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# Effect of Supplementation of Turmeric (*Curcuma domestica*) in Local Feed-based Goat Rations on in Vitro Digestibility

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**ABSTRACT**

Turmeric is a widely available herb. This study aimed to determine the effect of Turmeric (*Curcume domestica*) as an herbal additive in local raw material (LRM) goat rations on dry matter digestibility and organic matter digestibility, pH value, N-ammonia and, *in vitro* gas production. The study was conducted with a completely randomized design (CRD) of 5 treatments and three replications: treatment T0 = LRM goat ration, T1 = local feed ration (LFR) + turmeric 0.025%, T2 = LFR + turmeric 0.05%, T3 = LFR + turmeric 0.075%, T4 = LFR + turmeric 0.1%. Variance analysis showed that the effect of turmeric (*Curcuma domestica*) in goat rations made from LRM local has a significant impact ($P<0.05$) on dry matter digestibility (DMD) and organic matter digestibility (OMD). The most considerable N-ammonia value was obtained in treatment T1, which was 21.13 ± 1.29. From the results obtained, each treatment had a significant effect ($P<0.05$). The provision of turmeric in goat rations showed promising results regarding the value of rumen N-ammonia. The pH value produced in this study was 6.09 to 7.00, with no significant effect because the pH in the rumen has been maintained.
Keywords: Feed additive, turmeric, pH, N-ammonia, in vitro

## INTRODUCTION

The feed cost can account for 60–80% of total production costs. Good nutritional content, digestibility, and the availability of enough components to suit the needs of the cattle are among the requirements for the feed they require [1]. The limitations of forage as the primary source of feed for livestock still cause feed difficulties frequently, necessitating the use

of alternative feed in the form of local raw resources such as agricultural waste, fisheries, cattle, plantations, and industrial waste.

Local feed is a feed ingredient (FI) that can be used as an alternative feed. Local feed raw materials have potential nutritional content as animal feed raw materials and are readily available. However, efforts to use local feed raw materials still encounter obstacles, such as their high crude fiber content, low crude protein content, low amino acid balance, and anti-nutritional substances. Therefore, they must be processed before being used as feed ingredients [2].

Goat rations made locally with 0.5% and 1% turmeric flour can boost the output of hybrid ongole cattle [3]. In Ongole breeders, adding turmeric flour up to 1% dry matter positively impacted feed conversion and average daily weight gain (DWG). It is possible to use turmeric flour at a level of 1.5% in Balinese cattle concentrate because studies by Budiari et al. [4] demonstrated that it can boost body weight gain, ration efficiency, and farmer revenue. The performance of male local sheep fed additional turmeric flour at concentrations of 0.5%, 0.75%, or 1% [5]. When turmeric flour is added, DWG and feed conversion (FC) are often higher than when it is not added. The growth of the treatment group's body weight without turmeric is significantly impacted by the administration of 0.5% turmeric flour. According to Odhaib *et al.* [6], adding 1% and 2% turmeric can help sheep gain weight and become more digestible.

Habeeb and Tarabany [7] also reported that adding turmeric to goat rations can increase DWG. Li *et al*. [8] reported that curcumin and volatile oil in turmeric have antiprotozoal, antioxidant, and anti-inflammatory properties that can improve the digestive process by suppressing the protozoa population in the rumen. The research shows that adding turmeric to the ratio of goats made from LRM significantly affects the DMD and OMD, N-ammonia value, and pH value in vitro.

## MATERIALS AND METHODS

The research was conducted from January to April 2023. The stages of this research involve utilizing turmeric added to goat rations made from LRM as feed additives (FA) *in vitro* through rumen fermentability testing at the Feed Chemistry Laboratory and the Ruminant/Herbivore Nutrition Laboratory, Faculty of Animal Science, Hasanuddin University, Makassar.

