L-SELENOMETHIONINE AND OH-SELENOMETHIONINE:
BOTH ORGANIC, BUT NOT THE SAME SOURCE OF SELENIUM!

Selenium in animal feed

Selenium is an essential trace element with important effects on performance, health and fertility of animals. This trace element is used for the synthesis of various selenoproteins, which have a wide array of biological functions in the body, of which the antioxidant effect is the best known.

Different sources of selenium are available on the market, but it is important to make a distinction between them. Selenium sources can be categorised as inorganic (e.g. sodium selenite, sodium selenate) or organic (selenomethionine). Of all selenium sources, organic selenium in the specific form L-selenomethionine is considered to be the most effective. In the metabolism (Figure 1), L-selenomethionine is the only source of selenium that can be incorporated into animal proteins. The natural and safe storage of L-selenomethionine allows for the enrichment of milk, meat and eggs with selenium and for efficient transfer of selenium to the offspring. Another important aspect of the selenium incorporation in animal proteins, is the safe deposit of selenium inside the body. This natural reserve of selenium allows for a continuous selenium supply, for example during times of stress when feed intake, and thereby the selenium intake, is reduced. Occasions of low feed intake are often associated with higher requirements for selenium, for example during periods of diseases, heat stress or high stocking densities.

The advantages of L-selenomethionine compared to inorganic selenium sources is widely recognized in the feed industry. However, the differences between sources claiming to contain selenomethionine are still often overlooked.

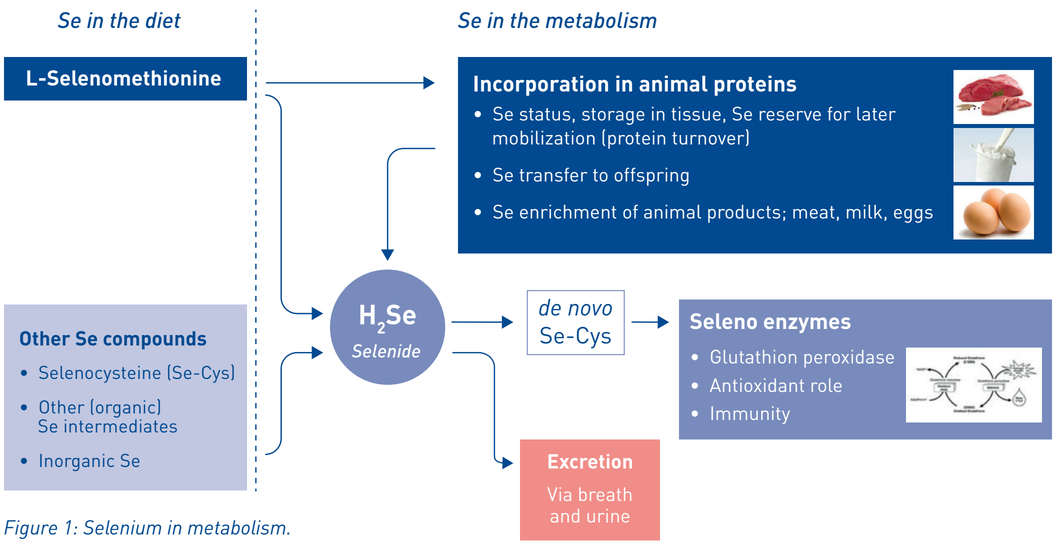


Figure 1: Selenium in metabolism.

OH-selenomethionine vs L-selenomethionine; what does the literature say?

OH-selenomethionine (OH-SeMet), otherwise known as hydroxy-selenomethionine, Synthetic R,S-2-hydroxy-4-methylselenobutanoic acid or HMSeBA, is a widely used form of organic selenium. Same as for L-selenomethionine, the use of OH-selenomethionine is based on a large foundation of scientific literature. The difference between the L- and the hydroxy-analogue of selenomethionine can be found in the bioavailability for the animal. To explain, the relative utilization of the methionine analogues can be used. Literature shows that OH-methionine has a relative utilization of only 80% in monogastric animals, while L-methionine has a utilization of 100% (Baker et al. 2006; Table 1).

