Effects of two supplemental dietary selenium sources (mineral and organic) on broiler performance and drip-loss

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SUMMARY

This experiment was conducted to determine the effects of two different supplemental dietary selenium (Se) sources on broiler performance and whole carcass drip-loss. A total of 273 one-day-old male broiler chicks (Avian Farms) were randomly divided into 3 groups of 91 birds each according to the dietary Se supplementation. The first group received no supplemental Se into starter (from the 1st to the 21st days), grower (from the 22nd to the 35th days) and withdrawal (from the 36th to the 42nd days) diets. The second and third groups were fed with the different dietary regimes supplemented with 0.3 ppm mineral Se (Sodium selenite) or organic Se (Se enriched yeast) respectively. Growth performance (body weight, body weight gain, feed intake and feed conversion ratio) were recorded on the 21st and the 42nd days and carcass traits (chilled carcass weight and chilled carcass yield, whole carcass drip-loss) were measured after slaughtering on the 42nd day. Whatever the origin of Se supplementation, no significant effect on body weight, body weight gain and feed intake was observed on days 21 and 42, and chilled carcass weights and their yield were also unaffected at the end of experiment. By contrast, total feed conversion ratio (from the 1st to the 42nd days) was significantly improved and whole carcass drip-loss was significantly reduced in birds receiving 0.3 ppm organic Se in comparison to the other groups (P<0.01). These results indicate that supplementation of broiler diets with organic Se improved feed conversion ratio and decreased drip-loss, leading to increase meat quality and economical gain.

Keywords : selenium - broiler performance - carcass - drip loss.

Introduction

Selenium (Se) is an essential trace mineral and has a profound impact on immune function, health and productivity. Rotronuck et al. [17] described the role played by Se as an essential component of an antioxidant enzyme, glutathione peroxidase (GSH-Px). Se deficiency in poultry, especially together with vitamin E deficiency, causes Se-deficiency diseases including exudative diathesis, pancreatic dystrophy and nutritional muscular dystrophy [11]. Se is found naturally in plant feed ingredients but concentrations vary greatly depending on both the plant species and in particular the Se status of the soil [11, 15]. Therefore, poultry diets require supplemental Se in order to provide a margin of safety against deficiency and to maintain productive performance.

The range of concentrations between a Se deficiency and toxicity is generally more narrow than other minerals. The NRC [14] reports that toxic concentration of Se is 10 mg per kg diet for broiler chickens. The NRC [14] also recommends that a minimum of 0.15 mg Se to be added per kg diet for broiler chickens. Sodium selenite and sodium selenate are two inorganic forms of Se commonly used in the feed industry today, while, organic Se can be derived from Saccharomyces cerevisiae, a yeast, grown in a medium containing high levels of Se. Feed ingredients only contain Se in the organic form, mainly as selenomethionine (SeMet). SeMet is not synthesised by animals but by plants [18] and accounts for the majority of the Se in Se yeast [8]. SeMet possesses antioxidant properties [18] while sodium selenite...
may act as a prooxidant in some conditions [19].

Drip-loss is a substantial economic problem for the broiler industry, especially for companies marketing pieces of chicken and processed products. NORTHCUPT ET AL. [13] estimated that drip loss can account for more than 3 % of the total yield of cut-up chicken. MAHAN [10] suggested that excessive cellular damage resulting from oxidation may be the cause of drip loss. SURAI [20] reported that GSH-Px contributes significantly to the overall antioxidant defence of muscle in broilers: moreover, organic selenium supplementation of the diet could achieve to decrease tissue susceptibility to lipid peroxidation and increase oxidative stability of skeletal muscle.

Consequently, the aims of the present study are to determine the effects of dietary Se supplementation on broiler performance and carcass drip-loss and to compare the eventual efficiency of Se organic form to mineral one.

**Material and Methods**

**BIRDS AND DIETS**

A total of 273 one-day-old male Avian Farms broiler chicks were used. The chicks were individually weighed and randomly distributed into 21 floor pens (1 x 1 m^2). Each pen contained 13 chicks. The dietary regimes were: control (C) (no supplemental Se), C + 0.3 ppm inorganic Se (sodium selenite) and C + 0.3 ppm organic Se (Se-enriched yeast, Sel-Plex, Altech, Inc., Nicholasville, KY). Therefore, the three dietary regimes were replicated seven times. The experimental diets were prepared as mash and formulated to contain equal amounts of energy and crude protein, which are necessary to meet the minimum nutrient requirements of broiler chickens, as recommended by the NRC [14]. All chicks were fed with a starter (0 to 21 days), a grower (22 to 35 days) and a withdrawal (36 to 42 days) diet. The composition of the broiler diets and nutrient composition of the control diets are shown in Table I and Table II, respectively.

