Dry matter, organic matter, crude protein, and crude fibre digestibility of local goats supplemented with herbs and humic acid

Dwatmadji Dwatmadji[a*], *Tatik* Suteky[a], *Edi* Soetrisno[a], *Novi Yanti* Situmorang[a], *Elsa Hotdiantama* Sitinjak[a]

[a]Department of Animal Science, Faculty of Agriculture, University of Bengkulu – Indonesia

Abstract. This study was conducted to investigate the effects of herbs and humic acid supplementation on Dry Matter, Organic Matter, Crude Protein, and Crude Fibre digestibility of local goats. Twenty-four growing female goats were randomly allocated in completely randomized design experiments with 4 treatments and 6 replications. The 4 treatments were the addition of herbs with No humic acid (T-0), Herbs + 2 g humic acid/goat (T-1), Herbs + 4 g humic acid/goat (T-2), and Herbs + 6 g humic acid/goat (T-3). The herbs used were a mix of Melastoma malabatrichum, Andrographis paniculata, Curcuma longa, and Nigella sativa. All goats were given the same amount of Tofu waste, fermented Palm Oil Sludge, and grasses. Feed offer, feed residue, fecal output, and digestibility were measured during a 7-day measurement period, with an adaptation period of 3 weeks. Data were analyzed using analysis of variance followed by Duncan's post-hoc test. Results showed no difference among all treatments on the intake of dry matter intake and organic matter, crude protein, and crude fiber. ADG and DMI/metabolic body weight of T-1 were significantly higher than that of the other treatments. The addition of herbs and humic acid tended to increase dry matter intake per metabolic body weight and increased significantly ($P<0.05$) for all feed digestibility measures. The digestibility of goats with supplementation of herbs and humic acid 2 g/goat (T-3) was significantly higher ($p<0,05$) than that of all treatments. It could be concluded that a combination of herbs and 2 g humic acid supplementation improves the digestibility of local goats.

1 Introduction

Adequate nutrition is needed for maximum productivity, and efficient feed will increase the farmer's profits. In tropical climates, natural pastures that have low-quality grasses are typically the main sources of feed for ruminant cattle, with limited availability during the dry season [1]. Therefore, other sources of feed are needed. Palm Oil Sludge (POS) is waste that causes environmental problems/pollution for the community but at the same time can be used for animal feed [2] [3]. To increase nutritional value and reduce the rancid of POS palm waste, a fermentation process is very necessary.

* Corresponding author: Dwatmadji.2008@gmail.com

Optimal nutrients for livestock that are following their physiological needs throughout the year are the main key to livestock productivity. The use of herbs rich in secondary metabolic substances will increase feed absorption, microflora balance improved bioavailability/bioenhancing of nutrients, and feed efficiency [4]. It has been demonstrated that these plants and herbs can control ruminal fermentation and enhance ruminant nutrition uptake. There are several pharmacologically active substances found in herbs, however, the most commonly utilized for rumen modulation are tannins, saponins, flavonoids, and essential oils [5].

It has been observed that Melastoma spp. Contains about 142 different chemicals, including terpenoids, organic acids, phenylpropanoids, flavonoids, and steroids [6]. Their chemical compounds showed their pharmacological activities, including antibacterial, antioxidant, gastroprotective, and hepatoprotective [6] [7]. The extract of Melastoma malabatricum administration as a natural gastrointestinal infection for goats naturally infected with those parasites indicated comparable results to the positive control (single dose ivermectin) in terms of feed digestibility [8].

Ref. [9] reported that supplementation with Andrographis paniculata on Boar goats improved feed utilization and absorption of nutrients by the animal. Ref. [10] inclusion of Melastoma malabathricum and Andrographis paniculata enhances the heat and humidity tolerance of Bali cattle. The annual herb Nigella sativa (NS) is widely recognized for its medical properties and is used worldwide. It is regarded as a natural substitute for antibiotics that can enhance animal health ([11]. The body weight, average daily gain, nutritional digestibility, and rumen fermentation activity of lambs were all enhanced by the partial substitution of Nigella sativa meal for cottonseed meal in their diet [11].

