Effects of Se supplementation on growth rate and blood parameters in lambs

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ABSTRACT: Forty-eight Appenninica lambs 30 d old received during a 63 d period the same diet (dry unifeed) supplied 4 different mineral premixes differing for their Se sources and levels to obtain the following 4 treatments (on an as fed basis): Control group (T1) - 0mg/kg Se; T2 – 0.30mg/kg Se as sodium selenite; T3 – 0.30mg/kg and T4 – 0.45mg/kg Se as Se yeast (Saccharomyces cerevisiae). Biweekly all the animals were weighed and feed consumption recorded. Moreover, at start (t0) and successively each two weeks (t14, t28, t42, t56), all the animals were blood sampled in order to evaluate plasma and whole blood Se concentration and blood glutathione peroxidase (GSH-Px) and creatine phosphokinase (CPK) activities. Daily weight gain (averaging 166±6g/d) never differed between treatments. Se supplementation increased Se concentration in blood in relation to dietary level (p<0.05) and, compared to selenite, Se yeast seemed more effective to obtain higher concentration in whole blood (P<0.05) but not in plasma. Blood GSH-Px activity was higher in lambs receiving Se supplementation but was not influenced by Se dietary level or source. No effects could be find on blood CPK activity.

Key words: Lamb, Selenium, Performances, Blood biochemistry.

INTRODUCTION – In Abruzzo region, as in others in Italy and EU, natural content of Se ranges from 0.03 to 0.12 mg/kg DM and nutritional deficiencies frequently occur, particularly in animals reared mainly on home-grown roughage and grains which contain low Se concentrations. To date, nutritional requirements for lambs are 0.10 to 0.20 mg/kg DM and sodium selenite is the commercial source of Se currently used. Recently, however, Se-yeast has been particularly studied as possible Se source for livestock. Se in yeast is incorporate into various organic compounds, for the most part Se-methionine and in much lesser amount Se-cysteine, in which Se molecules replaces the sulphur atom. True digestibility of Se from diets containing selenite have shown to be about 50% in the sheep while that from Se-yeast would be about 66% (Weiss, 2005); furthermore, the metabolism of inorganic Se and Se-methionine in the cell should be different, because inorganic selenium should be used exclusively for the synthesis of seleno-enzymes while Se-methionine can also be incorporated into any protein, serving as a possible Se storage capacity (Rock et al., 2001). Purpose of this investigation was to study the effects of inorganic Se compared to Se-yeast at different levels on live performances, Se blood concentration, basal blood biochemistry and haematology, Se tissues concentration and meat quality of light lambs. Particularly, this paper will focus data concerning growing performances, Se blood concentration, blood GSH-Px activity and CPK activity as indicators of muscular problems (Sobiech and Kuleta, 2002).

MATERIAL AND METHODS – 48 Appenninica lambs, 30 d aged and weighing 12-14kg were divided into 4 experimental groups (T1, T2, T3, T4). Each group, housed in 3 straw litter pens (4 animals per replicate, 1m²/head) received for a 63 d period the same basal diet (dry unifeed) formulated to meet animal requirements for this breed and to reach a daily gain 150-200 g. The diet, realized by mixing a concentrate meal with chopped alfalfa hay (for a 2/5 hay/concentrate ratio), was supplied 4 different mineral premixes differing for their Se content to obtain the following 4 treatments on an as fed basis: Control group (T1) - 0mg/kg Se; T2 – 0.30mg/kg Se as sodium selenite; T3 – 0.30mg/kg and T4 – 0.45mg/kg Se as Se yeast (Organic Selenium from Saccharomyces cerevisiae CNCM I-306). Selenium levels as analysed were respectively 0.13, 0.27, 0.34 and 0.44 mg/kg. The diets were fed at 6% live weight (700 g/lamb/day at start to 1300g/lamb/day at the end of the trial). Biweekly all the animals were weighed and feed consumption, based on daily refusal registration, recorded. Moreover, at start (t0) and successively each
two weeks (t₁₄, t₂₈, t₄₂, t₅₆), all the animals were blood sampled via jugular venipuncture in order to evaluate the Se concentration in plasma and total blood (by inductively coupled plasma mass spectrometry), GSH-Px (RanseL® kit, Paglia and Valentine, 1967) and CPK activities (IFCC, Olympus AU400). All the data were analysed according to the GLM procedure of the SAS statistical package (SAS, 1989). The model included the effects of treatments and sex.