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of the control diets (starter, grower and withdrawal diets) were 0.13, 0.12 and 0.12 ppm, respectively (Table II). Se is added to experimental diets to exceed NRC Se requirements [14] for broilers without creating a level of toxicosis. The supplemental Se amount of 0.3 ppm is a level provided in most trace mineral premixes used for broiler chickens.

In the experiment, water and feed were provided ad libitum. Birds were exposed to 23 h of light and 1 h of darkness per day. Wood shavings were used as litter. Mortality was recorded as it occurred. The experiment lasted 42 days.

MEASUREMENTS AND ANALYSES

All chicks were individually weighed at hatching and on the 21st and 42nd days of the experiment. Feed consumption was determined on a pen basis. Average bird weight gain and feed conversion ratio adjusted for mortality, were determined on days 21 and 42.

On day 42, after 12 hours of feed withdrawal, birds were slaughtered and carcasses were chilled in static slush-ice for 1.5 h, allowed to drip for 1 min and were weighed for chilled carcass weights. Chilled carcasses were stored at 4°C for 24 h, allowed to drip for 1 min and were re-weighed in order to determine whole carcass drip-loss.

Experimental diets were chemically analyzed according to the AOAC methods [1] for dry matter, crude protein, crude ash, ether extract, starch and saccharose. Metabolisable energy of experimental diets was calculated using the equation of HARTEL [7].

STATISTICAL ANALYSIS

One-way ANOVA was performed to compare the mean of body and carcass weight, after using Levene’s test of equality of error variances to show that the data had a normal distribution. The mean of feed intake, feed conversion ratio, body weight gain, percentage carcass yield and percentage whole carcass drip-loss were assessed using the Kruskall-Wallis ANOVA, followed by the Mann-Whitney test. The statistical analysis for mortality rates was calculated on the basis of replicates with one-way ANOVA. Statistical significance was assumed at a value of P<0.05. All statistical analysis was performed with SPSS software (version 10.0, SPSS Inc, Chicago, USA, 1999).

### Results and Discussion

The effects of dietary Se supplementation according to Se source on broiler performance are presented in Table III. Although body weights and body weight gains (on days 21 and 42) tended to increased when birds received dietary Se supplementation, differences between groups were not significant (P>0.05). Moreover, the nature of Se source (mineral vs. organic) did not significantly modify broiler growth. In the same way, feed intake and mortality were not significantly altered by selenium supplementation whatever the Se forms. By contrast, feed conversion ratio (from the 1st to the 42nd days) was improved when birds were supplemented by organic Se in comparison to control (P<0.01) or to broilers receiving sodium selenite (P<0.01). Previous studies have reported that broiler performance parameters (body weight and feed conversion ratio) were not affected by 0.3 ppm Se supplementation in organic or mineral forms [2]. Also, EDENS et al. [4] obtained similar results for performance and mortality in broilers receiving organic Se at 0.2 ppm when compared to control group or broilers receiving inorganic Se. However, NAYLOR et al. [12] found a significant improvement in feed conversion ratio in broilers fed with organic Se (P<0.05) at 0.25 ppm resulting from lower feed intakes while maintaining the same live weight gain. ROCH et al. [16] also reported that a combination of 0.3 ppm organic Se with 250 mg/kg vitamin E improved feed conversion ratio in broilers compared to the controls. The findings of NAYLOR et al. [12] and ROCH et al. [16] are consistent with results of the present study in that organic Se improved feed conversion ratio in broilers compared to controls or to broilers receiving inorganic Se. EDENS [3, 5, 6] suggested that improvement in feed conversion ratio could be related to the better feathering of chickens fed with a diet supplemented with organic Se.

In the present study, chilled carcass weight and chilled carcass yield were not significantly different (P>0.05) between

