The Use of Garlic as Feed Additive in Local Concentrate Feed for Goats on In Vitro Digestibility of Dry Matter and Organic Matter

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Abstract. The study aimed to determine the effect of garlic (*Allium sativum*) as an herbal additive in goat concentrate feed made from local feedstuff on in vitro digestibility of dry matter and organic matter. The study was conducted using a completely randomized design with 5 treatments and 3 replications. Treatment T0 = control, T1 = concentrate feed + 0.025% garlic powder, T2 = concentrate feed + 0.05% garlic powder, T3 = concentrate feed + 0.075% garlic powder, T4 = concentrate feed + 0.1% garlic powder. The analysis of variance showed that the effect of giving garlic (*Allium sativum*) in goat concentrate feed made from local feedstuff had a significant effect (P<0.05) on dry matter and organic matter digestibility. The results showed that the addition of 0.1% garlic in goat concentrate made from local feedstuff increased in vitro digestibility of dry matter and organic matter.

1 Introduction

Feed is one of the factors affecting animal production, it accounts for 60-80% of the total cost of production. The criteria of high-quality feed are nutritive value, well-digestible, and contains various and adequate feedstuff to meet the animal's needs [1]. Feed constraints often happen is limited forage as the main feed source, thus it is necessary to use alternative feedstuff by utilizing local feed resources such as agricultural by-products, animal by-products, aquacultural by-products, and agro-industrial by-products.

The local feed contains local feedstuff that could be a part of concentrate feed or basal diet of livestock. The goat raised and given feed concentrates need additional cost in the small-scale farms. However, to optimize the use of concentrate, it can be added by utilize

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natural feed additives addition in the ration. Indonesia is a tropical country that has various herbs and spices which contain bioactive substances and give a good effect for humans and livestock.

Garlic (Allium sativum) is a herb that may be used as a feed supplement. The community has long recognized the many functions of garlic as a plant, including as natural antibiotic and medication. Because of its organosulfur content, which includes flavonoids, essential oils, ajoene, and allicin, garlic is a good source of feed additives with antibacterial, antifungal, and antioxidant properties. Allicin may have antiviral, antifungal, and antibacterial properties [2].

According to Syafar (2020) [3], adding 1% garlic powder could raise the fermented complete feed's crude protein, fat, and fiber content. The effect of garlic in goat feed concentrate that contains local feedstuff on the in vitro digestibility of dry and organic matter must be observed based on the previously described information.

2 Materials and methods

This research was initiated by formulating and manufacturing concentrate feed at the Laboratory of Ruminant Nutrition. In vitro fermentation was carried out at the Feed Chemistry Laboratory, Faculty of Animal Science, Hasanuddin University, Makassar (Figure 1).

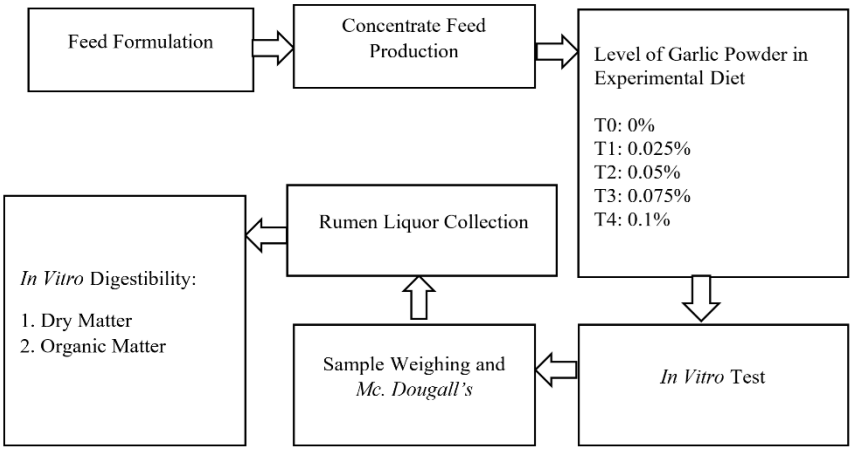

Fig. 1. Research Procedure Chart

2.1 Feed Preparation

The concentrate feed was formulated based on goat nutritional requirement and using local feedstuff obtained from South Sulawesi area. The feedstuff used were corn by product, rice bran, corn meal, palm kernel cake, shrimp head waste, coffee hull, full fat soya, molasses, mineral mix, and salt. Each ingredient was weighed based on formulation and mixed. The ration was ground using blender and dried using an oven for further test.

2.2 Experimental Diet

In order to make garlic powder, the garlic must first be cleaned, then chopped into little pieces and dried. A blender was then used to grind it. Five treatments and three replications were used in the block randomized design of the study. They were T0 = control, T1 =

concentrate feed + 0.025% garlic powder, T2 = concentrate feed + 0.05% garlic powder, T3 = concentrate feed + 0.075% garlic powder, T4 = concentrate feed + 0.1% garlic powder. Adding the garlic powder in the concentrate feed and putting the concentrate feed into a plastic bottle and then shaking it until the garlic powder was evenly mixed, then it was put into a glass jar.