Karadi lambs' rumen ammonia-nitrogen decreased when supplemented with Nigella sativa oil [12] without affecting their digestibility. The effect of herb supplementation has not been consistent on feed digestibility so [4] it is very necessary to formulate feed supplementation that can improve feed digestibility and efficiency. The effectiveness of feed supplements that alter the rumen environment to enhance ruminal fermentation and improve nutrient utilization in ruminants has been the subject of extensive investigation [13].

Humic acid is a natural additive obtained from the process of biodegradation by microorganisms. Which has a positive effect on the microorganism's composition in the ruminants' digestive tract. Humic acid (HA) has the potential to modify the ruminal fermentation pattern by altering the ruminal fermentability to more effective end products [14]. The addition of HA improved intake and diet digestibility without adverse effects on rumen fermentation profiles in Damascus goats [15]. Ref. [16] found that supplementing cattle with HA significantly reduced fecal N excretion, and favorably enhanced CP digestibility and N retention. This research aimed to evaluate the DM, OM, CP, and CF digestibility of local goats supplemented with herbs and humic acid.

2 Materials and Methods

The experiment was conducted on a research farm in Seluma, Bengkulu Province, Indonesia. The collected samples were prepared in the Animal Science Department, University of Bengkulu, while the proximate analysis was conducted in the Microbiology and Biochemistry Laboratory, the University of IPB, Bogor.

2.1 Animals and Feeding Treatment

Twenty-four 10-month-old thin-tail sheep, weighing 19.1 + 1.2 kg and having similar Body Condition Score. All 24 animals were divided into 4 treatments with 6 animals each, namely. The 4 treatments were:

T-0: No herbs and No humic acid,
T-1: Herbs + 2 g humic acid/goat,
T-2: Herbs + 4 g humic acid/goat, and
T-3: Herbs + 6 g humic acid/goat.

The herbs used were a mix of Melastoma malabatrichum, Andrographis paniculata, Curcuma longa, and Nigella sativa. All goats were given the same amount of Tofu waste, fermented Palm Oil Sludge, and grasses. Feed offer, feed residue, fecal output, and digestibility were measured during a 7-day measurement period, with an adaptation period of 3 weeks. Fresh Pennisetum purpuroides grass was provided ad libitum and all animals were housed in metabolic cages with 2% body weight supplementation. There was also free access to drinking water. The 21-day research period was divided into two parts: a 14-day adaptation period and a 7-day collection period. Every day, samples of feed that were provided, feed waste, and feces were gathered, dried in the sun to remove water, stored, and evaluated for crude protein (CP), energy, dry matter (DM), organic matter (OM), and crude fiber (CF).

2.2 Evaluation of digestibility

Feed digestibility was assessed using the complete collection approach, which involved putting the lambs in the metabolic pen every day to collect their waste. After the excrement was weighed, up to 10% of it was collected as a sample, dried in the sun, crushed, and stored for analysis. The crude protein, crude fiber, crude fat content, and DMI were measured using the Association of Official Analytical Chemists Official (AOAC) technique. This formula was used to calculate the feed's digestibility:

$$\text{Digestibility} = \frac{\text{Nutrition consumed} - \text{Nutrition excreted in the faeces}}{\text{Nutrition Consumed}} \text{X } 100\%$$

2.3 Statistical analysis

One-way analysis of variance [16] was used to analyze the data from this investigation, and SPSS for Windows (IBM Corp., USA) was used for the analysis. Duncan's Multiple Range Test was used to identify significant treatment means, which were indicated by $p<0.05$.