### Research Procedures

The In Vitro test was conducted using a two-stage technique based on Tilley and Terry's method [9]. Samples were weighed as much as 0.5 grams and put into the fermenter tube. Dougall's or artificial saliva solution was one of the materials used in this study. This solution served as a pH stability regulator during the fermentation process. The researchers used McDougall's solution mixed with rumen fluid at 4:1 [9]. The mixture of rumen fluid and McDougall's as much as 50 ml were transferred to the fermenter tube and attached to a rubber stopper that was given a gas discharge valve. The fermenter tube was shaken for 30 seconds and then incubated for 48 hours. Then, the fermenter tube was opened, and HCl was dropped until the pH was below 3 to kill rumen microbes. Add 5 ml of pepsin solution, then incubate

again for 48 hours without the rubber cap. The supernatant was discarded after filtering with sintered glass to measure the degradation rate in the rumen system. The residue was oven-dried at 105℃ for 24 hours to obtain dry matter, then ashed at 600℃ in a kiln to determine the organic matter content.

DMD and OMD measurements are calculated based on the formula:

$$\text{DMD (\%)} = \frac{DM\ sample - (DM\ residue - DM\ blank)}{DM\ sample} \times 100\%$$

$$\text{OMD (\%)} = \frac{OM\ sample - (OM\ residue - OM\ blank)}{OM\ sample\ (g)} \times 100\%$$

Description:
DMD = dry matter digestibility
OMD = organic matter digestibility
DM = dry matter
OM = organic matter

After the rumen fluid sample had been fermented and incubated for four hours, the electrode tip of an electronic pH meter was dipped into the liquid to measure the pH until the scale remained constant. After four hours, the fermenter tube was removed from the Shakker water bath.

The concentration of N-ammonia in rumen fluid was determined by the Conway microdiffusion method. A total of 1 ml of rumen fluid supernatant was placed on one of the other sides with 1 ml of saturated $Na_2CO_3$ solution. The Conway cup was positioned so the two did not mix before the cup was closed tightly. In the center of the Conway dish was 1 ml of boric acid solution with an indicator. The cup was then sealed with Vaseline. The supernatant and saturated $Na_2CO_3$ solution were mixed thoroughly by shaking the dish. Ammonia liberated from the reaction will be captured by boric acid, which is shown by a color change. After 24 hours, the ammonium borate was titrated with 0.001 N $H_2SO_4$ solution until a color change occurred from blue to the initial color of boric acid. Figure 1 is a flow chart of Research Procedures.

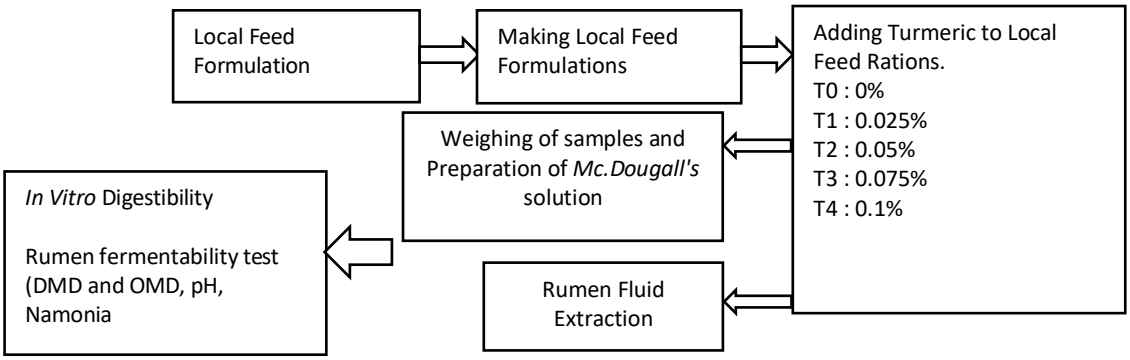


Figure 1: Chart of Research Procedures

## Research Methods

The research was conducted using the Completely Randomised Design (CRD) method with five treatments and four replicates with the following arrangement:

T0 : LFR

T1 : LFR + Herbal additive turmeric 0.025%

T2 : LFR + Herbal additive turmeric 0.05%

T3 : LFR + Herbal additive turmeric 0.075%

T4 : LFR + Herbal additive turmeric 0.1%

Based on the data above, the analysis was obtained using a completely randomized design (CRD), five treatments, and four replicates, and the total sample was 15 experimental units.