RESULTS AND CONCLUSIONS – None animal showed any problem ascribable to Se deficiency and daily weight gain was g/day 160; 166; 173 for T1 to T4 respectively (P>0.05). Recently, Juniper et al. (2006), following a Se supplementation as selenite or yeast for 112d has not verified any effect on growing performances and feed gain ratio. Probably Se requirements of the animal involved in our trial were so far covered by Se level as analysed in the basal diet (0.13mg/kg). As expected, males had a better weight gain than females with a significant difference in the last period (42-63 d) (204.7 vs 172.4 g/d, P<0.05).

Selenium level, in plasma and whole blood, increased during the trial independently from the treatment (table 1). Moreover, Se concentration in whole blood was 2 to 3 times higher than in plasma, as registered by other authors (Cristaldi et al., 2005). This is probably due to the greater amount of Se in cells membrane, enzymatic cytoplasmic systems and structural proteins than in the plasma where it is present as Selenoprotein P. Considering Se levels in whole blood, the animals of the control group (T1) constantly showed data significantly lower than treated groups (P<0.01). Blood concentration seems to relate to the supplementation level as demonstrated by the higher levels registered in T4 vs T3 and, significantly (p<0.05), vs T2 treatment. Cristaldi et al. (2005) demonstrated that Se levels generally reflect the level of dietary Se. This evidence is confirmed by the data of plasma concentration where T2 and T3 treatments never differ while after 28 d there is a significant difference between the two groups receiving selenium yeast. So, the chemical form of the selenium supplement did not affect the concentration of Se in plasma, in accordance with data found by Rock et al. (2001) in serum or by Van Ryssen et al. (1989) in plasma. In the same way in whole blood Juniper et al. (2006) did not find differences as related to organic or inorganic source of Se. Our data, according to Van Ryssen et al. (1989), show that lambs fed Se yeast tended to have higher concentration in whole blood which become significant (p<0.05) after 42d of treatment, probably as a consequence of Se-methionine incorporation into different blood protein, serving as a possible Se storage capacity (Rock et al., 2001).

Independently from the treatment, the activity of GSH-Px (table 2) showed an increase till t₂₈, probably due to the incorporation of Se into erythrocytes during erythropoiesis (Andrès et al., 1996). At the same time, differences related to the treatments became evident (T1 vs T2 e T3) (P<0.01) at the t₄₂ period, while no differences have been noted at t₅₆. On the contrary, Juniper et al. (2006) could find a strict relationship between Se dietary supplementation and GSH-Px activity. Furthermore, the chemical form of the selenium supplement did not affect GSH-Px activity in accordance with Juniper et al., 2006. In the same way, CPK activity, a muscle enzyme strictly related to muscular damage (Andrès et al., 1996), although with a high subjective variability, showed the highest levels at t₀ in all treatments. This is probably due to the stressing condition of weaning and group housing. No differences, however, in CPK activity could be related to Se supplementation level nor chemical form.

Table 1. Effect of supplemental Se on whole blood and plasma Selenium concentration in lambs.

|                | Whole blood Selenium (ng/g) |           | Plasma Selenium (ng/g) |           |
|----------------|-----------------------------|-----------|------------------------|-----------|
|                | T1  | T2  | T3  | T4  | S. D. | T1  | T2  | T3  | T4  | S. D. |
| t₀             | 100.4 | 124.2 | 116.3 | 115.0 | 42.5 | 41.0 | 50.3 | 51.0 | 50.9 | 15.4 |
| t₁₄            | 111.3B | 166.0A | 168.5A | 175.8A | 41.2 | 72.9 | 78.5 | 79.9 | 88.2 | 25.1 |
| t₂₈            | 123.0Bc | 191.4Ab | 201.3Aab | 230.5Aa | 40.1 | 480C | 81.8B | 88.7B | 105.8A | 11.7 |
| t₄₂            | 139.5Cc | 216.6Bb | 249.5AbA | 270.9Aa | 36.0 | 61.6C | 95.1B | 108.2B | 129.7A | 16.7 |
| t₅₆            | 170.5Cc | 276.3B | 308.3AB | 343.2A | 47.6 | 84.2Cc | 111.2Bb | 122.1ABb | 141.6Aa | 20.4 |

(a,b,c: P<0.05; A,B,C: P<0.01).

