The growth performance of sheep fed with different wafer feed supplement

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Abstract. Providing wafer feed supplement using ingredients that are easily obtained is one effective way to add nutrients consumed by livestock. This study aimed to evaluate the supplementation of wafer feed supplement derived from lamtoro (Leucaena leucocephala) leaves, bean sprouts, and morinda (Morinda citrifolia) leaves on sheep growth performance. The research used randomized block design with 4 treatments and 3 groups that were differentiated based on the initial body weight. The treatment given consisted of T0: control feed, T1: control feed + 15% lamtoro leaves wafer, T2: control feed + 15% bean sprouts wafer, T3: control feed + 15% morinda leaves wafer. The sheep were fed forage:concentrate with a ratio of 40:60 for 2 months. The results showed that supplementation of wafer feed supplement significantly increased nutrient intake, daily body weight gain, and increased income over feed cost (IOFC). Supplementation of wafer containing lamtoro leaves provides the highest daily body weight gain and IOFC compared to other treatments. This showed that even though there are additional costs for making wafer feed supplement, but this is able to support livestock productivity, so that it can provide greater benefits for farmers.

1. Introduction
The population of Indonesia is predicted to growth and will reach its peak in 2062 which puts Indonesia as the number sixth country with the largest population in the world. This is driven by an increase in livestock products, especially meat as a source of animal protein. Meat needs in Indonesia are met from small-scale farming systems as well as commercial farmers and large beef cattle companies whose target markets are mostly in Java. However, the gap between supply and demand for beef causes an increase in imports of live cattle and meat. The low productivity of national beef cattle in Indonesia is caused by low reproductive rates of cattle because low fertility includes a low conception rate (56%), long delivery intervals (18 to 21 months) and high calf mortality (5% to 10%), low body condition scores, resulting in slow national livestock growth, and due to the high level of sales and slaughter of productive female cattle [1]. In addition, conventional farming systems that are widely applied by small-scale farmers by relying on surrounding food resources have not been able to support the growth of livestock. In fact, the feed factor has a large influence on livestock production, so that the availability of good quality feed is needed. The main limitation of ruminant feed is the low quality of forage feed that affects palatability and digestibility [2].

Lamtoro (Leucaena leucocephala) leaves and morinda (Morinda citrifolia) leaves and market waste such as bean sprouts waste can be used as supplements and minimize the use of concentrates so that the cost of feed becomes lower. The proximate analysis showed that bean sprouts contain 63.35% water, 7.35% ash, 1.17% fat, 13-14% protein, crude fiber 49.44%, and TDN 64.65% [3]. Lamtoro
leaves have crude protein content of 25-32% [4]. Morinda leaves contain dry matter 92.92%, crude protein 21.63%, crude fiber 29.38%, and nitrogen free extract 45.93%. Lamtoro, morinda, and bean sprout waste has several disadvantages as feed, has high water content which lead to perishable product, so the quality as feed decreases rapidly. These ingredients needs to be processed to maintain its quality. One of the processing technologies that is being developed is feed in the form of wafers.

Wafers are compaction of fiber source raw materials that have long and wide dimensions [5]. Previous research on wafers has been carried out by [6] with a modified cuboid forage wafer made with heating and pressing technology with a press machine. Wafers are made in cubes so that they are easy to store and transport during transportation. Feed processing in the form of wafers has been able to preserve and maintain the quality of agricultural waste as feed ingredients [6]. Utilization of wafer processing technology were expected to have good feed palatability so that livestock productivity can increase. This study aimed to evaluate the supplementation of leucaena leaves, bean sprouts, and morinda leaves as wafer feed supplement on sheep growth performance.

2. Materials and methods
This research was conducted at the Laboratory of Feed Industry, Faculty of Animal Science, Bogor Agricultural University and Mitra Tani Farm, Tegal Waru, Ciampea, Bogor. Twelve 1-year-old male local sheep with an average body weight of 24.82±2.04 kg were used in this study.

