Optimizing productivity of fat-tail sheep using single cell protein in concentrate

P H Ndaru¹, Hermanto¹, Kusmartono¹ and A N Huda¹

¹ Faculty of Animal Sciences, University of Brawijaya, Jl Veteran, Malang, Indonesia

poespitasarihn@ub.ac.id

Abstract. Application single-cell protein in ruminant feed has a purpose to fattening, which one of parameter to measure is average daily gain (ADG). The name of single-cell protein in this research is ajitein. The research aimed to evaluate the nutritive value of ajitein toward feed consumption, average daily gain and feed conversion in fat-tailed sheep. In this research, ajitein was mixed with other feedstuffs (soybean meal, pollard, coconut cake, corn bran, palm cake, molasses, urea, and minerals) and the crude protein in this concentrate was isoprotein (22%). The treatments in this research consist of P0: elephant grass (ad libitum) with concentrate; P1: elephant grass (ad libitum) with concentrate (ajitein 2%); P2: elephant grass (ad libitum) with concentrate (ajitein 4%); P3: elephant grass (ad libitum) with concentrate (ajitein 6%). The result showed that the highest feed intake in this research was P0 (104.9 ± 12.90 g / kg BB0.75 / day). Then the higher body weight gains are P0 and P3, with 140 g/head/day respectively. The feed conversion of P3 was 6.6 ± 0.87. The conclusion was P3 had good ability to change the feed to be meat more effective.

1. Introduction

The potential for developing sheep fattening in Indonesia is growing due to an increasing amount of meat demand. Besides, sheep breeding is prospective to be developed in the future because of its easy maintenance, relatively short reproductive cycle, and resistance to disease. Sheep fattening ideally starts when the age of the sheep is less than one year old, considering it is the age when the sheep is in a fast growth phase, ie when feeding will be converted into meat. An important factor that needs to be considered in the process of sheep fattening is feed.

Feed is defined as a substance that can be eaten, digested and used by livestock. The amount of feed consumed by a livestock is one of the important factors that directly affect livestock production. Feed consumption is the number of feed that are eaten by livestock to meet nutrient needs for daily life, growth, and production. Sufficiency of these nutrients can be seen through the weight gain of livestock, making it the benchmarks for assessing feed quality. Knowing feed consumption and body weight gain, we can estimate the feed conversion value. Feed conversion value is used to see the efficiency of feed consumption. The lower the feed conversion value, the better the quality of the feed.

One nutrient requirement in feed that must be considered is protein. In the body of the cattle, protein is used to improve body tissues and produce new tissues [6]. Sheep get protein from feed and microbial protein. Increased protein consumption is also influenced by the protein content in the feed, the higher the protein content, the more protein is consumed. In addition to being associated with the level of feeding, the use of protein is also related to the body weight of livestock. Livestock with low body weight and that are in the growth phase require higher protein than adult livestock that are in the
fattening period [6]. Efforts made to improve the quality of ruminant feed are usually hampered by protein content because high protein feed ingredients have a higher price than the normal feed. Therefore, there is a need for an alternative to using protein feed from non-conventional feed ingredients. Many studies have suggested increasing the protein content in feed by utilizing single-cell proteins.

Ajitein is a single cell protein that has a high protein and amino acid content. Adding Ajitein in feed may reduce the use of soybean and fish flour, resulting in cheaper feed cost. As a conclusion, it is necessary to conduct research on the effect of ajitein as a source of protein used in concentrate on feed consumption, average weight gain (ADG), and the feed conversion of Fat Tailed Sheep. The objectives of this study was to evaluate the nutritive value of ajitein toward feed consumption, average daily gain and feed conversion in fat-tailed sheep and the optimum level of using Ajitein in the ratio of feed concentrate.

2. Material and Methods
The research method used in this study was an experimental method using a completely randomized design consisting of four feed treatments with three replications (table 1). The experiment was carried out by using fat-tailed sheep which were placed in individual cages (metabolic cages). Before entering the metabolic cage, body weight is weighed to classify livestock based on their body weight ie low body weight, moderate body weight, and big body weight.