3 Results and Discussion

It is apparent in the present study that increasing humid acid did not increase the DM, OM, CP, and CF intake (Table 1) as the DMI (g/day) of all treatments were not different, The result of DMI in this experiment were somewhat similar to Degirmencioglu [17] where the addition of humid acids on goats (with 0, 1.0, and 3.0 g humid acid kg^{-1} on live weight) has also no significant changes to goats. These results could be due to herb supplementation not affecting DMI [18]. [19]. also reported that herbal mixture has no effect on the feed intake of Shami goats with DM intake 80.57-85.36 g/Kg $^{0.75}$, OM intake 71.3-75.61, g/Kg $^{0.75}$, and CP intake 14.88-15.76 g/Kg $^{0.75}$.

In contrast, DMI (%/LW) of T-1 was higher compared to T-0, T-2, and T-3. It seems that the addition of 2 g humic acid increases DMI (%/LW), DMI, Crude protein, and crude fiber per metabolic LW. According to Kholif et al. [20] humic acid, supplementation can improve feed utilization.

Table 1. Intake, fecal output, apparent digestibility, digestible intake of DMI, OM, CP, and CF of fed different humid acid concentrations of the experiment.

	Treatments					
Intake (g/animal)/day	**T0**	**T1**	**T2**	**T3**	**SEM**	**P value**
DM	677.0	755.5	662.8	653.4	20.29	0.28
OM	531.8	593.3	531.7	531.8	10.63	0.42
CP	138.3	152.0	134.7	133.0	2.19	0.29
CF	102.4	115.9	101.0	99.0	3.21	0.15
DMI(%LW)	3.16^{ab}	3.46^{b}	3.05^{ab}	2.99^{a}	0.05	0.05
Intake / LW $^{0.75}$						
DM	67.69^{ab}	74.51^{a}	65.71^{b}	64.71^{b}	1.45	0.05
OM	53.20	58.52	52.71	52.57	1.09	0.16
CP	13.78^{a}	15.00^{b}	13.36^{a}	13.11^{a}	0.30	0.05
CF	10.56^{a}	11.05^{b}	9.44^{a}	9.36^{a}	0.28	0.05
Faecal output/ LW $^{0.75}$						
DM	24.80^{a}	25.67^{a}	23.34^{ab}	20.55^{b}	0.65	0.05
OM	19.39^{ab}	20.44^{b}	19.05^{ab}	16.82^{a}	0.49	0.05
CP	5.15^{a}	4.70^{a}	4.10^{a}	3.45^{b}	0.17	0.01
CF	6.57	6.76	5.94	6.31	0.16	0.32
Apparent Digestibiity (%)						
DM	63.18	65.50	64.51	68.18	0.71	0.06
OM	63.35	65.01	63.90	67.98	0.70	0.06
CP	62.72^{a}	68.61^{a}	68.08^{a}	76.04^{b}	1.31	0.01
CF	64.82^{a}	67.31^{b}	59.61^{a}	63.77^{a}	1.09	0.05
Digestible intake (g/day)						
DM	431.1	495.3	427.3	446.0	15.14	0.38
OM	276.5	323.0	272.8	304.1	0.03	0.46
CP	86.25	104.04	93.25	97.60	3.17	0.06
CF	65.85^{a}	79.65^{b}	62.84^{a}	68.06^{a}	3.1	0.05

It is interesting to note that the CP fecal output of T-3 was significantly lower ($P<0.05$) than that of the T-0, T-1, and T-2, resulting in higher CP apparent digestibility than other treatments. This result in CP utilization could be due to the ability of humic acids to enhance CP digestibility and N retention [16]. The excretion of fecal N (g/d) decreased linearly ($P < 0.04$) as the quantity of HS increased [16]. In addition to boosting the capacity to bind nitrogen and lowering its excretory rate, humate material may also impede urease activity in the rumen, reducing N degradability and increasing its consumption. It is known that humic acids boost the availability of microbial protein by reducing the number of ciliate protozoa in the rumen [21].

Table 2. Initial live weight of sheep fed with different humid acid concentrations of the experiment.

