Comparing ORGANIC SELENIUM sources

There is a growing interest in using selenium (Se) based products as an antioxidant, not only for breeding stock, but also for commercial animals. A wide range of products is available. The question is how to choose the most efficient one? Chemical analysis does not appear sufficient to appreciate the bioavailability of the large range of dietary sources of selenium available for animal feeding. Tissue Se deposition is a reliable criteria to evaluate the bio-efficacy of various Se sources write PIERRE-ANDRÉ GERAERT, MICKAËL BRIENS, YVES MERCIER and Y.G. LIU*.

A wide range of products is available; from inorganic, sodium selenite or selenate coated or not, even nanoparticles to organic forms such as selenized yeasts, chelates of selenium methionine (SeMet), pure forms of SeMet or hydroxy-selenomethionine, and some complexes sources of Se based on mixing mineral Se with glycines, proteinates, etc. It has been confirmed that, comparing with mineral selenium, its organic forms are better absorbed thus serve selenium needs more efficiently.

Research has revealed that selenium incorporated as selenocysteine (SeCys) is the key amino acid supporting the antioxidant properties of most of the 25 selenoproteins identified in animal species or humans such as glutathione peroxidase, thioredoxin reductase and methionine sulfoxide reductase. However, this SeCys has to be synthetized de novo by the cells and cannot be supplied through feeds. Dietary SeCys undergoes complete transformation to selenide (H₂Se) to synthesize de novo SeCys.

A rapid bioavailability test to evaluate efficacy potential of selenium sources

In normal conditions, the Se content in the breast muscle of day-old chicks depends on the Se supply in breeder’s diets. If not supplemented with Se or only with sodium selenite, chicks show a decrease of their muscle Se content at day 7 compared to hatch. Based on 7-d dietary supplementation of young chicks, the authors developed a rapid evaluation test on biological value of different organic Se sources using muscle Se concentration.

Seleno yeast: not all the same yet very difficult in differentiation

Numerous study reports have demonstrated that Se-yeasts may...
A new Se-yeast source has recently appeared based on Torula yeast. Its specificity lies on the fact that it does not contain mainly SeMet but seleno-homolanthionine (SeHLan). However, such a yeast seems difficult to analyse on a batch-to-batch basis, as most laboratories do not possess a calibration sample for this SeHLan. The guarantee will thus only be based on total Se. Moreover, scientists compared pure SeMet and SeHLan on rats and concluded SeHLan being only 60% of SeMet efficiency. More recent works compared Se-Torula yeast with other Se-yeasts, without measuring their SeMet contents, suggesting similar efficacy between those yeasts. It further points out the importance of complete characterization of the Se-yeasts when comparing efficacy.

Figure 2: Comparative muscle Se deposition at 7 days of age in broilers fed Se at the same dietary incorporation level (0.2 ppm total Se).

<table>
<thead>
<tr>
<th>Se source</th>
<th>Muscle Se (mg/Kg)</th>
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<tbody>
<tr>
<td>SS</td>
<td>19</td>
</tr>
<tr>
<td>GLY</td>
<td>23</td>
</tr>
<tr>
<td>PRO</td>
<td>50</td>
</tr>
<tr>
<td>SY1</td>
<td>65</td>
</tr>
<tr>
<td>SY2</td>
<td>80</td>
</tr>
<tr>
<td>CHEL</td>
<td>96</td>
</tr>
<tr>
<td>SM</td>
<td>100</td>
</tr>
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Na selenite (SS), Se-glycinate (GLY), Se-proteinate (PRO), Seleno-yeasts (SY1 and SY2), chelate of selenomethionine and zinc (CHEL), pure selenomethionine (SM) or pure OH-SeMet (Selisseo, SO). Se deposition from Se-yeasts depends on the SeMet content of the yeasts (45 vs. 65% for SY1 and SY2, respectively).

As for chelates of minerals (Zn, Cu, Mn) which show better bioavailability of several minerals, producers have tried to develop so-called chelates of selenium. However, Se is a metalloid and cannot be chelated. The only true available chelate existing is a chelate of selenomethionine with Zn, thus a source of SeMet and Zn. However, methionine or selenomethionine are absorbed through the same transporters and chelating methionine or SeMet with Zn, indeed enhances Zn absorption, but will reduce SeMet absorption (Figure 2). Moreover, chelation has often been promoted to enhance stability of the molecule, it is however clear that such weak bond cannot improve the stability. Anyway, measuring the stability of such chelate in feed processing is almost impossible through conventional analyses and this rapid in vivo test is the only way to determine the bioavailability of such a molecule.

**Selenomethionine chelate**

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**Glycinates and Proteinates of Se: just mixture of inorganic Se and organic materials**

As mentioned above, measuring the total Se content in various Se sources is easy, but determining its chemical form is much more difficult. Since Se does not disappear, many organic solutions have been tried to develop so-called chelates of Se: just mixture of inorganic Se and organic materials.

Figure 3: Stability of hydroxy-selenomethionine included at 0.2 or 2 ppm total Se to extrusion processing (115-130°C, 115 bars) - recoveries before or after extrusion.
to measure the benefits of such selenium sources on Se deposition in the muscular tissue. Figure 2 clearly shows no additional value of those so-called organic Se sources over mineral Se.

**Stability of organic Se sources: important for optimal efficiency**

As mentioned above, measuring the total Se content in various Se sources is easy, but determining its chemical form is much more difficult. Since Se does not disappear, many organic solutions have been tested under various feed processing conditions or even challenging conditions but only total Se contents were measured. Such an approach does not reveal the true dynamics of organic Se sources.

Extrusion as used in aquafeed or petfood processing represents the harshest and most challenging feed processing. Under such conditions, the stability of hydroxy-SeMet (HMSeBA, Selisseo) has been determined using either a standard 0.2 ppm concentration or even for analytical precision 2 ppm through measurement of HMSeBA and not total Se. In both conditions, HMSeBA displayed fully stable with recovery rates higher than 95% (Figure 3).

However, not all pure Se molecules exhibit the same behaviour. Pure L-SeMet appeared to be unstable when mixed with a standard premix containing trace minerals and vitamins and even more unstable when adding choline chloride. Figure 4 shows that under challenging conditions such as 40°C, 75% relative humidity for a month, up to 85% of the SeMet was no longer detected from the sample compared to less than 20% with HMSeBA.

**Conclusion**

Although there are a large variety of selenium sources on the market, most of suppliers only provide total selenium content, plus an indication of its chemical form. It is important to have a methodology to determine their respective availability. When evaluating Se sources, it is also important to have a guaranteed stability in feed processing conditions used in the industry. HMSeBA or hydroxy-selenomethionine represents a pure, reliable and stable source of organic selenium.

Tissue Se deposition is a reliable criteria to evaluate the bio-efficacy of various Se sources, either organic or mineral form. The objective of the dietary Se supplementation is definitely to enhance tissue Se deposition not only as SeMet, the reserve form, but more as the functional form: SeCys, part of the selenoproteins. SeCys should thus be the best predictor of the efficacy of the selenium source. Clearly, the OH-SeMet (HMSeBA) appeared to be the most bio-available form of organic Se to enhance tissue SeCys contents even compared to other SeMet sources.

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