Selenium level, in plasma and whole blood, increased during the trial independently from the treatment (table 1). Moreover, Se concentration in whole blood was 2 to 3 times higher than in plasma, as registered by other authors (Cristaldi et al., 2005). This is probably due to the greater amount of Se in cells membrane, enzymatic cytoplasmic systems and structural proteins than in the plasma where it is present as Selenoprotein P. Considering Se levels in whole blood, the animals of the control group (T1) constantly showed data significantly lower than treated groups (P<0.01). Blood concentration seems to relate to the supplementation level as demonstrated by the higher levels registered in T4 vs T3 and, significantly (p<0.05), vs T2 treatment. Cristaldi et al. (2005) demonstrated that Se levels generally reflect the level of dietary Se. This evidence is confirmed by the data of plasma concentration where T2 and T3 treatments never differ while after 28 d there is a significant difference between the two groups receiving selenium yeast. So, the chemical form of the selenium supplement did not affect the concentration of Se in plasma, in accordance with data found by Rock et al. (2001) in serum or by Van Ryssen et al. (1989) in plasma. In the same way in whole blood Juniper et al. (2006) did not find differences as related to organic or inorganic source of Se. Our data, according to Van Ryssen et al. (1989), show that lambs fed Se yeast tended to have higher concentration in whole blood which become significant (p<0.05) after 42d of treatment, probably as a consequence of Se-methionine incorporation into different blood protein, serving as a possible Se storage capacity (Rock et al., 2001).
In conclusion, Se supplementation increases Se concentration in blood in relation to the dietary level and, compared to selenite, Se yeast seems more effective to obtain higher concentration in whole blood. Blood GSH-Px activity was higher in lambs receiving Se supplementation but was not influenced by Se dietary level or source. No effects could be find on blood CPK activity. Further data, concerning Se tissues concentration and meat quality, could carry other interesting results.

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REFERENCES

- Andrés, S., Manè, M.C., Sanchez, J., Barrera, R., Jiménez, A., 1996. Changes in GSHPx and muscle enzyme activities in lambs with nutritional myodegeneration following a single treatment with sodium selenite. Small Rum. Res 23: 183-186.
- Cristaldi, L.A., McDowell, L.R., Buergelt, C.D., Davis, P.A., Wilkinson, N.S., Martin, F.G., 2005. Tolerance of inorganic selenium in wether sheep. Small Rum. Res 56: 205–213.
- Juniper, D.T., Givens D.I., Bertin G., 2006. Examination of selenium dose response in young lambs receiving an organic selenium supplement – Sel-Plex. Alltech’s 22nd Annual Symposium, April 24-26, 2006.
- Rock, M.J., Kincaid, R.L., Carstens, G.E., 2001. Effects of prenatal source and level of dietary selenium on passive immunity and thermometabolism of newborn lambs. Small Rum. Res 40: 129-138.
- Sobiech, P., Kuleta, Z., 2002. Usefulness of some biochemical indicators in detection of early stages of nutritional muscular dystrophy in lambs Small Rum. Res 45: 209–215.
- Van Ryssen, J.B.J., Deagen, J.T., Beilstein, M.A., Whanger P.D., 1989. Comparative metabolism of organic and inorganic selenium by sheep. J. Agric. Food Chem. 37, 1358-1363.
- SAS, 1989. User’s Guide: Statistics, Version 6. SAS Institute Inc., Cary, NC, USA.
- Weiss, W.P., 2005. Selenium sources for dairy cattle. Proc. Tri-State Dairy Nutrition Conference, Fort Wayne, IN, USA, 61-71.

### Table 2. Effect of Se supplementation on GSH-Px and CPK activities in lambs.

|                | T1  | T2  | T3  | T4  | S. D. | T1  | T2  | T3  | T4  | S. D. |
|----------------|-----|-----|-----|-----|-------|-----|-----|-----|-----|-------|
| GSH-Px U/g Hb  |     |     |     |     | Error. |     |     |     |     | Error. |
| t₀             | 40.6| 46.7| 38.3| 35.7| 12.6  | 4716| 9354| 5007| 1836| 9548  |
| t₁₄            | 42.6| 53.4| 43.5| 46.1| 20.0  | 965 | 2505| 869 | 763 | 1880  |
| t₂₈            | 53.2₈| 75.5₈| 66.2₈| 64.2₈| 14.1  | 342 | 1386| 551 | 272 | 1667  |
| t₄₂            | 49.2₈| 67.0₈| 59.1₈| 60.1₈| 11.6  | 698 | 220 | 242 | 291 | 787   |
| t₅₆            | 53.6 | 62.5| 56.6| 42.3| 14.0  | 306 | 215 | 386 | 232 | 254   |

(A,B,C: P<0.01).