2.1 Production of Wafer Feed Supplement
The making of wafer feed supplement derived from lamtoro leaves, bean sprouts waste, and morinda leaves are carried out as follows: leaves are separated between leaves and stem leaves. The leaves that have been separated were dried. After drying, the leaves are ground using a grinder into leaf flour. After that, the leaf flour was mixed with additional ingredients using mixer machine. Additional ingredients used are coconut cake, soybean meal, corn gluten meal (CGM), molasses, urea, and CaCO₃. After being homogeneously mixed, the ingredients put into a wafer machine with a temperature of 100-115°C for 10 minutes. Wafers that have been formed were cooled at room temperature and were given to sheep.

| Table 1. Nutrient content of lamtoro leaves, bean sprout waste and morinda leaves. |
|-----------------|--------------------------|--------------------------|
| Parameters      | Lamtoro leaves [7]    | Bean sprouts [3]        | Morinda leaves [8] |
| Dry matter (%)  | 29.90                   | 36.65                   | 26.71               |
| Ash (%)          | 8.50                    | 7.35                    | 9.15                |
| Crude protein (%)| 23.30                   | 1.17                    | 14.13               |
| Crude fat (%)    | 4.00                    | 13.00                   | 2.53                |
| Crude fiber (%)  | 19.90                   | 49.44                   | 23.09               |
| Nitrogen free extract (%) | 44.30                   | 29.04                   | 51.10               |

2.2 Feeding Treatment
Supplementation of wafer feed supplement was carried out for 7 weeks. Feed treatment given were basal feed + wafer feed supplement. Basal feed consists of 60% commercial concentrates and 40% dried kale (Ipomoea aquatica). The nutritional content of the research feed is presented in table 2. Before being fed in the morning, the sheep were given 15% wafers. The sheep are given concentrated feed in the morning and kale in the afternoon. Every morning, the remaining feed is calculated to determine the amount of feed intake.
2.3 Data Analysis

This research used completely randomized block design with 4 feed treatments and 3 groups, as follows:

- T0: control feed
- T1: control feed + 15% lamtoro leaves wafer
- T2: control feed + 15% bean sprouts wafer
- T3: control feed + 15% morinda leaves wafer

Data were analyzed using analysis of variance (ANOVA) and if there were significant differences followed by Duncan test [13].

### Table 2. Nutrient content of control feed and wafer feed supplement.

| Parameters               | Control feed | Leucaena leaves wafer | Bean sprout wafer | Morinda leaves wafer |
|--------------------------|--------------|-----------------------|-------------------|----------------------|
| Dry matter (%)           | 88.94        | 89.28                 | 71.96             | 88.87                |
| Ash (%)                  | 10.75        | 8.24                  | 5.90              | 8.02                 |
| Crude protein (%)        | 14.24        | 32.33                 | 27.11             | 27.01                |
| Crude fat (%)            | 4.22         | 1.67                  | 4.23              | 12.60                |
| Crude fiber (%)          | 19.50        | 10.33                 | 22.65             | 6.99                 |
| Nitrogen free extract (%)| 51.29        | 47.43                 | 40.11             | 45.38                |

3. Results and discussions

3.1 Nutrient intake

The results of the variance analysis showed that the supplementation of wafer feed supplement was significantly increased (P<0.05) the intake of dry matter in male local sheep compared to without wafer supplementation (table 3). This is because the addition of wafer supplements can increase the crude protein content in feed. The high availability of crude protein in feed is thought to increase the activity and growth of rumen microbes so that the process of food degradation in the rumen also increases. The average yield of sheep dry matter intake with the addition of wafers ranged from 1074.60 to 1497.33 g, this value exceeded the standard of dry matter needs of sheep weighing 20 to 30 kg which is 590 to 1030 g [9]. Body size can affect nutrient intake [10]. The higher the body weight, the greater the capacity of the digestive tract [11]. However, the results of this study showed that the average dry matter intake of sheep with a small weight was highest. This was thought to be caused by small weight sheep having rumen microbes that are easily adapted to crude proteins so that the rate of feed degradation is faster.