Table 1: Utilization of methionine isomers in rats, mice, pigs and chicks. Values represent percentage of the growth efficacy of the methionine isomer (adapted from Baker et al. 2006).

Amino Acid	Rat	Mouse	Pig	Chick
L-SeMet	100	100	100	100
D-Met	90	75	100	90
DL-Met	95	88	100	95
DL-OH-Met	70	70	80	80

OH-selenomethionine is in fact a precursor for **L-selenomethionine**

OH-selenomethionine is in fact a precursor for L-selenomethionine. The OH-selenomethionine is converted into L-selenomethionine via a two-step enzymatic process, using L-hydroxy acid oxidase (L-HAOX) and D-hydroxy acid dehydrogenase (D-HADH). The -OH group has to be replaced by an $-NH_2$ group before the molecule can effectively be used by the animal and inserted into protein (Figure 2).

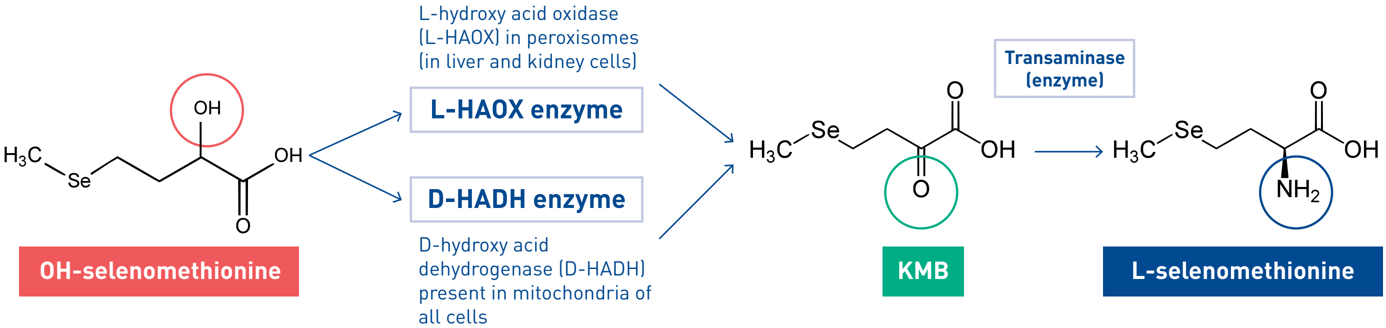


Figure 2: Conversion of OH-selenomethionine into L-selenomethionine via a two-step enzymatic process.
KMB: 2-keto-4 (methylthio) butanoic acid.

Differences in bioavailability *in vivo*

The notion on the differences in bioavailability between the different selenomethionine analogues is confirmed in several *in vivo* trials. Van Beirendonck et al. (2018), from the University of Leuven, Belgium, studied the selenium deposition in the muscle tissue of broilers after 14 days (Figure 3). L-selenomethionine (Excential Selenium 4000, Orffa) was tested at 0.16 and 0.20 ppm selenium and compared to a commercial available source of OH-selenomethionine (OH-SeMet) at 0.20 ppm selenium. Similar results in selenium muscle deposition were found between the lower dosage of L-selenomethionine (0.16 ppm) and OH-selenomethionine (0.20 ppm). The higher dosage of L-selenomethionine (0.20 ppm) showed significantly ($P<0.05$) the highest selenium deposition in the broiler muscle tissue. The selenium deposition for L-selenomethionine (0.20 ppm) was shown to be 17% higher than that of OH-selenomethionine (0.20 ppm).

The study of Van Beirendonck (2018), confirmed the lower bioavailability of OH-selenomethionine compared to L-selenomethionine in broilers. Lower bioavailability was also confirmed by other publications (Van Beirendonck et al. 2016, Rovers et al. 2016). Similar as what was found in literature for methionine (Table 1), the bioavailability of the OH-analogue seems to be 80%, compared to 100% for L-selenomethionine.

