Influence of Dietary Black Cumin Meal (Nigella sativa L.) on the Performance and Body Measurements of Garut Sheep

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ABSTRACT

Black cumin meal has potential as feed ingredient of sheep. This study aimed to evaluate the influence of dietary black cumin meal on the performance and body measurements of Garut sheep. The study used 28 heads of male Garut sheep aged ±10 months with an average initial body weight of 20 ± 2.34 kg/head. A completely randomized design (CRD) was used to compare the influence of 4 different levels (0%, 5%, 10%, and 15%) of black cumin meal in the diet on dry matter intake (DMI g/head/d), average daily gain (ADG, g/head/d), feed efficiency (%), body length gain (cm), chest circumference gain (cm), and height at withers gain (cm) during 70 d feeding trial using 7 replicates. The data were statistically analyzed using a One-Way Analysis of Variance and continued with Duncan new Multiple Range Test for significant results, operated by the IBM SPSS 26 program. The results showed that DMI (P<0.05), ADG (P<0.01), and feed efficiency (P<0.05) of Garut sheep were increased for a diet containing black cumin meal compared with control. Furthermore, dietary black cumin meal enhanced body length gain (P<0.05), followed by chest circumference gain, and height at withers gain (P<0.01). Dietary black cumin meal 10% is the optimum level to increase the performance and body measurements. In conclusion, dietary black cumin meal improves the performance and body measurements of Garut sheep.

Keywords: Black cumin meal, Body measurements, Garut sheep, Performance

Introduction

Sheep has a huge contribution to overall red meat production. The sheep’s population in West Java reached 9.987.870 heads in 2022 (Directorate General of Livestock and Animal Health, 2022). Garut sheep (Indonesian National Standard 7532:2009) is one of the most popular local sheep in West Java. Garut sheep have characteristics such as a combination of telinga rumpung or ngadaun hiris (the shape of the earlobe resembles an iris leaf <4 cm), and ngabuntut bagong or ngabuntut beurit (the shape of tail resembles a triangle with fat deposits at the base of the tail with a width of >1 cm and tapers at the tip of the tail). Compared to other local sheep, Garut sheep have a good weight gain and a high carcass percentage, so they a wide marketplace in Indonesia, especially in West Java (Nurjannah et al., 2019).

In Garut sheep farming systems, feeding management is a factor in increasing productivity. The component of nutrition in the diet must be balanced to improve sheep performance. In addition, the diet also requires 60% to 80% of the total production costs (Sanjaya et al., 2020). So, feed technology is needed that can reduce production costs and increase efficiency. Nascimento et al. (2011) reported that in a sheep fattening system, the feed consists of forage in both fresh and fermented, and concentrate. The use of straw is also used as a substitute for fresh forage even though it has low protein and high lignin content, it will reduce its digestibility (He et al., 2020).

Black cumin (Nigella sativa L.) is one of the plants that is known as a feed supplement because it has rich oil and contains various phytochemical compositions (Ahmed et al., 2022; Cherif et al., 2018). Basically, black cumin seed has the main function as a human medicine to treat various diseases with its efficacy as a phytopharmacae. In Indonesia, the potential availability of black cumin seed can reach 1.997.779 kg/year based on import number from India and other Middle Eastern countries (Central Bureau of Statistics, 2022). Black cumin seed will be processed into a product of “Habbatussauda essential oil”, this industry produces residue called black cumin meal (BCM). According to (Obeidat, 2021), BCM represents 70-
75% of the essential oil industry. Due to the high number of imported black cumin seed, Indonesia has the estimation of BCM production up to 1.398.445 kg/year. Black cumin meal has high dry matter and crude protein. It also contains the main active ingredient, such as thymoquinone, which functions as an antioxidant and boosts the sheep’s immunity (Retnani et al., 2019). Other active substances found in BCM are tannins and flavonoids (Paarak, 2010). Those active substances and chemical compositions in several doses are expected to increase the ability of rumen microbes to feed degradation. It is also supposed to increase productivity during the increase of body weight and body measurements.