The treatment in this study is the usage level of Ajitein in concentrate by considering the same protein content (isoprotein). The treatment given to sheep during the study is as follows: P0 = Elephant Grass (ad libitum) + concentrate without Ajitein; P1 = Elephant Grass (ad libitum) + concentrate (Ajitein 2%); P2 = Elephant Grass (ad libitum) + concentrate (Ajitein 4%); P3 = Elephant Grass (ad libitum) + concentrate (Ajitein 6%).

| Feedstuff       | Treatments | P0  | P1  | P2  | P3  |
|-----------------|------------|-----|-----|-----|-----|
| Soybean meal    |            | 8   | 7   | 6   | 5   |
| Pollard         |            | 27  | 25  | 26  | 23  |
| AJITEN          |            | 0   | 2   | 4   | 6   |
| Coconut cake    |            | 26  | 26  | 16  | 14  |
| Corn bran       |            | 27  | 28  | 36  | 40  |
| Palm cake       |            | 5   | 5   | 5   | 5   |
| Material liquid |            | 5   | 5   | 5   | 5   |
| Mineral         |            | 2   | 2   | 2   | 2   |
| Total           |            | 100 | 100 | 100 | 100 |

Data obtained during the study were analyzed using variance analysis (ANOVA). If the treatment has a significant effect on the variables observed, the next analysis will be Duncan's Test.

3. Result and Discussions
3.1. Feed Nutrient Content
The content of DM (dry matter), OM (organic matter), and CP (crude protein) of feed used in the study can be seen in table 2. The content of these nutrients was obtained from the analysis at the Laboratory of Animal Nutrition, Faculty of Animal Sciences, University of Brawijaya.
Table 2. Nutrient contents of fat-tailed sheep feed.

| Treatments       | DM  | OM  | CP  |
|------------------|-----|-----|-----|
| Elephant grass   | 20.2| 85.25| 11.46|
| P0               | 90.59| 91.72| 21.73|
| P1               | 87.24| 91.72| 22.85|
| P2               | 86.88| 92.35| 22.61|
| P3               | 86.76| 91.99| 22.3 |

The CP forage content of elephant grass used in this study is 11.46%. The number of leaves is closely related to cutting age, the older the cutting age, the greater the production of stems. Forages that have the ability to produce a lot of leaves will have good quality, namely high nutritional content and ultimately large digestibility [10]. Production of elephant grass, if it exceeds or passes the age of cutting, will reduce the quality of the forage. To optimize production and maintain quality, cutting must be done on time. Optimal cutting age is 7 weeks or 50 days.

The protein content of the concentrate for each treatment P0, P1, P2, and P3 based on the data above is 21.73%; 22.85%; 22.61% and 22.3% respectively. From these data, it can be concluded that the protein content of the studied feed used is isoprotein. This showed that the protein content in the feed is in accordance with the research method. The protein content is sufficient for the CP sheep needs. The CP concentrate in this study has higher content compared to that in [3] study which added FML (Fermented Mother Liquor) to the concentrate. CP content at P0, P1, P2, and P3 was 19.22%; 19.62%; 20.01% and 20.39% respectively. In general, CP requirement for sheep is 9.6% -19.3% [8]. This requirement declined as the body weight of the sheep increased. The addition of concentrates in livestock rations is an attempt to meet the needs of feed substances for livestock, both protein and energy need, in order to obtain high production. Besides, the use of concentrates can increase digestibility of dry matter ration, increase body weight and efficiency in ration used.

3.2. Feed consumption

Feed consumption is the amount of feed that can be eaten by livestock in a certain time [7]. Consumption is an important indicator in the feed evaluation. Consumption of DM (DMC), OM (OMC) and CP (CPC) for each feed treatment is shown in Table 3.

Table 3. Feed Intake

| Treatments | Feed Intake (g/d) | Total Intake (g/kg BB^{0.75}/day) |
|------------|-------------------|----------------------------------|
|            | DM    | OM    | CP     | DM    | OM    | CP     |
| P0         | 0.972 | 0.867 | 0.179  | 104.90±12.9 | 93.54±11.25 | 19.06±1.75 |
| P1         | 0.846 | 0.749 | 0.153  | 96.31±7.68  | 85.41±7.19  | 17.49±2.17  |
| P2         | 0.889 | 0.791 | 0.158  | 99.02±10.01 | 88.02±8.92  | 17.52±2.21  |
| P3         | 0.915 | 0.811 | 0.162  | 102.93±9.07 | 91.28±7.79  | 18.23±1.63  |

Note: Different superscript were significantly different (P<0.05).

The results of the DM consumption (g/kg BB^{0.75}/day) showed that the addition of Ajitein did not give a significant effect on the consumption of DM. This could be due to the CP and TDN (total digestible nutrient) content in the treatment feed used was similar so that it did not affect the feed consumption.

From the data above, it is known that the total consumption of DM (kg/head/day) for P0, P1, P2 and P3 respectively are 0.972 kg, 0.846 kg, 0.889 kg and 0.915 kg. Dry matter consumption in this study was higher than the results of the study by [3] who used the addition of FML to the concentrate. The dry matter requirement in sheep feeding according to [8] is 500-1000 grams per day with a body
weight of 10-20 kg. Low consumption of total dry matter might be due to the low level of palatability. Palatability is influenced by the smell, taste, texture, and form of feed given to livestock. The factors that affect the palatability for ruminants are the brightness of forage color, taste, texture, and nutrient content. This is influenced by the physical and chemical factors of forage [4]. The amount of the feed consumption depends on palatability, the crude protein content of feed, body size of livestock, type of ration and physiological status of livestock [7]. The more the amount of concentrate given, the higher the amount of feed consumption.