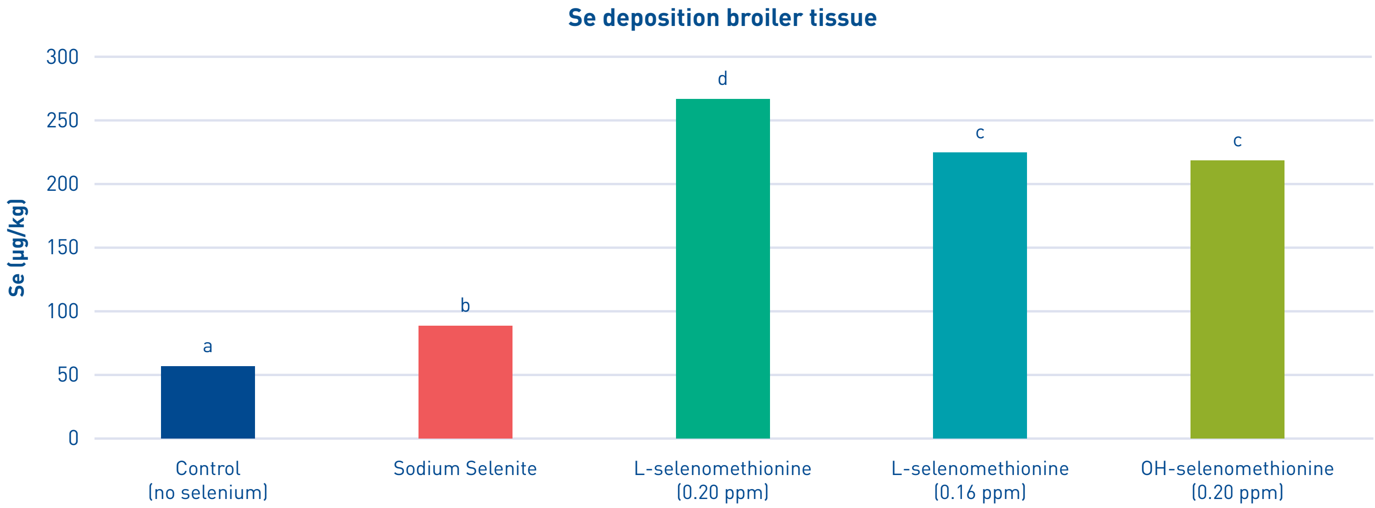


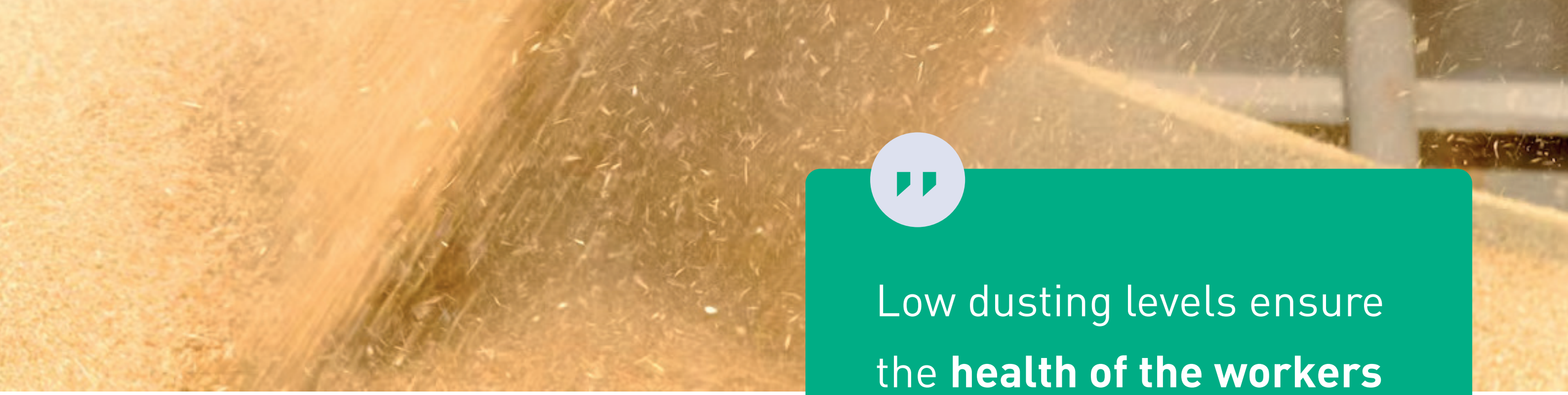
Figure 3: Selenium deposition in broiler muscle tissue at day 14 (adapted from Van Beirendonck et al. 2018).

