Role of Organic Selenium in poultry feed

INTRODUCTION

With time, poultry farming, which used to be backyard turned out to be fully commercial and intensive nowadays. Due to this one and only production centered goal, resulting stress to the birds is inevitable. Efficient poultry production depends upon well-balanced nutrition, feed regime, proper management activities, deworming, and vaccination. As feed cost accounts for nearly 60% of the total production costs, providing a well - balanced ration to the birds is a must. The most important element that comes to rescue in de-stressing the birds is **SELENIUM**.

Selenium (Se) is one of the essential trace elements required in poultry and animal nutrition. It is proved to play a vital role in the antioxidant defense mechanism of the body. Selenium is the cofactor for the enzyme glutathione peroxidase which catalyzes the removal of peroxides (oxidative reaction of free radicals) thus important in the prevention of oxidative stress. It has a role in improving reproductive health too.

Its deficiency in chickens results in exudative diathesis (hemorrhagic disease), nutritional muscular dystrophy, gizzard myopathy (turkeys), dystrophy of the heart (turkeys), and degeneration of pancreas apart from reproductive issues such as impaired hatchability, fertility, reduced viability of sperms, etc.

SOURCES OF SELENIUM

Two major sources of selenium (Se) in poultry are :

- Inorganic Se in the form of sodium selenite or selenate.
- Organic selenium in the form of selenomethionine (SeMet)

In natural feed ingredients like grains, soya & oilseeds, selenium is available in the form of selenomethionine (around 50% of the total available Se). In contrast, commercial Se sources constitute sodium selenite and selenate *(Surai, 2006)*. Mahmoud and Edens (2003) reported that the glutathione peroxidase activities in the liver of broilers significantly increased when fed with organic selenium under heat stress conditions. Their experiments and results even stated that organic selenium has higher bioavailability and antioxidant properties compared to inorganic selenium.