Crude protein consumption for each treatment P0, P1, P2, and P3 respectively are 0.179 kg; 0.153 kg; 0.158 kg and 0.162 kg. The results of variance analysis showed that the treatment had no significant effect on the total CP consumption of livestock (g/kg BW^{0.75} /day). These results showed that the addition of Ajitein levels on experiments may increase the consumption of crude protein. The requirement of crude protein in sheep feeding according to [8] is 114-160 kg, for the body weight of 20-30 kg and daily body weight gain of 100-200 g/head/day. Therefore, it can be concluded that the CP requirement have been met. Protein is an important element in the livestock's body and is needed continuously to repair cells in the synthesis process [2].

Livestock consume feed to meet feed needs. The feed consumption is influenced by several factors, namely the type of animal, type of feed, and the environment. In addition, limited rumen capacity is a factor that influences the consumption of dry matter. Although the data from this study did not show any significant differences, consumption (g/kg BW^{0.75} / day) of DM, OM and CP tended to increase along with the addition of Ajitein in the treatment feed.

Tabel 4. Dry Matter Intake (% Body Weight Gain)

| Treatments | DM Intake (% BB) |  
|------------|-----------------|
|            | Forage | Concentrate | Total |
| P0         | 1.95   | 3.05        | 5.00  |
| P1         | 2.07   | 2.60        | 4.67  |
| P2         | 2.25   | 2.52        | 4.77  |
| P3         | 2.23   | 2.74        | 4.97  |

From the total DM consumption data above, it is known that the total consumption of livestock (% BW) ranges from 4.67-5.00%. The higher the Ajitein levels in the treatment feed may increase the amount of livestock feed consumption. This can be seen from the increase in consumption (% BW) at P1, P2, and P3 in table 4. The ratio between consumption of forage and concentrate for P0, P1, P2, and P3 were 38.96%: 61.04%, 44.33% : 55.67%, 47.17% : 52.83%, and 44.78% : 55.22% respectively. These ratios are still below the normal feeding ratio for fattening.

According to [7], meeting the needs of balanced protein and energy in fattened cattle cannot be obtained from forage feeding only but also from additional concentrate feeding. This is because the concentrate is a source of protein and energy, while forage is only the source of fiber. Therefore, the ration prepared for sheep fattening should consist of fiber and concentrate to complement the needs of livestock and optimized its appearance. The high energy content in feed may cause ruminant to stop eating if the feed needs have been met even though the rumen capacity is still able to accommodate more feed [1].

Addition of Ajitein in sheep feeding does not give a real effect on the level of consumption of DM, OM, or CP. However, the addition of Ajitein leads to the lower use of soybean pulp in the ration. The following is a diagram of the use of soybean pulp in the researched ration.

In P0 (without Ajitein addition), the highest amount of soybean meal used is 8%. This is considered inefficient and requires high feed cost. But in the treatment of P1, P2, and P3 with the addition of Ajitein, the use of soybean meal is lower than P0. In P3, the use of soybean meal is only 5% of the ration, this greatly saves the feed cost. From this argument, it can be seen that the addition of Ajitein at
the level of 2%, 4% and 6% may reduce the use of soybean meal in rations and followed by an increase in the amount of feed consumption.

### 3.3. Average Daily Gain

One factor that influences body weight gain is feed consumption. This is closely related to the nutrients contained in the feed and the level of digestibility of the feed. Rations that have high nutritional value and a good level of palatability may quickly increase body weight gain of livestock during fattening. The average daily weight gain of sheep in each treatment can be seen in Table 5.

| Treatment | ADG (g/head/day) |
|-----------|------------------|
| P0        | 140.00 ± 29.06a  |
| P1        | 120.00 ± 24.04a  |
| P2        | 126.67 ± 40.55a  |
| P3        | 140.00 ± 6.67a   |

Note: Different superscript were significantly different (P<0.05).

The results of the analysis of variance in the data above showed that the treatment had no significant effect (P> 0.05) on the daily body weight gain of sheep. However, it can be seen that the Ajitein addition of 2% to 6% gives a good influence on increasing the average daily gain. ADG of P0, P1, P2, and P3 in this study was 140; 120; 126.67 and 140 g/head/day respectively. The results of ADG are in line with feed consumption, namely DMC, OMC and CPC in Table 3. The increase of Ajitein addition, leads to increased feed consumption, followed by increased ADG.