## Statistical Analysis

The data were analyzed using a completely randomized design (CRD) with five treatments and four replications [10]. The mathematical model is as follows:

$$Yij = \mu + \text{I} + \epsilon ij$$

Description:

**Yij** = Observation value with i-th treatment and j-th replication

**μ** = Average of observations

$\tau_i$ = Effect of i-th treatment (1,2 and 3)

**I** = Treatment (1,2, 3)

**J** = Repeat (1,2,3,4 and 5)

**ϵij** = Residual effect on the remainder of the i-th and j-th treatments

## RESULTS AND DISCUSSIONS

### Dry matter digestibility (DMD)

The effect of the addition of turmeric (*Curcuma domestica Val*.) in goat rations made from LRM on DMD in each treatment based on the results of analysis of variance showed that the addition of turmeric in goat rations made from LRM had a significant effect ($P<0.05$) on the DMD of the ration. This can be seen in the value of DMD T0 treatment of 52.5%, significantly different ($P<0.05$) to the treatment T1 of 55.2%, T2 of 57.1%, T3 of 54.9%, and T4 of 57.4%. Then, proceed with the orthogonal polynomial test, which has a quadratic response, and get the graph shown in Figure 2.

Based on the graph in Figure 2, the equation y = -531.1x2 + 91.039x + 52.855 and $R^2$ = 0.5136 was obtained (Figure 2). According to this equation, 0.086% with a digestibility value of 56.76% is the ideal number. The degree to which an animal's body uses its diet is indicated by its DMD. Turmeric's curcumin components and essential oils benefit feed digestion, which explains why local feed diets without turmeric had the lowest dry matter digestibility among other treatments. This supports the assertion by Budiari *et al.* [11] that curcumin, present in

turmeric, might enhance animal productivity. Higher levels of curcumin have been shown to improve animal health and antioxidant activity, improving productivity. Additionally, the rhizomes of turmeric plants contain curcumin, which improves food digestion.

The higher the percentage of DMD of a feedstuff, the higher the quality of the feedstuff. The higher rate of DMD indicates that the feed material is easily degraded by rumen microorganisms and the better digestibility [12]. Habeeb and Tarabany [7] also reported that adding turmeric to goat rations can stimulate digestibility and rumen function and increase the absorption of nutrients so that livestock weight gain occurs. Adding 5% turmeric to livestock rations has the potential, both in quantity and good quality, to meet feed needs throughout the year and improve goat performance.

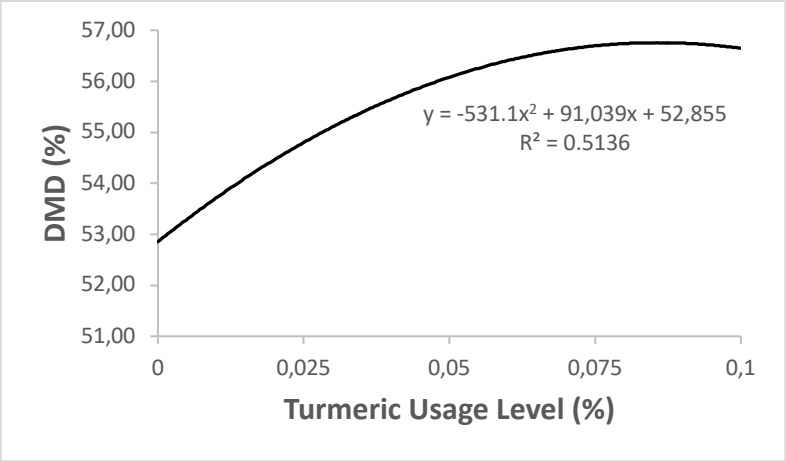


Figure 2. Dry Matter Digestibility

Good protein quality, acceptability, and rationing are linked to high DMD [13]. Energy and nitrogen sources boost rumen microbial activity. Wijayanti *et al*. [14] state that rumen bacteria produce ammonia through the fermentation of nitrogen molecules, and DMD and OMD are directly correlated with rumen ammonia production. According to Khoiriyah *et al*. [15], the microbial community in the rumen influences the degree of digestibility.

**Organic matter digestibility (OMD)**

Based on the analysis of variance, the effect of adding turmeric (*Curcuma domestica Val*) to goat rations made from LRM on the OMD for each treatment showed that the addition of turmeric had a significant effect ($P<0.05$) on the digestibility of ration organic matter. The digestibility value of local feed rations without adding turmeric T0 treatment of 49.4% had the lowest OMD compared to T1 treatment of 51.2%, T2 by 3.5%, T3 by 50.5%, and T4 by 53.0%. Then, the orthogonal polynomial test was carried out, and a quadratic response was displayed in Figure 3.