The use of black cumin meal as feed in Indonesia is not commonly used, then the study about BCM has not been carried out on the performance and body measurement of Garut sheep. Previous studies informed that the use of 15% BCM was able to replace soybean meal and increase the body weight gain of Awwasi sheep (Obeidat, 2020). The addition of BCM 20% was also able to improve the performance of sheep fed by elephant grass (Retnani et al., 2019). Therefore, this study aims to evaluate the influence of dietary BCM on the performance and body measurement of Garut sheep.

Materials and Methods

Animals

The object of research used in this study were 28 male Garut sheep aged ± 10 months and initial body weight 20 ± 2.34 kg/head (coefficient of variation <13%). All sheep were housed individually (1.0 x 1.0 m). During the adaptation period, each sheep was cleaned and sheared. They were also given anthelmintic by Veta Bendazole®, injected with vitamin B-Sanplex® and Limoxin-200 LA® at prescribed doses.

Diet preparation and chemical analysis

The study was conducted for 84 d with details of 14 d of feeding adaptation period, and 70 d of feeding trial. The schedule of feeding was carried out 3 times a day, at 07.00 am, 12.00 pm, and 04.00 pm. The diets were based on dry matter, which had been formulated at 3–4% dry matter intake (DMI) requirement from the body weight according to Paul et al. (2003). Those diets were formulated with 30:70 of fermented paddy straw and commercial concentrate, while the black cumin meal formulation replaced the amount of commercial concentrate. During the study, the diets were taken to analyze the chemical composition. For chemical composition determination, all ground diet samples were analyzed for dry matter (DM), ash, crude protein (CP), and ether extract (EE) using AOAC procedures (AOAC, 1990). The neutral detergent fiber (NDF) and acid detergent fiber (ADF) were analyzed following the procedures of Van Soest et al. (1991). Total tannin (TT) was analyzed using the Folin–Ciocalteu method following the procedure of Makkar (2003). Drinking water was provided ad libitum. The formula of diets and chemical composition in the study are provided in Table 1 and 2.

Analysis of performance

Animals were weighed at day 0 and 70 using a digital scale (accuracy 1 kg). The weighing process was carried out in the morning before morning feeding and average daily gain expressed in units of g/head/d. The DMI was calculated daily using a digital scale (accuracy 1 g). The calculation of DMI was carried out by subtracting the amount of dry matter that was given with the remaining dry matter of the residual diet in units of gram (g/head/d). Moreover, feed efficiency was calculated by comparing the average daily gain with DMI and expressed as a percentage (%), it could be calculated using following equation:

\[
\text{Feed efficiency (\%)} = \frac{\sum \text{average daily gain (g)}}{\sum \text{dry matter intake (g)}} \times 100\% 
\]

Body measurements

Body Length is the distance in a straight line from the spinous processus of the highest thoracic vertebrae to the lump of the sieve bone (sitting bone), it was measured using a measuring tape in cm units. Chest circumference was measured by circling the chest cavity through os scapula using a measuring tape in cm. Then the height at withers is the highest distance from the shoulder to the ground, it was measured using a measuring stick in cm (Heriyyadi and Mayasari, 2006).

Experimental design and statistical analysis

The design used was a completely randomized design (CRD) with 4 treatments. Each treatment had 7 replications. Statistical significance for all parameters conducted analysis were set at \( P<0.05 \). The data that showed a significant effect were continued with Duncan’s test. The data were statistically analyzed by one-way ANOVA in IBM SPSS Statistics 26.