Changes in body weight data are used as an indicator to determine the nutritional needs of livestock. Increasing and decreasing of feed consumption is usually followed by an increase and decrease in body weight each week. This shows that body weight gain is positively correlated with feed consumption and feed substances.

The amount of feed consumption of sheep will experience a shift in accordance with the BW of the sheep. According to [8], at 10 kg BW, DM consumption of sheep may reach 5% BW and at BW 50 kg the consumption may shift to 3% BW. Based on the value of the shift, it can be seen that each increase of 1 kg BW, DM consumption by sheep may decrease by 0.05% BB.

### 3.4. Feed Conversion

Feed conversion shows the ability of livestock to convert feed consumed into meat. The lower the conversion value, the higher the ability of livestock to turn feed into meat. The results of the variance analysis showed that the treatment did not give a significant effect on feed conversion (P> 0.05) because DM consumption and ADG produced showed no significant effect. Average feed conversion can be seen in Table 6.

| Treatment | Feed Conversion |
|-----------|-----------------|
| P0        | 7.00 ± 0.55a    |
| P1        | 7.23 ± 1.39a    |
| P2        | 7.20 ± 0.88a    |
| P3        | 6.56 ± 0.87a    |

Note: Different superscript were significantly different (P<0.05).

From the above data it can be seen that the feed conversion at P0, P1, P2, and P3 is 7.00; 7.23; 7.20 and 6.59 respectively. The lowest conversion value is 6.59 (P3) which means that to produce 1 kg of
meat requires 6.59 kg of feed. P3 feed conversion value is better than P0. At P0, DM consumption is 972.45 gr/head/day with BWG 140 gr having a conversion value of 7.00 while in P3 the consumption of DM is 914.87 g/head/day with ADG 140 g having a conversion of 6.59. By comparing these two data, it can be seen that sheep feeding using Ajitein addition has the ability to convert feed into meat better than feed with no Ajitein. Although in P0 feed consumption is higher than P3, the ADG produced are the same. Accordingly, it can be concluded that feed with the addition of Ajitein is more efficient and may reduce the feed conversion value. This indicates that the addition of 6% Ajitein in the concentrate is most effective for increasing body weight gain.

This study differs from the research done by [10] which has a higher feed conversion average value of 7.63. This might be due to the use of different protein feed and crude protein content. The CP content in the feed used in this study was 21.73 - 22.3% while the average CP used in [10] study was lower, i.e. 13.60-16.99%.

The feed conversion value estimated in this study is good because according to [5], feed conversion for sheep in tropical regions ranges from 7-15. Sheep in the fattening period, generally have a feed conversion value of 5 to 10. Feed conversion, especially for small ruminants, is influenced by the quality of the feed, digestibility, and efficiency of nutrient utilization in metabolic processes in the body tissues of livestock. The better the quality of feed consumed by livestock, followed by high body weight gain, the lower the conversion value and the more efficient the feed consumption.

4. Conclusion

Addition of Ajitein level may increase feed consumption, body weight gain, and reduce feed conversion value. P3 treatment (6% Ajitein addition) showed the highest consumption and weight gain, as well as low conversion value and is efficient in the use of soybean meal.

References

[1] Akbar N 2018 J Adv Dairy Res. 6:2
[2] Batista E D, Gomes DI, Detmann E and Rufino LMA 2016 Animal Production Science. 57 (10)
[3] Darojah W D 2012 Fakultas Peternakan. Universitas Brawijaya Malang
[4] Forbes J M 2007 Voluntary Feed Intake and Diet Selection in Farm Animals 2nd edn (UK: CAB International, Wallingford)
[5] Gatenby R M 1986 Sheep Production in the Tropics and Sub-Tropics (Singapure: Longman Singapore Publisher Ltd)
[6] Gebreegziabher Z 2016 International Journal of Livestock Research. 6 (04)
[7] Mc Donald P, Edwards R A, Grecham J F D, Morgan C A, Sinclair L A, and Wilkinson R G 2011 Animal Nutrition 7th ed (UK: Prentice hall, Pearson Education Limited, Essex)
[8] NRC 2007 Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids and New World Camelids (Washington, DC : The National Academic Press)
[9] Pittroff W and Soca P 2006 Physiology and models of feeding behavior and intake regulation in ruminants. In: Feeding in Domestic Vertebrates; From Structure to Behaviour (UK:CAB International, Wallingford) Pp. 278-301
[10] Purbowanti E, C I Sutrisno, E Baliarti, S P S Budhi and W Lestariana 2007 Proc. Conf. Animal Veterinary (Bogor : Indonesian Agency for Agricultural Research and Development) p 394-401
[11] Rosendo O, Freitez L and Lopez R 2013 ISRN Vet Sci doi: 10.1155/2013/532528