INORGANIC SELENIUM

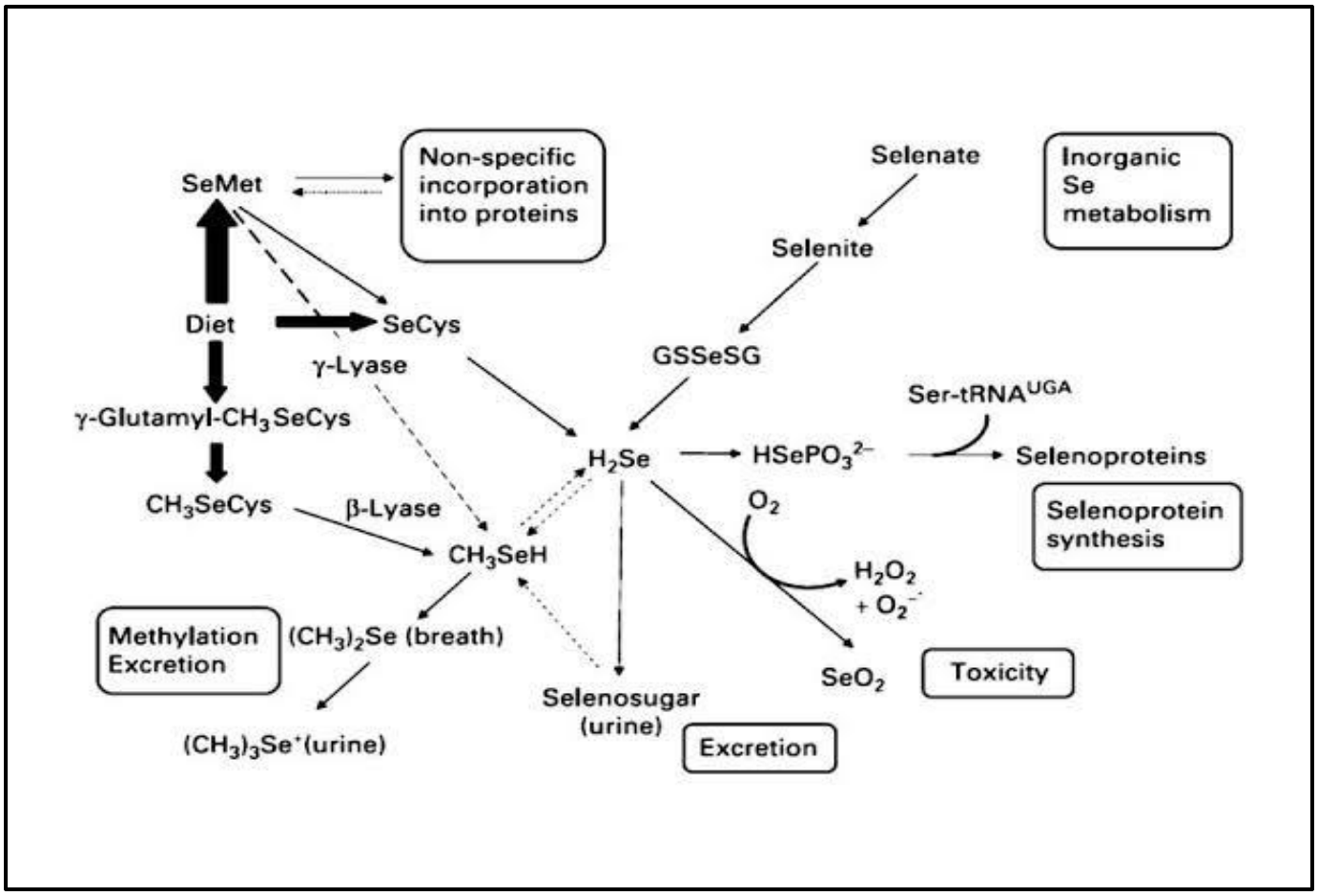
In 1974, FDA approved the supplementation of selenium in the poultry and swine feed in the form of selenite or selenate *(Surai, 2006)*. Since then it has been used as a source of selenium and various disadvantages have been documented. Sodium selenite in feed interacts with other nutrients such as ascorbic acid and is reduced to the elemental form which is biologically unavailable in the digestive tract. If selenite is dispersed in feeds with high water activity it is converted to the seleniferous acid (volatile form) and can be lost as a vapor. Pro-oxidant effects of selenite possess detrimental effects on the gut and vacuolar degeneration of epithelial cells in the crypts of the duodenum, mononuclear infiltration in the ileum *(Atria et al., 2010)*. Sodium selenite is hardly transferred to an egg resulting in the limited antioxidant defense against oxidative stress for a growing embryo *(Surai, 2006)*. It cannot be stored in the body as a reserve to combat the stress and most of the selenium consumed is simply excreted.

Considering the above disadvantages due to the use of inorganic selenium, the concept of organic selenium was developed in 2000 and a range of organic Se products appeared in the market *(Surai, 2006)*.

ORGANIC SELENIUM

SeMet naturally available in the feed ingredients is advantageous over the traditional selenite. SeMet transferred to the eggs provides a stronger antioxidant defense to the developing embryo and improves the hatchability and viability of newly hatched chicks in the breeder nutrition *(Fisinin et al., 2008; Surai and Fusion, 2014)*. Chick embryo antioxidant capacity improved and better expressed under oxidative heat stress conditions when fed in the form of selenomethionine rather than sodium selenite through deposition from maternal diet. Under heat stress conditions SeMet showed a higher value in reducing the oxidative damage than sodium selenite. Glutathione peroxidase activity in the liver of chick embryos increased when organic selenium deposition was noted through maternal diet thus increasing their anti-oxidant activity in heat stress conditions *(Xiao et al., 2015)*.

