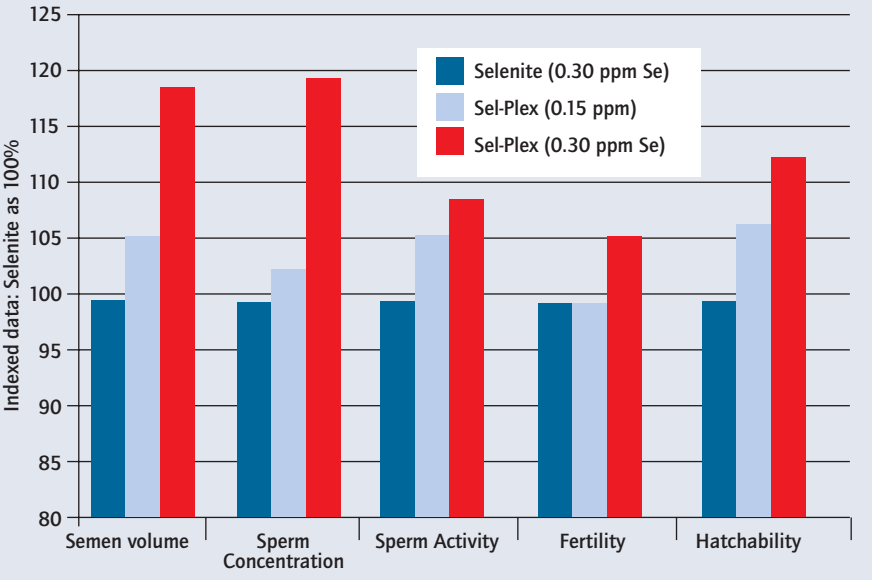


Figure 5 - Effect of organic Se on guinea fowl reproduction (Papazyan et al, 2006)



Recent work in broilers suggests that improvement of Se status through organic Se supplementation enhances performance *(Table 2)*. ■

References available on request

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