

# Selenium deposition as a quality indicator for dietary selenium sources

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Supplementing animal diets with organic selenium in the form of selenomethionine enhances the selenium deposition in animal proteins, such as milk, eggs and meat. Selenium deposition in muscle tissue is a good indicator of the selenium status of the animal. Recent animal trials demonstrate the difference in efficacy between sources and show the benefits of a new generation of organic selenium.

## Introduction

Selenium is a key nutrient in animal nutrition and is crucial for optimal antioxidant status and immune function. Selenium in animal diets can be supplied via feedstuffs or via supplemented selenium. Selenium from feedstuffs is predominantly in the form of L-selenomethionine, which is the natural form of selenium in plant and animal protein. Supplemented selenium can be either in an organic or an inorganic form. Organic selenium has an important benefit compared to inorganic selenium due to the fact that selenomethionine is utilized by the body as an amino acid (in same way as methionine). Organic selenium allows Se reserves to build in tissues, mainly in muscles, in the form of selenomethionine which can be used in stress conditions to improve antioxidant defences (Surai, 2016). Se reserves in the body are important to ensure a good selenium and anti-oxidant status at all times. In addition to the benefit of selenium reserves, organic selenium in the form of L-selenomethionine is also able to provide efficient transfer of selenium to offspring via placenta, milk and eggs and to enrich animal products.

## Insight in selenium metabolism

In the metabolism there is a crucial difference between selenomethionine and all other forms of selenium. Traditionally organic selenium was supplied via selenium enriched yeast. EU authorized selenized yeast products contain a minimum of 98% of selenium in an organic form, but not all of this organic selenium is selenomethionine. Part is in the form of selenocysteine or other (organic) intermediates.

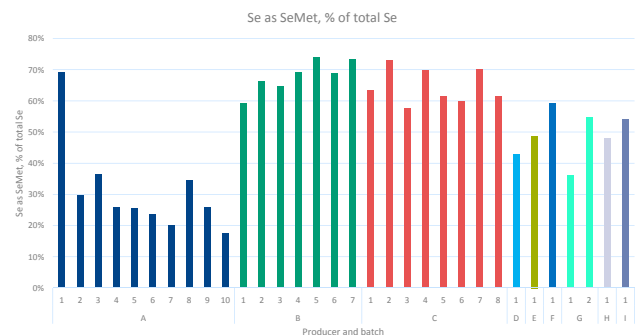
In the metabolism, all selenium compounds are recognized as a selenium supply and all can be used for selenoprotein (selenoenzymes) synthesis. Besides this general pathway, selenomethionine is the only organic selenium that can be built into body proteins instead of methionine. Via this specific pathway selenomethionine is able to build up selenium reserves in the body and is able to transfer selenium to the offspring via the placenta, milk or eggs. The selenium reserve in the body can be mobilized for later selenoprotein synthesis. An adequate selenium reserve ensures an optimal selenium and anti-oxidant status at all times, even in times of stress or low feed intake. However, dietary selenocysteine, similar to sodium selenite, is not effective in increasing selenium tissue concentration (Surai, 2016). Selenocysteine can be

used in metabolism, but dietary selenocysteine is not used directly for selenoprotein synthesis, since it is first reduced to selenide from which new *de novo* selenocysteine is formed. Inorganic selenium is also reduced to selenide and then utilized for selenocysteine and selenoprotein synthesis.

## Market survey

Several producers offer selenium yeast products for animal nutrition. To evaluate the quality of selenized yeast products, it is important to check the selenomethionine level in these products. A survey was set up to check the selenomethionine content in commercially available selenized yeast products in the market. In total 32 samples were collected from different producers. The samples were analyzed for total selenium and for selenium in the form of selenomethionine. The survey was set up by Orffa in cooperation with the lab of CODA CERVA (Tervuren, Belgium). The applied method of analysis is specific for selenomethionine and is based on HPLC ICP MS after enzymatic extraction. The results are shown in graph 1.

**Graph 1: Selenium in form of selenomethionine, % of total selenium in commercial selenized yeast samples**



From this market survey it can be concluded that there is a major variation in the level of selenium in the form of selenomethionine between different commercial samples of selenized yeast. The overview shows differences between producers as well as variations between batches of the same producer. This variation is also known from scientific literature and is confirmed in other commercial reviews. The level of selenomethionine is an important quality parameter. Nutritionists are more and more aware of this, requesting guarantees from their suppliers.