2.3 In Vitro Fermentation

The in vitro test was carried out using a one stage technique according to Tilley and Terry (1963) method [4]. The sample was weighed 0.5 g and put into the fermenter tube. Mc Dougall's solution or artificial saliva solution is one of the materials used in this study. This solution functions as a regulator of pH stability during the fermentation process. The researchers used McDougall's solution mixed with rumen liquor at ratio 4:1 [4]. Transfer 50 ml of the rumen liquor mixture and Mc. Dougall's to the fermenter tube and attach the rubber stopper that has been provided with a gas discharge valve. Shake the fermenter tube for 30 seconds then incubate for 48 hours. After 48 hours of incubation, open the fermenter tube, drop HCl until the pH is below 3 to kill rumen microbes, and adding 5 ml of pepsin solution then incubate again for 48 hours without a rubber cap. The supernatant was discarded after filtering with sintered glass to measure the degree of degradation in the rumen system. The residue was dried using an oven at 105℃ for 24 hours to obtain dry matter. Furthermore, it was ashed at 600℃ in a furnace to determine the organic matter content.

2.4 Statistical Analysis

Data obtained were analyzed using analysis of variance (ANOVA). Dry matter and organic matter digestibility were analyzed according to completely randomized design. Differences between mean tested using the Duncan multiple range test and declared at $P<0.05$ (Gomes & Gomes, 2010).

3 Result and discussion

3.1 Dry Matter Digestibility

The effect of garlic powder (Allium sativum) in the concentrate feed on dry matter digestibility each treatment is shown in Figure 2.

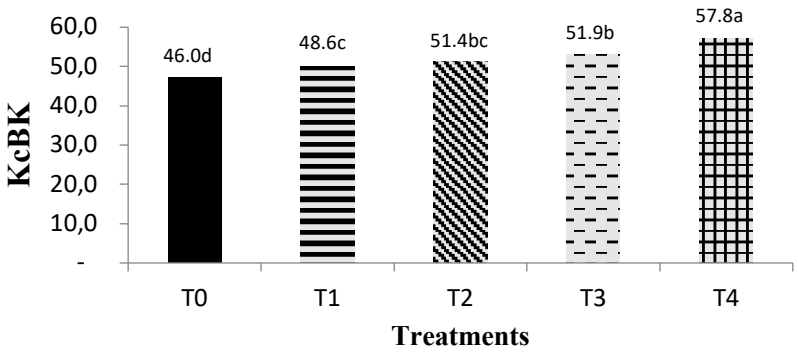

Fig. 2. Treatment effect on dry matter digestibility. [a,b,c,d different superscript significantly affect among the treatments ($P<0.05$)].

T0: Local Concentrate
T1: Local Concentrate + garlic powder 0,025%
T2: Local Concentrate + garlic powder 0,05%
T3: Local Concentrate + garlic powder 0,075%
T4: Local Concentrate + garlic powder 0,1%

Addition of garlic to the goat ration significantly affects in vitro dry matter digestibility, statistically. Duncan multiple range test showed that local feed rations incorporated with 0.1% garlic (T4) had higher dry matter digestibility compared to treatments T0, T1, T2, and T3. The untreated concentrate (T0) had the lowest dry matter digestibility among other treatments, which was due to the organosulfur compounds in garlic indirectly helping to optimize the digestion process of feedstuff. Kekana et. al. (2021), reported alliin and allicin decrease acetate, enhance the formation of propionate, and improve nutrient use efficiency by lowering the production of methane gas [5]. According to Ahmed et al. (2009), adding 2.5% garlic juice improved the dry matter's digestibility, however adding 7.5% dried matter decreased its digestibility [6].

The dry matter digestibility is an indicator to determine the feed ingredient quality. The higher the dry matter digestibility, the greater the nutritive value of the feed ingredient. The process of digestion of feedstuff in the rumen is carried out by microbes. Optimal conditions were needed in the rumen are required for bacteria in carrying out fermentation activities so that the ration consumed by livestock would increase the digestibility of the dry matter [7].

Dry matter digestibility of the rations is influenced by the proportion of each feedstuff, fat and minerals percentage, and the protein content. One part of the dry matter that is digested by microbes in the rumen is structural carbohydrates and non-structural carbohydrates. The high level of crude fat and gaseous substances causes low digestibility [8].

3.2 Organic Matter Digestibility

The effect of garlic powder (*Allium sativum*) in the concentrate feed on organic matter digestibility each treatment is shown in Figure 3.

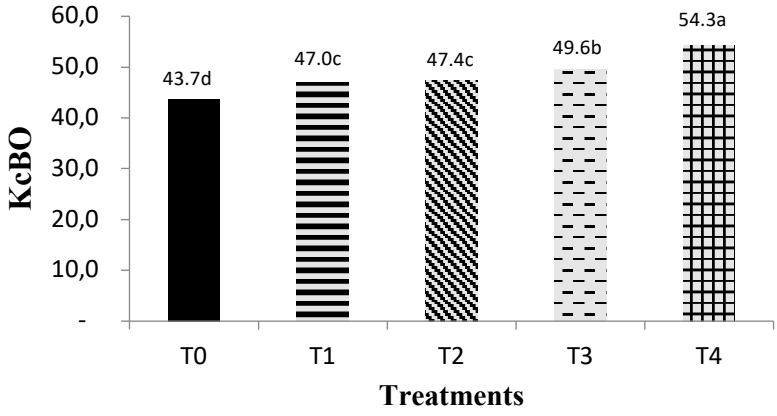

Fig. 3. Treatment effect on organic matter digestibility. [a,b,c,d different superscript significantly affect among the treatments (P<0.05)].