The equation y = -451.84x2 + 71,216x + 49,659 and $R^2 = 0.3005$ was obtained (Figure 3). From the equation, the optimum value is 0.079%, with a digestibility value of 52.47%. Unlike other treatments, local feed rations that are not added to turmeric have the lowest OMD. This shows that adding herbal additives such as turmeric can also increase the digestibility value of

ration organic matter. According to Rahmawati *et al*. [16], the digestibility value of feed is closely related to the nutrient content in feed ingredients. Hence, the higher the content of complex organic compounds (carbohydrates, fats, proteins, and fiber components) in feed ingredients, the more digestibility usually increases. An increase will follow the increased digestibility value of feed ingredients in livestock productivity.

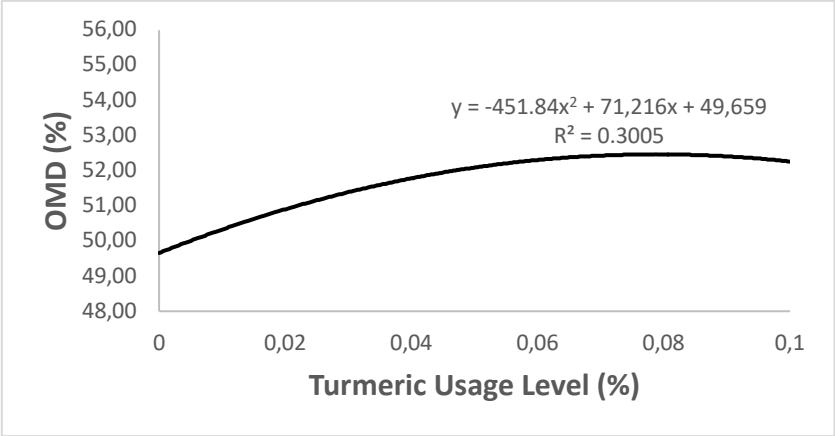


Figure 3: Digestibility of Organic Matter

The activity of microorganisms in the rumen affects digestibility. Ideal rumen conditions are required for bacteria to carry out fermentation activities and boost digestibility efficiently [17]. Digestibility, which has a high value, indicates the amount of nutrients contributed to livestock production and basic living [18].

The digestibility value of organic matter is directly proportional to the digestibility value of dry matter because organic matter is part of dry matter. Most of the DM components consist of OM except ash, so if the dry matter digestibility is high, the digestibility value of organic matter is also high [16]. The higher the dry matter digestibility, the higher the chance of nutrients being utilized by livestock for growth [19].

**Measurement of pH Value and N-ammonia Concentration**

The analysis of variance showed that adding turmeric to the ration of goats made from local raw materials had no significant effect ($P<0.05$) on rumen pH. The results showed that the average treatment of rumen pH obtained was 6.6. The fermentation process in the rumen is maintained due to the presence of salivary secretions that maintain the pH value in the range of 6.5 - 7.0. This research is in line with the research of Indrayanto [20], which states that the pH value is good if all treatments are in the range of 6.5 to 7.0 because the pH value in the range of 6.5-7.0 keeps the fermentation process in the rumen running. The rumen's pH value determines whether or not the rumen conditions are suitable for the fermentation process. The rumen pH value of various ruminants and feeds generally ranges from 5.5 to 7.3 [21]. The pH condition in the rumen varied greatly, influenced by the type of feed consumed by livestock and the degraded substrate [22].

The pH values obtained from all treatments were nearly identical, suggesting that adding garlic has little effect on them. Instead, the environment and rumen microbial development supported this pH value. This supports the finding of Lin *et al*. [23] that the kind and concentration of essential oils did not affect the rumen's pH. The typical pH range for grain and concentrate feed is 5.5–6.5; for forage feed, it is 6-7. Rumen pH has been shown to impact microbial growth, digestibility, and VFA content [24].