Results and Discussion

Performance of Garut sheep

The influence of dietary BCM 0% (T0), 5% (T1), 10% (T2), and 15% (T3) of Garut sheep on performance (DMI, ADG, and feed efficiency) during 70 d of the feeding trial are presented in Table 3. The average initial body weight of Garut sheep in each treatment did not show a significant difference (\( P>0.05 \)). This shows that the sheep given as experimental units were similar. After feeding trial period, they also produced the same final weight (\( P>0.05 \)). Table 3 indicates that dietary black cumin meal had a significant difference to DMI (\( P<0.05 \)). This difference was also followed by ADG (\( P<0.01 \)) and feed efficiency (\( P<0.05 \)).
Table 1. Chemical composition of feed ingredients

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Fermented paddy straw</th>
<th>Commercial concentrate</th>
<th>Black cumin meal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter (%)</td>
<td>31.7</td>
<td>93.5</td>
<td>94.9</td>
</tr>
<tr>
<td>Crude ash (%)</td>
<td>21.0</td>
<td>10.2</td>
<td>6.64</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>7.33</td>
<td>14.7</td>
<td>36.8</td>
</tr>
<tr>
<td>Ether extract (%)</td>
<td>2.04</td>
<td>4.88</td>
<td>5.55</td>
</tr>
<tr>
<td>NDF (%)</td>
<td>56.2</td>
<td>44.4</td>
<td>24.5</td>
</tr>
<tr>
<td>ADF (%)</td>
<td>36.2</td>
<td>26.0</td>
<td>15.5</td>
</tr>
<tr>
<td>Metabolizable energy (MJ/kg DM)</td>
<td>3.38</td>
<td>6.70</td>
<td>6.63</td>
</tr>
<tr>
<td>Total tannin (%)</td>
<td>3.38</td>
<td>6.70</td>
<td>21.6</td>
</tr>
</tbody>
</table>

Analyzed in Laboratory of Research and Experiment Biotechnology, Animal Husbandry Faculty, Universitas Padjadjaran (2023). NDF: neutral detergent fiber; ADF: acid detergent fiber.

Table 2. Ingredients and chemical composition of diets

<table>
<thead>
<tr>
<th>Treatments</th>
<th>T0</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fermented paddy straw</td>
<td>30.0</td>
<td>30.0</td>
<td>30.0</td>
<td>30.0</td>
</tr>
<tr>
<td>Commercial concentrate</td>
<td>70.0</td>
<td>65.0</td>
<td>60.0</td>
<td>55.0</td>
</tr>
<tr>
<td>Black cumin meal</td>
<td>0.00</td>
<td>5.00</td>
<td>10.0</td>
<td>15.0</td>
</tr>
</tbody>
</table>

Chemical composition

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>T0</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter (%)</td>
<td>73.9</td>
<td>74.0</td>
<td>74.1</td>
<td>74.1</td>
</tr>
<tr>
<td>Metabolizable energy (MJ/kg DM)</td>
<td>5.84</td>
<td>5.84</td>
<td>5.83</td>
<td>5.83</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>13.5</td>
<td>13.3</td>
<td>13.1</td>
<td>12.9</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>12.5</td>
<td>13.6</td>
<td>14.7</td>
<td>15.8</td>
</tr>
<tr>
<td>Ether extract (%)</td>
<td>4.03</td>
<td>4.06</td>
<td>4.10</td>
<td>4.13</td>
</tr>
<tr>
<td>NDF (%)</td>
<td>31.0</td>
<td>30.4</td>
<td>29.8</td>
<td>29.2</td>
</tr>
<tr>
<td>ADF (%)</td>
<td>47.9</td>
<td>47.0</td>
<td>46.0</td>
<td>45.0</td>
</tr>
</tbody>
</table>

T0: Fermented paddy straw 30% + commercial concentrate 70% + black cumin meal 0%; T1: Fermented paddy straw 30% + commercial concentrate 65% + black cumin meal 5%; T2: Fermented paddy straw 30% + commercial concentrate 60% + black cumin meal 10%; T3: Fermented paddy straw 30% + commercial concentrate 55% + black cumin meal 15%. NDF: neutral detergent fiber; ADF: acid detergent fiber.