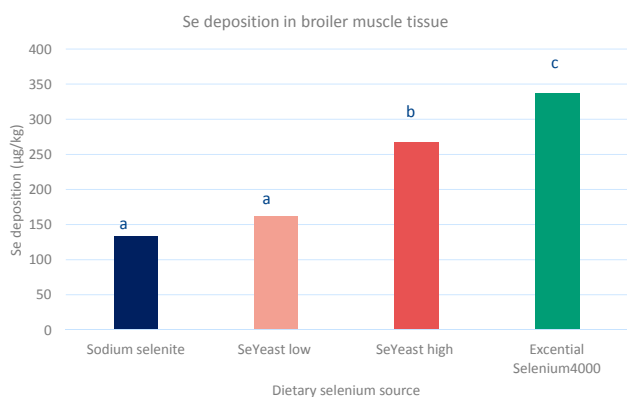
Recently, a new type of organic selenium has been introduced into the animal nutrition market and this product tackles the problem of variable concentration. The product, Excential Selenium4000,

contains the highest and most constant level of L-selenomethionine which is considered 100% digestible. It is consequently the most effective organic form and ensures the most efficient selenium supply to the animal.

### Deposition trials in broilers and pigs

The variability in selenized yeast products that has been observed in lab analyses (graph 1) can also be seen in vivo. In a recent broiler trial two different selenized yeast products with different level of selenomethionine were compared. One product contained 26% of Se in form of selenomethionine (SeYeast low) and the other product had 69% of its selenium in form of selenomethionine (SeYeast high). The selenized yeast with low selenomethionine shows a significantly lower deposition compared to the selenized yeast with higher selenomethionine. The new generation of organic selenium shows the highest selenium deposition, significantly higher than both selenized yeast products (graph 2).

**Graph 2: Effect of dietary Se source (0.2 ppm) on Se deposition in broiler muscle tissue (Van Beirendonck et al, 2016)**



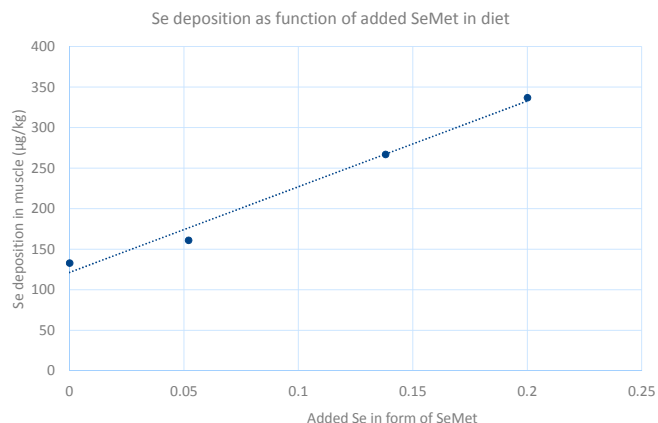
From graph 2 it can be concluded that the selenium deposition is dependent on the selenomethionine content in the different sources. The total selenium was the same for all products (0.2 ppm), but the selenium from selenomethionine varies. In table 1 the level of selenium in form of selenomethionine is calculated.

**Table 1: Total selenium and selenium in form of selenomethionine in different treatments**

Se source	Added total Se, mg/kg	Added Se in form of seMet, mg/kg	
T1	NaSe	0.2	0
T2	SeYeast low	0.2	0.052
T3	SeYeast high	0.2	0.138
T4	Excential Se4000	0.2	0.2

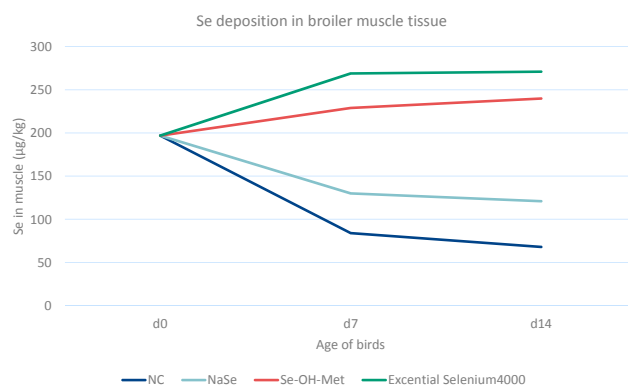
If the selenium deposition is expressed as a function of the added selenium in form of selenomethionine it can be concluded that there is a very strong linear correlation. This linear correlation with high R<sup>2</sup> (0.7186) is shown in graph 3.