Table. 1 Measurement of pH Value and N-ammonia Concentration

| Parameter | Treatment | | | | |
|---|---|---|---|---|---|
| | T0 | T1 | T2 | T3 | T4 |
| pH | 7.11±0.40 | 7.10±0.17 | 7.09±0.56 | 6.10±0.31 | 6.09±0.31 |
| N-amonia concentration | 15.53±2.56$^{b}$ | 21.13±1.29$^{c}$ | 14.82±5.32$^{b}$ | 10.35±1.27$^{a}$ | 14.68±4.00$^{b}$ |

Source: Research Data from Animal Nutrition and Feed Laboratory, Faculty of Animal Science, Hasanuddin University, Makassar 2023.

The increase in temperature will cause the activity of mesophilic bacteria to stop and then be replaced by a group of thermophilic bacteria. With this change, eating ammonia and nitrogen gas will be produced so that the pH value changes to alkaline. In line with the activity of microorganisms in the material, the temperature will rise and eventually produce organic acids. This condition decreases the pH value [25]. The pH value of the in vitro media measured after 4 hours of fermentation is categorized into the optimal pH in the range of 6.9 to 7.0. This is an indicator of a good feed degradation process because, at that pH, microbes producing enzymes that digest crude fiber can live optimally in the rumen [26]. The research of Zhou *et al*. [27] reported that the optimum rumen pH value was 6.56-6.95.

According to Chaturvedi *et al*. [28], the optimum pH value indicates that the feed is well degraded because, at that pH, the microbes producing crude fiber-digesting enzymes can live well in the rumen. This means that feed degradation occurs well, allowing microbes in the rumen to live optimally.

Wanapat *et al*. [29] reported that the range of average pH values, due to using artificial saliva as a buffer, maintained the stability of rumen conditions during the fermentation process. The pH value of the rumen plays an essential role in the fermentation process because it supports microbial growth and produces fermentation products.

**N-ammonia concentration**

Controlling the concentration of N-ammonia in the rumen is very important because it determines the optimization of rumen microbial growth. Rumen $NH_3$ concentration is also one of the benchmarks for assessing feed fermentability and is closely related to rumen microbial activity and population.

Based on the research that has been done, the addition of turmeric in goat rations made from local raw materials has a significant effect ($P<0.05$) on the value of rumen N-ammonia. The results showed that the average value of N-ammonia concentration in T0 was 15.53 ± 2.56, T1 was 21.13 ± 1.29, T2 was 14.82 ± 5.32, T3 was 10.35 ± 1.27 and in T4 was 14.68 ± 4.00. From

the results obtained, each treatment had a significant effect (P<0.05). Giving turmeric in goat rations showed promising results on the value of rumen N-ammonia. Low ammonia concentrations in rumen fluid can reflect the fermentation process [30] that runs well so that ammonia is adequately utilized, ratio protein is difficult to degrade, or low ratio protein content.

The optimum ammonia concentration for microbial protein synthesis in rumen fluid varies widely, ranging from 85-300mg/l to 6-21mM [31]. The lowest ammonia concentration resulted from the T3 treatment. However, the ammonia concentration was statistically significantly influenced by the T0, T1, and T2 treatments. The optimal concentration of N-ammonia for rumen microbial activity ranges from 85-300 mg/l or 6-21 mM. Protein fermentation produces the final product, N-ammonia, which is very important for protein synthesis in the rumen and is partially utilized by microbes for microbial protein synthesis [32] [33].

Low rumen fluid ammonia concentrations may indicate a well-functioning fermentation mechanism that allows ammonia to be used effectively and a difficult-to-degrade ration protein or low ration protein content [26]. Isonitrogen was the ration used in each treatment, and its concentrate crude protein concentration was 18.4%. As a result, the study's low ammonia concentration indicates a successful fermentation process.

## CONCLUSIONS

Adding turmeric (*Curcuma domestica Val*) as an herbal additive to the ration of local goat feed *in vitro* can increase DMD and OMD. N-ammonia concentration and pH value have no significant effect because the pH in the rumen has been maintained, and the pH value of the rumen ranges from 6.09 to 7.00 significantly compared to the ratio without the addition of turmeric flour. Adding 0.05% turmeric herbal additive in local feed rations produced the best DMD and OMD values.

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