Table 3. Effects of black cumin meal on performance of Garut sheep during 70 d

<table>
<thead>
<tr>
<th>Parameters</th>
<th>T0</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>SEM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial body weight (kg)</td>
<td>21.0 ± 2.70</td>
<td>22.6 ± 0.90</td>
<td>20.6 ± 3.00</td>
<td>18.6 ± 2.75</td>
<td>0.90</td>
<td>0.060</td>
</tr>
<tr>
<td>Final body weight (kg)</td>
<td>30.1 ± 3.23</td>
<td>32.4 ± 2.24</td>
<td>33.0 ± 3.04</td>
<td>29.1 ± 2.77</td>
<td>1.08</td>
<td>0.120</td>
</tr>
<tr>
<td>Average daily gain (g/head/d)</td>
<td>130.0 ± 26.4a</td>
<td>140.0 ± 26.9de</td>
<td>177.1 ± 19.2a</td>
<td>160.0 ± 13.3a</td>
<td>8.18</td>
<td>0.003</td>
</tr>
<tr>
<td>Dry matter intake (g/head/d)</td>
<td>1,128 ± 36.7b</td>
<td>1,181 ± 36.5d</td>
<td>1,200 ± 38.0a</td>
<td>1,180 ± 52.4b</td>
<td>15.8</td>
<td>0.020</td>
</tr>
<tr>
<td>Feed efficiency (%)</td>
<td>11.4 ± 2.12c</td>
<td>11.8 ± 2.43c</td>
<td>14.7 ± 1.58c</td>
<td>13.5 ± 1.44e</td>
<td>0.72</td>
<td>0.017</td>
</tr>
</tbody>
</table>

T0: Fermented paddy straw 30% + commercial concentrate 70% + black cumin meal 0%; T1: Fermented paddy straw 30% + commercial concentrate 65% + black cumin meal 5%; T2: Fermented paddy straw 30% + commercial concentrate 60% + black cumin meal 10%; T3: Fermented paddy straw 30% + commercial concentrate 55% + black cumin meal 15%. SEM: standard error of mean. Mean values were significantly different at (P<0.05).

Average daily gain

The results in Table 3 shows that there was an influence of dietary BCM by the increased average daily gain (ADG) (P<0.01). According to Abdullah and Farghaly (2019) reported that the supplementation of BCM improved the ADG. The control diet (T0) had a lower ADG than T2 and T3 (P<0.01), although it was similar with T1 (P>0.05). Dietary of BCM 10% (T2) was greater to enhance ADG although it was similar compared with the level 15% (T3) (P>0.05). The average daily gain in this study ranged from 130.0 ± 26.4 - 177.1 ± 19.2 g/head/d. Retnani et al. (2019) reported that the ADG of local sheep reached 126.3 g/head/d.

Body weight showed the nutrient intake that could fulfill basic life requirements and production (Khotijah et al., 2014). Average daily gain was also used to determine the growth rate of sheep. The high amount of DMI and palatability of diet could influence the ADG. The higher of ADG of dietary BCM than control (T0) caused by the amount of DMI, which increased the amount of nutrient intake that would be digested in rumen. Nutrient intake is used for the metabolic system in the livestock’s body to fulfill their basic life requirements and increase the body weight. According to Soepriananondo et al. (2007) stated the amount of DMI would determine the amount of nutrient intake.

The diets that have high quality and palatability can quickly increase ADG (Nurjannah et al., 2019). Providing dietary protein balanced with energy would increase the formation of adipose tissue and ultimately increased body weight (Danso et al., 2018). Protein and energy have the main function of supporting body functions and tissue repair processes (Adiwimarta, 2021). Black cumin meal has protein of 36.8%, the high protein in BCM could improve the quality of diet, which caused total protein intake would higher and increase the body weight (Table 1). The protein content of BCM could be used to build muscle in the sheep’s body and increase the body weight.