	Treatments					
	T-0	**T-1**	**T-2**	**T-3**	**SEM**	**P value**
Initial LW (kg)	22.34	22.17	21.89	21.98	1.36	0.293
ADG (gr/day)	72.38^{b}	101.43^{c}	71.19^{b}	53.10^{a}	4.06	0.01
FCR (%)	9.53^{b}	7.45^{a}	9.35^{b}	12.59^{c}	0.49	0.05

A better FCR value was obtained by T-1 because its ADG was significantly higher ($P<0.5$) than that of the other treatments. Better feed usage efficiency was indicated by a lower FCR. Goats' ADG was considerably enhanced when herbs (*Curcuma longa*) were added to their diet [10].

4 Conclusion

In conclusion, the supplementation of herbs and humic acid 2 g/goat has improved the DMI (%LW), reduced CP fecal output, and improved apparent digestibility. The supplementation of herbs and 2 g humid acid has also improved the ADG and FCR values. It could be concluded that a combination of herbs and 2 g humid acid supplementation showed the best result in this experiment.

Acknowledgments

The author expresses gratitude to Bengkulu University's Faculty of Agriculture for funding this study under "Penelitian Unggulan Fakultas Pertanian 2022 contract No. 5638/UN30.11/LT/2022."

References

1. Khaing, K.T., T.C. Loh, S. Ghizan, and R. Halim. 2015. Feed intake, growth performance and digestibility in goats fed whole corn plant silage and Napier grass," Malaysian J. Anim. Sci., 18 (1): 87–98.
2. Elisabeth. J dan S. P. Ginting. 2003. Pemanfaatan hasil samping industri kelapa sawit sebagai bahan pakan ternak sapi potong. Pusat Penelitian Kelapa Sawit. Sumatera Utara.
3. Sinurat, A. P., I. W. Mathius, dan T. Purwadaria. 2012. Pengolahan Hasil Samping Industri Sawit Sebagai Bahan Pakan, no. November 2013. 2012.
4. Patil, P.N. 2009. Herbal cattle feed supplement compositions for enhancing productivity and quality of milk by improved bioavailability," 2009.
5. Kuralkar, P. and S. V. Kuralkar. 2021. Role of herbal products in animal production – An updated review," Journal of Ethnopharmacology, 278.doi: 10.1016/j.jep.2021.114246.
6. Zheng, Wen-Jun., Ying-Shan Ren, Miao-Li. Wu, Ya-Ling Yang, Yi. Fan, Xiu-Hong Pi, Yue-Wei Ge, Shu-Mei Wang. 2021. A review of the traditional uses, phytochemistry and biological activities of the Melastoma genus," Journal of Ethnopharmacology, vol. 264. 2021, doi: 10.1016/j.jep.2020.113322.
7. Danladi, S. A. Wan-Azemin, Y. N. Sani, K. S. Mohd, M. Rao, S. M.Mansor and S. Dharmara. 2015. Phytochemical screening, antioxidant potential, and cytotoxic activity of Melastoma malabathricum linn. from different locations," Int. J. Pharm. Pharm. Sci., 7(7): 408–413.
8. Suteky, T., Dwatmadji, Hidayat, and D. Sanata. 2018. Effects of Melastoma malabatricum extract on nutrient digestibility of local goat infected with gastro intestinal parasites concise and informative," Int. J. Agric. Technol. 14(7): 2014–2026.
9. Yusuf, A. L., Y. M. Goh, A. A. Samsudin, A. R. Alimon, and A. Q. Sazili. 2014. Growth performance, carcass characteristics and meat yield of Boer goats fed diets containing leaves or whole parts of Andrographis paniculata," Asian-Australasian J. Anim. Sci., 27(4): 503–510, doi: 10.5713/ajas.2013.13533.
10. Dwatmadji, T. Suteky., Hidayat and D. Sanata. 2020. Intake and digestibility of mix-herbal supplement blocks for Bali Cattle fed with agricultural by-product in Bengkulu, Indonesia," Int. J. Agric. Technol.16 (1): 37–48.
11. Abdulah, M. A. M. and M. M. Farghaly. 2019. Impact of Partial Replacement of Cottonseed Meal by Nigella," Egypt. J. Nutr. Feed. 22:11–20.

