Impact of Dietary Supranutritional Selenium on Improving the Meat Quality of Goats

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Selenium (Se) a crucial micronutrient, is required in many biochemical processes in animals. Supranutritional levels of Se in the diet have been suggested to potentially enhance meat quality in livestock. However, limited research exists on the impact of dietary supranutritional Se on meat quality in goats.

Objective: To evaluate the influence of dietary supranutritional Se on goat muscle meat quality, examining pH, water holding capacity (WHC), cooking and drip losses, moisture, protein, fat, ash, and glycogen contents.

Methods: Sixteen male goats were randomly grouped into two viz., A and B (n = 8 per group) and offered basal diets without (group A) or with addition of Se (group B) for 10 weeks. Meat samples were collected from the longissimus dorsi (LD) and semimembranosus (SM) muscles at the completion of trial and the physico-chemical characteristics were determined.

Results: Supranutritional Se supplementation resulted in significantly higher (P < 0.05) WHC and lower (P < 0.05) cooking and drip losses in both LD and SM muscles compared with control. Additionally, the protein and fat contents were significantly elevated (P < 0.05) and the ash contents lowered (P < 0.05) in both LD and SM muscles of goats fed Se supplemented diet compared with control. However, the pH and glycogen contents were not altered (P > 0.05) between the two groups.

Conclusions: The findings of present trial demonstrated that supranutritional Se supplementation improved the quality of goat meat, contributing to its nutritional value and consumer acceptance.
metabolizable energy (ME, MJ/kg)

Table 1: Chemical Composition of Diets Offered to Goats

<table>
<thead>
<tr>
<th>Chemical composition</th>
<th>Concentrate</th>
<th>Roughage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Matter (%)</td>
<td>87.75</td>
<td>89.81</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>20.89</td>
<td>7.32</td>
</tr>
<tr>
<td>Crude fat (%)</td>
<td>3.64</td>
<td>2.02</td>
</tr>
<tr>
<td>Crude fiber (%)</td>
<td>6.67</td>
<td>28.25</td>
</tr>
<tr>
<td>Crude ash (%)</td>
<td>7.73</td>
<td>6.4</td>
</tr>
<tr>
<td>Metabolizable Energy (ME, MJ/kg)</td>
<td>10.85</td>
<td>6.96</td>
</tr>
</tbody>
</table>

Experiment Design and Feeding Management
After adaptation, animals were randomly assigned to two groups, i.e., control (A) and Se supplemented (B), with eight animals in each group. They were individually housed and fed either BD (A) or BD supplemented with Se (B) for 10 weeks.

The Se Source and Dosage
The background Se levels (mg kg-1 diet) in concentrate (0.15) and roughages (0.03), were analyzed through inductively coupled plasma mass spectrometry (ICP-OES Optima 2100-DV, Perkin Elmer). Animals in group B received a BD diet supplemented with supranutritional dose (0.5 mg kg-1 diet). The Se was fed from organic source i.e., Selenium yeast (SY)(Sel-Plex®, Alltech®, USA).

Slaughtering and Skeletal Muscle Collection
After the completion of feeding trial, goats were humanely sacrificed via the Halal method by cutting the jugular veins. The skin was immediately removed and then the muscles were carefully extracted from two different regions, washed with a cold phosphate buffer solution (PBS), and collected in a clean container.

Physico-Chemical Characteristics of Meat
To examine the physical and chemical features of the meat, the samples were obtained from longissimus dorsi (LD) and semimembranosus (SM) muscles, respectively [7]. The LD muscle was extracted from the left carcass (between the 8th and 11th thoracic vertebrae) as described by Honikel [8]. Before conducting any physical and chemical analyses, all visible fat was meticulously removed from the muscles.

Physical Properties of Muscle Meat
1. pH: Effects of supranutritional Se treatment on pH of goat meat are shown in Table 2. The pH of LD muscle and SM muscle (thigh muscle) was non-significant between A and B group.

2. Water Holding Capacity (WHC, %): Dietary supranutritional Se produced significant effect on WHC in LD and SM muscles in goats. WHC in LD muscle raised (P < 0.05) in B (82.3 %) than in A (78 %). Likewise, WHC in SM muscle raised (P < 0.05) in B (79 %) than in A (74 %). In addition, the WHC was detected higher (P < 0.05) in LD compared with SM muscle in goats fed Se supplemented diet (table 2).

3. Cooking Loss (%): Cooking loss in LD and SM muscles was significant (P < 0.05) between groups. Cooking loss in LD muscle elevated (P < 0.05) in A (37 %) compared with B (33.66 %). Similarly, cooking loss in SM muscle was higher (P < 0.05) in A (34.1 %) compared with B (28.29 %). In addition, cooking loss was observed higher in LD muscle compared with SM muscle in goats fed Se supplemented diet (table 2).

4. Drip Loss (%): Drip loss in LD and SM muscles was significantly (P < 0.05) affected by Se treatment (table 2). Drip loss in LD muscle was higher (P < 0.05) in A (2.4 %) compared with B (2.2 %). Similarly, drip loss in SM muscle was higher (P < 0.05) in A (2.29 %) compared with B (2.17 %).
Moreover, the drip loss (%) was determined higher in LD muscle compared with SM muscle in goats fed Se supplemented diet.