Dry matter intake

In the current study, dietary BCM could increase DMI (P<0.05) compared with control. However, as BCM levels increased, a similar effect also occurred with increasing DMI (P>0.05). According Obeidat (2020), BCM had a positive effect on DMI. Dietary BCM 10% (T2) was the
optimum level that provided the higher amount of DMI. The DMI in this study was ranged from 1.128 \( \pm 36.7 \) - 1.200 \( \pm 38.0 \) g/head/d. Retnani et al. (2019) reported DMI of local sheep was 864 g/head/d. The higher value of DMI in this study could be speculated by the increased of diet’s palatability.

Palatability is one of the factors that influence DMI and it shows the level of the preference for diet. The texture, color, aroma, and taste that livestock like show that the quality of the feed is very good to increase palatability (Christi et al., 2018). The aromatic components such as phenolics, alkaloids, tannins, and flavonoids, which are good to increase palatability. The aroma from diet plays a role in stimulating livestock to choose the diet quickly without needing to consume it before (Adiwimarta, 2021). Black cumin meal contains tannin, this component would provide an aroma that could stimulate Garut sheep to consume the diet and increased the palatability.

Dry matter intake aims to reach nutrient requirements and determine livestock productivity. The amount of DMI also to determine the amount of nutrient intake of the livestock (Soepranianando et al., 2007). The DMI would provide opportunities for nutrient intake, especially for protein and energy to be utilized by the sheep’s body. Moreover, the treatment of the dietary BCM increased the protein content of the diet, which provided greater opportunities for used by microbes in the rumen and increase the digestibility (Table 2). Tannin component in BCM was also thought to help protein content to be directly digested by the sheep’s body without fermentation by microbes in the rumen. Tannin would be beneficial because it was a bypass protein, which would escape rumen microbial degradation, this protein would be used by the sheep’s body through the post-rumen tract (small intestine) (Sagito et al., 2022). According to (Akbar, 2007), DMI also inseparable from the digestive process, including fermentation in the rumen. If fermentation in the rumen occurred on optimally, this condition would make the rumen contents to be empty quickly and stimulated the livestock to increase consumption.

**Feed efficiency**

Enhanced DMI in this study is followed by the high amount of ADG (Table 3). This proved that the feed conversion into the body weight would reflect the feed efficiency. The increasing of feed efficiency was directly proportional to the amount of DMI and ADG. This condition could affect the small amount of DMI, then it could increase the body weight highly, so that the efficiency value of the diet would increase. Table 3 shows a significant result of the feed efficiency (P<0.05), especially in T2 which similar with T3 compared to T1 and control treatment (T0). The feed efficiency in this study ranged from 11.4 \( \pm 2.12 \) - 14.7 \( \pm 1.58 \) %. It was related to Abri et al. (2022) that the feed efficiency of local male sheep could reach 14.3%.

Feed efficiency is one of the factors in the sheep farming industry, including economic environmental, and social. Obeidat (2020) reported that the inclusion of BCM could reduce the feed costs. This opinion shows that BCM was an efficient source of feed ingredients. A similar thing happened in this study, BCM was able to increase the feed efficiency throughout with increasing of average daily gain and DMI. In addition, compared to wasting them, it might lessen environmental pollution and would be an alternative feed ingredient in sheep farming industry.

**Body measurements of Garut sheep**

The results of body measurements of Garut sheep during 70 d of feeding trial are shown in Table 4. It shows that the average initial body measurements for each treatment did not show a significant difference (P>0.05). After 70 d of feeding trial, there was a significant difference on final body length and chest circumference measurements (P<0.01). However, the final height at withers measurements shows the same similarity (P>0.05). The results indicates that there was a significant difference to enhance the body length gain (P<0.05), dietary BCM also affected on the chest circumference gain and the height at withers gain (P<0.01).

**Body length gain**

The average body length gain of Garut sheep is provided in Table 4. The results shows that dietary BCM affected (P<0.05) on body length gain as long as the increasing of the BCM’s level. The dietary BCM 5% (T1) and 10% (T2) was similar with 15% (T3) and control treatment (P>0.05), while T3 showed the optimum result of the body length gain and significant difference compared with control treatment (T0) (P<0.05).