**Graph 3: Selenium deposition as function of the added selenomethionine (Van Beirendonck et al, 2016)**



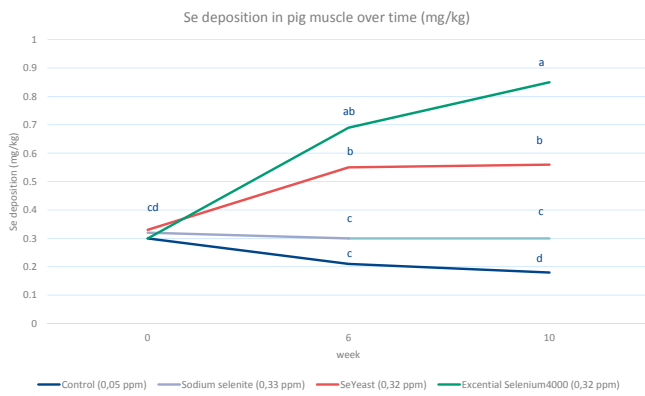
In another broiler trial, two different organic selenium sources, Excential Selenium4000 and Se-OH-Met (hydroxy analogue of selenomethionine or seleno hydroxymethionine) were evaluated. The trial showed that both organic sources increased Se in muscle, while supplementing inorganic Se (sodium selenite, NaSe) decreased Se in muscle. The Se deposition in the group that was supplemented with Excential Selenium4000 was numerically higher compared to the Se-OH-Met group (see graph 3). A possible explanation between the two organic sources could be that Seleno-hydroxy-methionine needs to be converted in the body into L-selenomethionine, while the selenium in Excential Selenium4000 is already in the L-selenomethionine form.

**Graph 4: Effect of dietary Se source (0.2 ppm) on Se deposition in broiler muscle tissue at day 0, 7 and 14 (Rovers et al, 2016)**



The difference between Se sources has also been observed in growing pigs. In a recent trial, three different selenium sources were compared, being sodium selenite, selenium yeast and Excential Selenium4000. The trial started at week 0 with pigs of 30kg live weight. The total selenium levels in the diets were comparable (analysed total Se in diets was 0.33 ppm for sodium selenite and 0.32 for both organic sources), but the selenium deposition in the muscle tissue was significantly different between sources. Pigs that received selenium in the form of Excential Selenium4000 had a higher Se deposition, compared

**Graph 5: Effect of dietary Se source on Se deposition in pig muscle tissue at week 6 and week 10 (Falk et al, 2016).**



to pigs that received Se in form of selenized yeast (graph 5).

Besides muscle tissue, eggs and milk can be a good indicator for Se deposition. The described results in broiler and pig muscle tissue are in line with previous published results in laying hens and dairy cows.

Delezie et al (2014) found higher levels of Se in eggs in laying hens that received Excential Selenium4000 in the diet, compared to laying hens that received selenized yeast or inorganic selenium. Vandeale et al (2014) concluded that dairy cows that received Excential Selenium4000 had a higher selenium transfer to milk in comparison with dairy cows that received selenized yeast or inorganic selenium in the ration.

## Conclusion

Organic selenium in the form of selenomethionine is able to increase selenium deposition, which is a good indicator of the selenium status of the animal. Recent animal trials demonstrate the difference between dietary organic selenium sources and show that the level of selenomethionine is the most important parameter for the quality of products. Selenium yeast products show a variable level of selenomethionine. Excential Selenium4000 is a new generation of organic selenium, with the highest concentration of available selenomethionine and shows consequently the highest Se deposition. It allows a more standardized amount of active ingredient (selenomethionine) in the diet and ensures the most efficient selenium supply for the animal.