Table 2: Effects of Dietary Supranutritional Selenium on the Physical Properties of Muscle Meat in Goat

<table>
<thead>
<tr>
<th>Groups</th>
<th>pH</th>
<th>WHC (%)</th>
<th>Cooking Loss (%)</th>
<th>Drip Loss (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LD</td>
<td>SM</td>
<td>LD</td>
<td>SM</td>
</tr>
<tr>
<td>A</td>
<td>5.93</td>
<td>5.90</td>
<td>78.00</td>
<td>74.00</td>
</tr>
<tr>
<td>B</td>
<td>5.76</td>
<td>5.94</td>
<td>82.33</td>
<td>79.00</td>
</tr>
<tr>
<td>SEM</td>
<td>0.1872</td>
<td>0.2028</td>
<td>1.0541</td>
<td>1.6330</td>
</tr>
<tr>
<td>P-value</td>
<td>0.4468</td>
<td>0.8774</td>
<td>0.0017</td>
<td>0.0371</td>
</tr>
</tbody>
</table>

LD = Longissimus Dorsi Muscle; SM = Semimembranosus Muscle. A = Control; B = Selenium Yeast (0.5 mg kg-1 feed); Values are Mean, Significance level P<0.05.

Chemical Properties of Muscle Meat

1. Moisture Content (%): Supranutritional Se treatment exerted significant (P<0.05) effect on moisture content (%) in muscle meat of goat as shown in table 3. Moisture content in LD muscle was reduced (P<0.05) in B (71.63 %) compared with A (74.37 %). Similarly, significant drop (P<0.05) in moisture content of SM muscle was seen in B (74.52 %) compared with A (76.42 %). Moreover, the moisture content was observed higher in SM muscle compared to LD muscle in goat fed Se supplemented diet.

2. Protein Content (%): The protein content in LD muscle and SM muscle was significant (P<0.05) between A and B groups. The protein content in LD muscle was higher (P<0.05) in B (23.82 %) compared with A (21.34 %). Similarly, the protein content in SM muscle was higher in B (21.34 %) compared with A (19.78 %). Moreover, the protein content was observed higher in LD compared with SM muscle in goat fed Se supplemented diet.

3. Fat Content (%): Muscle fat content (%) was significantly (P<0.05) affected by Se treatment between A and B groups. Fat content in LD muscle was higher (P<0.05) in B (2.84 %) compared with A (2.54 %). Similarly, the fat content in SM muscle elevated (P<0.05) in B (2.46 %) compared with A (2.28 %). Moreover, the fat content was determined higher in LD compared with SM muscle in goat fed Se supplemented diet.

4. Ash Content (%): The ash content (%) in LD muscle and SM muscle was non-significant (P>0.05) between A and B groups. However, the ash content in LD muscle was higher in A (0.75 %) compared with B (0.61 %). Similarly, the ash content in SM muscle was higher in A (0.68 %) compared with B (0.43 %). Moreover, the ash content was determined higher in LD muscle compared to SM muscle for both A and B group.

5. Glycogen Content (%): The glycogen content in LD and SM muscles was significant (P>0.05) between A and B group (table 3). The LD muscle glycogen was higher in B (1.1 %) compared with A (0.9 %). Similarly, the SM muscle glycogen was higher in B (1.05 %) compared with A (0.84 %). Moreover, the glycogen content was determined higher in LD muscle compared with SM muscle for both A and B group.

Table 3: Effects of Dietary Supranutritional Selenium on the Chemical Properties of Muscle Meat in Goat

<table>
<thead>
<tr>
<th>Groups</th>
<th>Moisture %</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Ash (%)</th>
<th>Glycogen (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LD</td>
<td>SM</td>
<td>LD</td>
<td>SM</td>
<td>LD</td>
</tr>
<tr>
<td>A</td>
<td>74.37</td>
<td>78.42</td>
<td>21.44</td>
<td>19.78</td>
<td>2.54</td>
</tr>
<tr>
<td>B</td>
<td>71.63</td>
<td>74.52</td>
<td>23.82</td>
<td>21.34</td>
<td>2.84</td>
</tr>
<tr>
<td>SEM</td>
<td>1.776</td>
<td>1.802</td>
<td>0.793</td>
<td>0.328</td>
<td>0.068</td>
</tr>
<tr>
<td>P-value</td>
<td>0.021</td>
<td>0.033</td>
<td>0.08</td>
<td>0.009</td>
<td>0.011</td>
</tr>
</tbody>
</table>

LD = Longissimus Dorsi Muscle; SM = Semimembranosus Muscle. A = Control; B = Selenium Yeast (0.5 mg kg-1 feed); Values are Mean, Significance level P<0.05.