What about dustiness?

Dust is an airborne solid particle. Dust particles are a major issue in working places, since exposure to high concentrations of dust can lead to occupational diseases that impair lung function. Irritation, asthma and cancer can all be caused by exposure to dust, even at low concentrations. This highlights the need to reduce the dusting potential of industrially produced compounds such as trace minerals.

Limits are set to minimize exposure to dangerous substances in the air, in order to protect workers at premix production sites. Occupational exposure limits (OEL) indicate the maximum exposure to dust in the workplace that is still considered as safe. For new authorisations, dust potential of feed additives is taken into account by the EFSA and the EU commission.

In general, selenium feed additives are considered to be dusty products. Selenium is known to be toxic upon inhalation (Dudley, H.C. 1938). People handling selenium products on a regular basis, such as workers in a premix factory, are at serious risk of being exposed to high levels of selenium dust which can impair health. In European Union, an OEL for selenium has been set at 0.2 mg Se/m^3 of air. This value holds true for additives that have been registered after 2013. Previous, already existing EU authorisations have no limitations on dust potential.



Low dusting levels ensure the **health of the workers** and minimize spilling

The dust potential can be measured, by using the Stauber-Heubach dust meter. There is large variation in the dustiness of organic selenium sources. Orffa has analysed different selenium sources for their dustiness in collaboration with Delft Solids Solutions, an independent laboratory in the Netherlands (Table 2). For OH-selenomethionine, dustiness has been shown to be high, with values of 37.7 mg Se/m^3 air. For the development of Excential Selenium 4000, Orffa has applied a special manufacturing procedure which ensures the product to be dust free and therefore complying with the OEL of 0.2 mg Se/m^3 air. The low dusting level ensures the health of the workers that are handling the product, and also minimizes spilling, which allows optimal use of the product and therefore economic benefits.

Table 2: Overview of the dustiness of OH-selenomethionine and L-selenomethionine (Excential Selenium 4000).

Product	Dustiness mg Se/m^3 air
OH-selenomethionine	37.7
L-selenomethionine (Excential Selenium 4000)	< 0.2

In conclusion; the same yes or no?

In literature, several studies can be found on the efficacy of OH-selenomethionine, as well as on L-selenomethionine. Both are sources of organic selenium, however after taking a closer look, the conclusion arises that these products are not interchangeable. OH-selenomethionine has been shown to have a lower efficacy (of around 80%) compared to L-selenomethionine. This information is based both on literature on utilization of methionine analogues, as well as on *in vivo* trials comparing L-selenomethionine and OH-selenomethionine. Also when considering workers' health, the dustiness of OH-selenomethionine has been shown to be higher, even exceeding safe limits.

To conclude and answer the question whether these two sources of selenium are the same, it can be stated that they are not. L-selenomethionine has been shown to have higher efficacy and lower dustiness compared to OH-selenomethionine!

Literature

- Baker, D.H. (2006) *Comparative species utilization and toxicity of sulfur amino acids*, Journal of Nutrition, 136 (6 Suppl), DOI: 10.1093/jn/136.6.1670S
- Dudley, H.C. (1938) *Selenium as a Potential Industrial Hazard*, Public Health Reports (1896-1970) 53 (8), p. 281-292, https://doi.org/10.2307/4582466
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