### Table 4. Effect of black cumin meal on body measurement of Garut sheep during 70 d

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Initial body length (cm)</th>
<th>Final body length (cm)</th>
<th>Body length gain (cm)</th>
<th>Initial chest circumference (cm)</th>
<th>Final chest circumference (cm)</th>
<th>Chest circumference gain (cm)</th>
<th>Initial height at withers (cm)</th>
<th>Height at withers gain (cm)</th>
<th>SEM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>48.0 ± 3.74</td>
<td>50.0 ± 2.38</td>
<td>6.19 ± 2.93</td>
<td>64.43 ± 1.71</td>
<td>67.5 ± 2.28</td>
<td>3.09 ± 1.60</td>
<td>60.8 ± 2.41</td>
<td>63.8 ± 2.26</td>
<td>5.14 ± 1.77</td>
<td>0.007</td>
</tr>
<tr>
<td>T1</td>
<td>50.0 ± 2.38</td>
<td>50.29 ± 0.95</td>
<td>10.01 ± 2.77</td>
<td>67.0 ± 2.16</td>
<td>71.9 ± 2.54</td>
<td>7.62 ± 1.88</td>
<td>60.5 ± 2.41</td>
<td>66.1 ± 3.53</td>
<td>6.71 ± 2.05</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>T2</td>
<td>50.0 ± 2.09</td>
<td>50.8 ± 1.93</td>
<td>11.92 ± 3.20</td>
<td>64.0 ± 3.22</td>
<td>71.83 ± 2.28</td>
<td>8.73 ± 1.77</td>
<td>60.3 ± 3.88</td>
<td>66.1 ± 3.54</td>
<td>6.50 ± 1.64</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>T3</td>
<td>36.7 ± 2.93</td>
<td>40.0 ± 2.38</td>
<td>12.51 ± 3.20</td>
<td>68.63 ± 2.28</td>
<td>75.93 ± 2.54</td>
<td>9.21 ± 1.88</td>
<td>61.3 ± 3.88</td>
<td>66.1 ± 3.54</td>
<td>6.12 ± 0.35</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

T0: Fermented paddy straw 30% • commercial concentrate 70% + black cumin meal 0%, T1: Fermented paddy straw 30% • commercial concentrate 65% + black cumin meal 5%, T2: Fermented paddy straw 30% • commercial concentrate 60% + black cumin meal 10%, T3: Fermented paddy straw 30% • commercial concentrate 55% + black cumin meal 15%.

SEM: standard error of mean. Mean values were significantly different at (P<0.05).

**ab** The value in the same row with different alphabet showed a difference (Duncan multiple test).
The results of this study indicates that BCM in diet increases height at withers and an increase in body weight indicates it.

Conclusion

Based on results obtained, it could be concluded that the influence of dietary BCM in fermented paddy straw-based diet improved performance and body measurement (DMI, ADG, feed efficiency, body length gain, chest circumference gain, and height at withers gain) of Garut sheep compared with the control diet. Dietary black cumin meal 10% is the optimum level to increase the performance and body measurements of Garut sheep. Moreover, more research is needed to find the effect of BCM at different levels on carcass characteristics, cost of gain, and in vitro study of sheep or other ruminants.

Conflict of interest

The authors whose names are listed have no affiliations with or involvement in any organization or entity with any financial interest or nonfinancial interest in the subject matter or materials discussed in this manuscript.

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Author’s Contribution

All authors contributed to the work that is being presented here. KNJ carried out experimental study, collected data and statistical analysis, then prepared the manuscript. IH performed the literature search and reviewed the manuscript. KRGA contributed in writing and reviewing of the manuscript. DRT as the supervisor and designed the experimental study. All authors have read and agreed to the published version of the manuscript.

Ethics Approval

This in vivo study has received approval from the Research Ethics Commission of Universitas Padjadjaran Number: 246/UN6.KEP/EC/2023.

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