### Table 3. Average nutrient intake of twelve sheep in each treatments.

| Parameters (g head\(^{-1}\) day\(^{-1}\)) | T0         | T1          | T2           | T3           |
|------------------------------------------|------------|-------------|--------------|--------------|
| Dry matter                               | 808.41±33.40a | 1283.75±204.36b | 1091.41±15.38b | 1317.32±34.42b |
| Crude protein                            | 117.50±7.53a  | 245.07±39.01b  | 199.84±2.82b  | 240.94±6.29c  |
| Crude fat                                | 34.82±2.23a   | 57.38±9.13b    | 53.04±0.75b   | 80.49±2.10c   |
| Crude fiber                              | 160.90±10.31a | 270.23±43.02b  | 249.93±3.52b  | 270.71±7.07b  |
| Nitrogen free extract                     | 423.22±27.13a | 749.84±119.36b | 625.49±8.81b  | 765.36±20.00b |

Notes are referenced using alpha superscripts show significantly different (P<0.05); T0: control feed; T1: control feed + 15% lamtoro leaves wafer; T2: control feed + 15% bean sprouts wafer; T3: control feed + 15% morinda leaves wafer
3.2 Growth performance
The results of the variance analysis showed that daily body weight gain in male local sheep given wafer feed supplement was significantly different (P<0.05) greater than without wafer supplementation (table 4). This is due to the addition of wafer supplements increase dry matter intake and crude protein so the growth of livestock body weight gain increases. Livestock body weight gain was influenced by crude protein intake [12]. The three types of wafer supplements used in this study produce the same weight gain in sheep. However, sheep that were given lamtoro leaf wafer supplements had better feed efficiency than other treatments. If seen from table 2, lamtoro leaf wafers contain higher crude protein than other wafers which causes higher intake of crude protein, which in turn affects the body weight gain and better feed efficiency.

**Table 4.** Average growth performances of twelve sheep in each treatments.

| Parameters                        | T0            | T1            | T2            | T3            |
|-----------------------------------|---------------|---------------|---------------|---------------|
| Initial body weight (kg day⁻¹)    | 23.68±1.53a   | 25.25±2.54b   | 24.73±2.35ab  | 25.62±2.31b   |
| Final body weight (kg day⁻¹)      | 27.28±1.40a   | 34.28±3.66b   | 32.05±1.88b   | 32.92±0.88b   |
| Average daily weight gain (g head⁻¹ day⁻¹) | 73.47±11.77a  | 184.35±64.20b| 149.32±11.24b| 148.98±54.66b|
| Feed efficiency (%)               | 8.97±1.81     | 14.07±2.99    | 13.69±1.22    | 11.24±3.87    |

Notes are referenced using alpha superscripts show significantly different (P<0.05); T0: control feed; T1: control feed + 15% lamtoro leaves wafer; T2: control feed + 15% bean sprouts wafer; T3: control feed + 15% morinda leaves wafer

3.3 Income over feed cost
Income over feed cost is an efficiency measure that possible to measure returns from feed provided to livestock. The supplementation of wafer feed supplement to livestock causes an increase in feed costs, due to the processing process starting from drying to making into wafer forms. However, the increase in feed costs is in line with the improvement in sheep growth performance, so that the income obtained by farmers also increases compared to without wafer feed supplement.

**Table 5.** Average income over feed cost of twelve sheep in each treatments.

| Parameters       | T0            | T1            | T2            | T3            |
|------------------|---------------|---------------|---------------|---------------|
| Buying sheep cost | 1 657 833     | 1 767 500     | 1 731 333     | 1 793 167     |
| Selling price    | 1 909 833     | 2 399 833     | 2 243 500     | 2 304 167     |
| Feed cost        | 1 758 914     | 1 961 509     | 1 901 781     | 1 991 288     |
| Income over feed cost | 150 919⁵     | 438 324⁵     | 341 719⁵     | 312 879⁵     |

Notes are referenced using alpha superscripts show significantly different (P<0.05); T0: control feed; T1: control feed + 15% lamtoro leaves wafer; T2: control feed + 15% bean sprouts wafer; T3: control feed + 15% morinda leaves wafer

4. Conclusion
Supplementation of wafer feed supplement significantly increased nutrient intake, daily body weight gain of sheep, and increased income over feed cost (IOFC) and wafer feed supplement containing lamtoro leaves provides the highest daily body weight gain and IOFC compared to other treatments.
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