<table>
<thead>
<tr>
<th>Item</th>
<th>Control</th>
<th>Inorganic Se (0.3 ppm)</th>
<th>Organic Se (0.3 ppm)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight (g)</td>
<td>D0 39.60 ± 0.32</td>
<td>39.75 ± 0.33</td>
<td>40.28 ± 0.35</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>D21 590.09 ± 7.87</td>
<td>600.01 ± 7.19</td>
<td>612.71 ± 7.07</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>D42 1866.29 ± 27.28</td>
<td>1960.19 ± 25.27</td>
<td>1963.74 ± 30.11</td>
<td>NS</td>
</tr>
<tr>
<td>Body weight gain (g)</td>
<td>D0-21 550.77 ± 9.18</td>
<td>559.57 ± 8.69</td>
<td>571.24 ± 9.67</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>D0-42 1857.71 ± 35.18</td>
<td>1920.59 ± 27.24</td>
<td>1948.14 ± 42.64</td>
<td>NS</td>
</tr>
<tr>
<td>Feed intake (g)</td>
<td>D0-21 910.76 ± 11.95</td>
<td>924.67 ± 11.05</td>
<td>935.95 ± 14.29</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>D0-42 3647.21 ± 59.73</td>
<td>3755.76 ± 51.17</td>
<td>3712.29 ± 79.60</td>
<td>NS</td>
</tr>
<tr>
<td>Feed/Gain (g/g)</td>
<td>D0-21 1.65 ± 0.01</td>
<td>1.64 ± 0.01</td>
<td>1.63 ± 0.01</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>D0-42 1.96 ± 0.01</td>
<td>1.96 ± 0.00</td>
<td>1.90 ± 0.00</td>
<td>**</td>
</tr>
<tr>
<td>Mortality (%)</td>
<td>D0-42 3.29 ± 1.55</td>
<td>3.29 ± 1.55</td>
<td>2.19 ± 1.42</td>
<td>NS</td>
</tr>
</tbody>
</table>

TABLE III. — Influence of Dietary Selenium Sources on Broiler Performance.

a, b : Mean values within a row with different superscripts are significantly different **(P<0.01). NS: not significant. Results are expressed as mean ± SEM of 7 pens of 13 chicks per treatment.
treatments but there was a significant reduction (P<0.01) in whole carcass drip-loss for broilers fed with organic Se (Table IV). The results of the present study are similar to those that are reported by other researchers [2, 6, 12]. DOWNS et al. [2] found that chilled carcass yield and whole carcass drip-loss of broilers were not affected by Se sources but breast fillet drip-loss increased when broiler diets were supplemented with inorganic Se. Both NAYLOR et al. [12] and EDENS [6] reported that birds receiving dietary organic Se had significantly lower drip-loss (P<0.01) than those receiving inorganic Se. Similarly, MAHAN et al. [9] noted that the 120-hour post-slaughter drip-loss of pork from pigs receiving inorganic Se was higher than that of pigs receiving organic Se or of controls (no supplemental Se). They concluded that inorganic Se might act as a tissue destroying pro-oxidant. Although the mechanism of drip-loss is completely unclear, MAHAN [10] suggested that contributing factor to drip-loss of raw meat products might be excessive cellular damage resulting from oxidation, creating “leaky” cellular components and membranes.

In conclusion, the supplementation of broiler diets with organic Se improved feed conversion ratio and reduced whole carcass drip-loss. However, body weight gain, mortality, carcass weight and carcass yield were unaffected by selenium sources. It is possible that the use of organic Se instead of inorganic Se in broiler diets may increase both meat quality and economic gain by reducing drip-loss.

### References

4. EDENS F.W., PARKHURST C.R., HAVENSTEIN G.B.: Selenium yeast (Sel-Plex 50) improves feathering rate of broilers reared in

### Table IV. — Influence of Dietary Selenium Source on Broiler Carcass and Drip-Loss.

<table>
<thead>
<tr>
<th>Item</th>
<th>Control</th>
<th>Inorganic Se (0.3 ppm)</th>
<th>Organic Se (0.3 ppm)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-slaughter live weight (g)</td>
<td>1890.29 ± 27.28</td>
<td>1960.19 ± 25.57</td>
<td>1983.74 ± 30.11</td>
<td>NS</td>
</tr>
<tr>
<td>Chilled carcass weight (g)</td>
<td>1427.51 ± 20.11</td>
<td>1457.00 ± 19.15</td>
<td>1494.56 ± 23.08</td>
<td>NS</td>
</tr>
<tr>
<td>Chilled carcass yield (%)</td>
<td>75.21 ± 0.45</td>
<td>74.32 ± 0.16</td>
<td>75.34 ± 0.69</td>
<td>NS</td>
</tr>
<tr>
<td>Whole carcass drip-loss (%)</td>
<td>1.06a ± 0.020</td>
<td>1.08b ± 0.030</td>
<td>0.69b ± 0.034</td>
<td>**</td>
</tr>
</tbody>
</table>

a, b: Mean values within a row with different superscripts are significantly different ** (P<0.01). NS: not significant.

Results are expressed as mean ± SEM of 7 pens of 13 chicks per treatment.