12. Mustafa, K. N., H. M. Hidayet, and C. A. Yateem. 2022. Effect of Supplementation of Nigella Sativa Oil on Nutrient Digestibility, Some Blood Metabolites and Rumen Parameters in Karadi Lambs," Yuz. Yil Univ. J. Agric. Sci. 32(3): 584–590. doi: 10.29133/yyutbd.1104782.
13. Ikyume, T., A. O. Oni, A. O. Yusuf, O.S. Sowande and S. Adegbehin. 2020. Rumen Metabolites and Microbiome of Semi-intensively Managed West African Dwarf Goats Supplemented Concentrate Diet of Varying Levels of Sodium Humate," Egypt. J. Vet. Sci., 51(2): 263–270, 2020, doi: 10.21608/ejvs.2020.23856.1151.
14. El-Zaiat, H. M., A. S. Morsy, E. A. El-Wakeel, M. M. Anwer, and S. M. Sallam. 2018. Impact of humic acid as an organic additive on ruminal fermentation constituents, blood parameters and milk production in goats and their kids growth rate," J. Anim. Feed Sci. 27(2): 105–113 doi: 10.22358/jafs/92074/2018.
15. Sallam, S.M.A., M.A.M. Ibrahim, A. M. Allam, A.M. El-Waziry, M. F. A. Attia, M. A. Elazab, Amr E. A. El-Nile and H. M. El-Zaiat. 2023. Feeding Damascus goats humic or fulvic acid alone or in combination," Trop. Anim. Health Prod. 55: 265. https://doi.org/10.1007/s11250–023, 2023.
16. Terry, S. A., Ribeiro, G. de O., Gruninger, R. J., Hunerberg, M., Ping, S., Chaves, A. V., Burlet, J., Beauchemin, K. A., and T.A. McAllister. 2018. Effect of humic substances on rumen fermentation, nutrient digestibility, methane emissions, and rumen microbiota in beef heifers. Journal of Animal Science, 96(9): 3863–3877. https://doi.org/10.1093/jas/sky265
17. Degirmencioglu, T. 2012. "Possibilities of using humic acid in diets for Saanen goats," Mljekarstvo. 62(4): 278–283.
18. Wanapat, M., S. Kang, P. Khejornsart, and S. Wanapat, 2013. Effects of plant herb combination supplementation on rumen fermentation and nutrient digestibility in beef cattle," Asian-Australasian J. Anim. Sci. 26(8): 1127–1136. doi: 10.5713/ajas.2013.13013
19. Rabee, A.E., M. M. M. Ghandour, A. Sallam, E. A. Elwakeel, R. S. Mohammed, E.A. Sabra, A. M. Abdel- Wahed, D. M. Mourad, A. A. Hamed and O.R. Hafez. 2024. Rumen fermentation and microbiota in Shami goats fed on condensed tannins or herbal mixture," BMC Vet. Res., 20 (1):1–17. doi: 10.1186/s12917-024- 03887-2.
20. Kholif, A. E., O. H. Matloup, E. A. EL-Bltagy, O. A. Olafadehan, S. M. A. Sallam, and H. M. El-Zaiat. 2021. Humic substances in the diet of lactating cows enhanced feed utilization, altered ruminal fermentation, and improved milk yield and fatty acid profile: Humic acid in the diet of lactating cows," Livest. Sci.253: 104699, 2021, doi: 10.1016/j.livsci.2021.104699.
21. Helmy, S.A., H. M. Ebeid, M. A. Hanafy, A. E. M. Mahmoud, and R. R. A. El-Tanany. 2022. Rumen Parameters, Nutrients Digestibility and Milk Production of Lactating Boer Goats Fed Diets Containing Clay Minerals," Pakistan J. Biol. Sci., 25(8,):755–764, 2022, doi: 10.3923/pjbs.2022.755.764.