T0: Local Concentrate
T1: Local Concentrate + garlic powder 0,025%
T2: Local Concentrate + garlic powder 0,05%
T3: Local Concentrate + garlic powder 0,075%
T4: Local Concentrate + garlic powder 0,1%

The analysis of variance data showed that the addition of garlic had a significant ($P<0.05$) impact on the organic matter digestibility in goat rations made with local feedstuff. Duncan's test showed that the concentrate feed added 0.1% of garlic (T4) had the highest organic matter digestibility compared to treatments (T0, T1, T2, T3). The untreated feed had the lowest organic matter digestibility among the other treated feed. It is similar to the results performed by Yang et. al. (2007) that supplementation of garlic powder as much as 5g/day/head can increase the digestibility of organic matter from 49.6% to 55.4%, but did not affect the concentration of VFA [9]. It is due to the active substances in garlic in the form of allicin and saponins which are able to stimulate the activity of cellulolytic bacteria. Incorporating lemongrass, peppermint, and garlic powder into ruminant diets may enhance ruminal fermentation characteristics and promote the use of propionate and nitrogen [10].

According to Prayitno and Hidayat (2013), the digestibility of organic matter increased from 44.04% to 45.22% when 250 ppm of garlic extract with Cr [7]. was added to dry basal straw diet. Methanogenic bacteria are directly inhibited and reduced by allicin. However, the total bacteria were unaffected. Allicin, a sulfur-containing compound found in garlic (*Allium sativum*), exhibits potent antibacterial properties by disrupting various bacterial cellular functions. Its mechanisms of action include inhibition of enzymatic activity by reacting with thiol (-SH) groups in bacterial enzymes, such as alcohol dehydrogenase and thioredoxin reductase, leading to enzyme inactivation and disruption of essential metabolic processes [11]. Additionally, allicin causes oxidative stress in bacterial cells by producing reactive oxygen species (ROS), which damages proteins, lipids, and DNA. This leads to a breakdown of cell membrane integrity by weakening bacterial cell membranes, increasing their permeability, and causing the leakage of vital cellular contents, ultimately resulting in cell death [12]. According to Nakamoto et. al. (2020), allicin can also inhibit biofilm formation by interfering with quorum sensing, a communication system bacteria use to coordinate group behaviors, thereby inhibiting biofilm formation and reducing bacterial resistance to treatments [13].

The increasing organic matter digestibility is influenced by the microbial population. Bata (2008) reported that the organic matter digestibility of ammoniated rice straw with molasses addition was higher than untreated rice straw [14], it was due to nitrogen availability provided by ammoniated rice straw for microbial protein synthesis. The higher the microbial population, the higher the fermentation product (VFA and NH3) produced. Abd El Tawab et al. (2020), reported that ruminants can benefit from the usage of herbal mixtures [15]. Thyme and celery, for example, can enhance ruminal fermentation and lower gas production without compromising nutrient degradability.

The addition of garlic into goat concentrate feed made from local feedstuff had a significant ($P<0.05$) effect on the digestibility of organic matter in the rations. Duncan multiple range test showed that local feed rations with the addition of 0.1% garlic (T4) had the highest organic matter digestibility compared to other treatments (T0, T1, T2, T3). Control (T0) had the lowest organic matter digestibility among the other treatments. This outcome is comparable to that of Yang et al. (2007), who found that supplementing with 5 g/day/bird garlic powder improved organic matter digestibility from 49.6% to 55.4% without affecting VFA content [9]. Allicin and saponins, two of garlic's bioactive substance, cause cellulolytic bacteria to become more active. Prayitno and Hidayat (2013), supplementation of 250 ppm of garlic extracts into the basal feed of fermented rice straw enriched with Cr was

able to increase the digestibility of organic matter from 44.04% to 45.22% [7]. Garlic can lower methane generation through allicin, which directly lowers methanogenic bacteria without affecting the number of bacteria.

4 Conclusion

According to the findings, the in vitro digestibility of dry matter and organic matter was enhanced when 0.1% garlic powder was added to goat's concentrate feed.

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This research receives no external funding.

Data availability statement
The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author contribution statement
Mita Arifa Hakim: Conceptualization, Methodology, Investigation, Writing- Original draft preparation. Ummul Khasanah: Data curation, Writing- Reviewing and Editing. Ahmad Rifai: Investigation, Writing- Reviewing and Editing. Jamila Jamila: Investigation, Writing- Reviewing and Editing. Syahriani Syahrir: Investigation, Writing- Reviewing and Editing. Asmuddin Natsir: Investigation, Writing- Reviewing and Editing.

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