In layer diets organic selenium is associated with higher efficiency of transfer to eggs and improved internal egg quality (Haugh Unit) through the activation of a selenoprotein, methionine sulfoxide reductase B (Msr B) required for the prevention of protein oxidation and maintaining the water holding capacity of the albumen *(Jlali et al., 2013; Tufarelli et al., 2016)*. Selenium also has a positive effect on the eggshell quality, breaking strength as it improves the organic matrix formation *(Surai, 2006)*. Organic Selenium increases the transfer of Se to the muscles and also building up reserves in the body which have a positive impact on the immunity, gut health, meat quality and protects against stressors *(Surai and Fisinin, 2014)*.



Source : **Rayman et al., 2008, Food-chain selenium and human health: spotlight on speciation.**

DIFFERENT SOURCES OF ORGANIC SELENIUM

Se Yeast

Selenium is cultured using the aerobic fermentation of the yeast Saccharomyces cerevisiae in a Se enriched medium containing beet or cane molasses, vitamins, and sodium selenite as a source of Se *(Esmaeili and Khosravi-Darani, 2014)*. This technology works on the fact that when sulphur is replaced by the selenium, SeMet is synthesized instead of methionine. As stated in *All About Feed article, 2018*, SeMet content of Se-yeast is highly variable ranging between 20% - 75%. The SeMet molecule is also incorporated in yeast protein and needs to be digested before it can be adsorbed by the animal. This will reduce the bioavailability of the SeMet molecule provided by Se yeast.

OH-SeMet

The hydroxy-analogue of selenomethionine (or R,S-2-hydroxy-4-methylselenobutanoic acid, HMSeBA) is a molecule which cannot be used by the animal directly. After absorption it will be converted to L-selenomethionine by a two-step enzymatic pathway. Looking at the bioavailability of the molecule it can be seen that it is only 80% compared to 100% for L-selenomethionine *(Van Beirendonck et al. 2018)*.

L-SeMet

Among the L-SeMet, D- SeMet, DL- SeMet forms L-SeMet is more efficient in antioxidant defense, daily weight gain and feed conversion ratio. In an article from All About Feed, 2018, it was experimented and proved that that L-SeMet was better alternative over other selenium additives like Se yeast or OH-SeMet, since it is a 100% bioavailable form to the animal body. The deposition of Se in the muscle is linearly correlated to the amount of L-SeMet, thus proving the direct effects of L-SeMet in the diet (Van Beirendonck et al. 2016).

Gender-specific Gene Regulation of Selenium in Chicken:

Selenium supplementation in Hens: *(Brennan et al., 2011)*

Improvement on:

- Egg production percentage
- Egg weight, egg quality
- Haugh Unit
- Fertility and hatchability percentages
- Selenium content in yolk and albumen
- Live body weight.

Selenium supplementation in Cocks:

Improvement on:

- Sperm concentration
- Semen ejaculate volume
- Advanced motility (%)
- Alive sperm (%)

Mechanism:

Dietary selenium an essential trace mineral for poultry, directly influences the activity of glutathione peroxidase (GPx) in the chicken embryo (Surai,2016), improving the hatchability of fertile eggs *(Surai, 2006)*.

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CONCLUSION

Selenium has a major role in antioxidant property, biosynthesis of ubiquinones and protecting against peroxidation in tissues and membranes. It influences the absorption and retention of vitamin E, another important anti-oxidant important for metabolism. Excess of selenium may lead to toxicity. So adding an optimum level of organic selenium in the poultry diet may result in increased performance of the bird. As stated in the above mentioned findings, organic selenium that too in the form of **L-SeMet**, is most advisable giving credibility to its bioavailability and efficient anti-oxidation properties compared to other sources of selenium. With this, selenium induced deficiencies can be avoided, reducing stress to the birds, hence improving their fertility, and hatchability. Hence the overall productivity of the farm may be increased with optimum inclusion of organic selenium in the diet. Anti-cancer efficiency, improved thyroid functioning,reducing the risk of secondary infections in immune-compromised patients, fighting ability against inflammation due to viruses are the added benefits for humans those who consume these selenium treated poultry products like eggs and meat. Keeping track on the daily intake of selenium to avoid toxicity in any species is advisable.

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methylselenobutanoic acid as a dietary selenium supplement to improve the selenium concentration of table eggs

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