DISCUSSION

In this study, goats receiving supranutritional Se at 0.5 mg kg-1 diet, exhibited significantly higher levels of WHC, moisture, protein, and fat in longissimus dorsi (LD) and semimembranosus (SM) muscle compared with control. Conversely, control goats showed significantly higher cooking loss, drip loss, and ash content in both LD and SM muscles compared with Se treated goats. In terms of meat's physical properties, including pH, WHC, cooking loss, and drip loss, our findings are consistent with previous research [9]. This aligns with other studies showing that supplementing with Se did not significantly affect these meat characteristics in lambs and calves [10]. Additionally, it was demonstrated that dietary treatment did not lead to substantial differences (P>0.05) in pH, water loss percentage, drip loss, or cooking loss [11]. The high Se exhibited comparatively darker meat color. However, according to Silva et al., Se supplementation, whether organic or inorganic, did not affect carcass pH, drip loss, or cooking loss [12]. In another study, Markovic et al., reported the decrease in pH of meat from broilers fed high Se in diet [13]. In addition, extra Se supplementation increased both protein and lipid contents in breast muscle meat of broilers. Moreover, the protein content was comparatively higher in thigh muscle meat compared with breast muscle meat in broilers fed extra-Se diet [13]. According to Silva et al. reported Se supplementation, whether organic or inorganic, did not affect weights, drip percentage, cooking loss, or drip loss, our findings are consistent with previous research [9]. This aligns with other studies showing that supplementing with Se did not significantly affect these meat characteristics in lambs and calves [10]. Additionally, it was demonstrated that dietary treatment did not lead to substantial differences (P>0.05) in pH, water loss percentage, drip loss, or cooking loss [11]. The high Se exhibited comparatively darker meat color. However, according to Silva et al., Se supplementation, whether organic or inorganic, did not affect carcass pH, drip loss, or cooking loss [12]. In another study, Markovic et al., reported the decrease in pH of meat from broilers fed high Se in diet [13]. In addition, extra Se supplementation increased both protein and lipid contents in breast muscle meat of broilers. Moreover, the protein content was comparatively higher in thigh muscle meat compared with breast muscle meat in broilers fed extra-Se diet [13]. The ash content in breast muscle meat decreased in broilers receiving high-Se diet [13]. One study demonstrated that supplementing the diet with Se did not affect the meat's pH levels [14]. However, previous studies have shown that Se addition decreased muscle meat pH in dose-dependent manner, leading to much decrease in pH with extra dose of Se in broilers diet [15]. Another investigation observed an upward trend in the pH of loin muscle in beef treated with Se [16], likely due to greater hydrogen peroxide depletion. Oxidative stress, linked to increased drip loss in breast
meat, accelerated pH decreases after slaughter, and increased lightness (color) of thigh meat, has been implicated in previous research [17]. In our study, the meat's moisture, protein, and ash concentrations were significantly higher in Se treated goats compared with control. Previous research found no appreciable effects of a diet supplemented with Se on moisture, protein, and ash levels, which is not consistent with our results [18]. In contrast, calves given a diet deficient in Se, they did note a non-significant rise in meat fat content of 11.76% in the former group. Given that insulin has been shown to have anabolic effects on fat [19], the increased synthesis of fat in the muscles of goats given SY may be due to the Se's insulin-like properties. Similarly, another research discovered that broilers given supplemental Se had muscles with a greater crude protein content than those fed unsupplemented Se [20]. The higher protein absorption brought on by Se-enhanced thyroid hormone metabolism may be the cause of this rise in protein content. Several investigators have noted that greater doses of Se supplementation were associated with an increase in the intramuscular fat content of meat [15]. Overall, it has been shown that Se enhances the nutritious content, flavour, and keeping quality of meat. Oxidation processes may have a detrimental effect on the nutritional content, and flavours of meat products, although glutathione peroxidase (GSH-Px) has the antioxidant capacity to counteract these effects [4]. The concentration of Se in ruminant tissues is increased by dietary Se [5]. This phenomenon is regulated by several parameters, including the animal species, the amount of Se in the diet, the length of the experiment, and the source of Se [21]. Although Se may be found in several tissues at different concentrations, the liver, kidneys, and spleen have the highest concentrations of this mineral, while skeletal muscles, cardiac muscles, intestines, and lungs have lower concentrations [6]. Se supplements to ruminant diets may improve the meat’s oxidative stability. Oxidative processes have a substantial influence on the qualitative features of meat [4]. Reducing oxidation is one way to maintain meat quality [22] and having antioxidants in the meat itself is essential to doing this.

C O N C L U S I O N S

The findings of present study indicate that dietary supranutritional Se addition positively affected the muscle meat quality in goat, presenting the opportunities to enhance consumer satisfaction and marketability. However, additional studies are required to optimize supplementation levels and fully to understand the underlying mechanisms.

A u t h o r s C o n t r i b u t i o n

Conceptualization: MM
Methodology: MAM, ABK
Formal analysis: MAM, MM, ABK, GSB
Writing-review and editing: MAM, MM, ABK, GSB

All authors have read and agreed to the published version of the manuscript.

C o n f l i c t s o f I n t e r e s t

The authors declare no conflict of interest.

S o u r c e o f F u n d i n g

The authors received no financial support for the research, authorship and/or publication of this article.

R E F E R E N C E S


