IOP Conference Series:
Earth and
Environmental Science

PURPOSE-LED PUBLISHING™

PAPER • **OPEN ACCESS**

The effect of *Leucaena leucocephala* leaves supplementation in high proportion concentrate ration on blood glucose and urea nitrogen of lactating dairy cow

To cite this article: Dimas Fajar Nugroho *et al* 2026 *IOP Conf. Ser.: Earth Environ. Sci.* **1625** 012034

View the article online for updates and enhancements.

You may also like

- *In silico* approach to predict antidiabetic activity of bioactive peptide from *Leucaena leucocephala* seed during gastrointestinal digestion
Dwi Ishartani, Danar Praseptiangga, Setyaningrum Ariviani et al.
- The effects of leguminous supplementation on ammoniated rice straw based completed feed on nutrient digestibility on *in vitro* microbial protein synthesis
Mardiati Zain, Rusmana W S Ningrat, Erpomen et al.
- Physicochemical test of leucaena leucocephala pellets using various types of adhesives
Syamsuddin, W Kurniawan, M Syaikrullah et al.

This content was downloaded from IP address 87.49.43.243 on 04/10/2026 at 17:24

IOP Conf. Series: Earth and Environmental Science **1625** (2026) 012034 doi:10.1088/1755-1315/1625/1/012034

The effect of *Leucaena leucocephala* leaves supplementation in high proportion concentrate ration on blood glucose and urea nitrogen of lactating dairy cow

Dimas Fajar Nugroho[1], Yuni Suranindyah[2]* and Andriyani Astuti[3]

1 Department of Animal Nutrition and Feed Science, Faculty of Agriculture, Lambung Mangkurat University, Banjarmasin, Indonesia

2 Department of Animal Production, Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta, Indonesia

3 Department of Animal Nutrition, Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta, Indonesia

*E-mail: yuni.suranindyah@ugm.ac.id

Abstract. This study evaluated the effect of *Leucaena leucocephala* leaves supplementation on nutrient consumption and blood profile of lactating dairy cows. Twelve lactating Friesian Holstein Crossed were used in the experiment for 60 days observation in "Mawar Mekar Farm" Karanganyar, Central Java. The treatments were P0, P1 and P2. Dairy cows in P0 were given basal ration which contained dry matter (DM) as 3% of body weight. The basal ration consisted of a 40:60 ratio of forage to concentrate based on DM. Treatments P1 and P2 consisted of a basal ration, and respectively supplemented with 10% and 20% *Leucaena leucocephala* leaves, as a proportion of the forage DM. Data were collected on DM and crude protein (CP) consumption, blood glucose and urea nitrogen concentration. The result showed that the consumption of DM and CP, as well as urea nitrogen in blood of cows in P1 and P2 significantly higher than P0 ($P < 0.05$), but blood glucose was not affected by treatments. The level of blood glucose in P0, P1 and P2 were 55.1; 54.9 and 53.5 mg/dL, respectively, while for urea nitrogen were 15.40; 20.10 and 26.50 mg/dL. In conclusion, adding *Leucaena leucocephala* leaves at a level of 10% of DM forage, is effective in maintaining blood glucose within physiological range, and achieving moderate level of blood urea nitrogen of dairy cows that received ration with a high proportion of concentrate.

1. Introduction

One of the challenges of producing dairy cattle in tropical regions is the fluctuation in the availability and quality of forage. Low forage production, particularly during the dry season, often leads to increase concentrate utilisation in the ration, which can potentially cause changes in rumen digestion. The quality of concentrate for dairy cows was determined by its protein content.

Content from this work may be used under the terms of the Creative Commons Attribution 4.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

Lactating cows require high-quality protein to support rumen microbial protein synthesis and to achieve their milk production potential (1). Without proper nutritional management, dairy cows tend to produce low milk during lactation (2). One effective way to overcome that problem is to feed protein-rich supplements. *Leucaena leucocephala*, is a local source of protein with a drought-resistant, so that becomes valuable source of feed in semi-arid and tropical regions (3). *Leucaena leucocephala* being classified as proteinaceous roughage due to its high crude protein content, which averages 21.9% (4). *Leucaena leucocephala* contains a high proportion of rumen-degradable protein (RDP) and a significant proportion of by-pass protein (5). This high RDP fraction is essential for stimulating rumen microbial growth, while the by-pass fraction goes directly to the small intestine for absorption, making it a comprehensive source of nutrition for dairy cows (6). The study by (2) showed information on the digestibility of *Leucaena leucocephala* in the rumen of lactating Friesian Holstein cows.

Blood glucose and urea levels can indicate the energy and protein status of dairy cattle. Glucose is the main precursor of milk lactose (7), while blood urea nitrogen (BUN) indicates efficiency of nitrogen utilization in feed (8). High BUN concentration indicates that nitrogen (in the form of ammonia) from rumen digestible protein degradation in the rumen has exceeded the capacity of microbes to synthesize microbial protein. This excess ammonia is absorbed into the liver and converted into urea, which is a wasteful process in terms of energy and protein (8).

Leucaena leucocephala contains anti-nutritional factors, such as mimosine and other non-protein amino acids, as well as their derivative, 3,4-dihydroxypyridone (DHP), which limits its use (9). Therefore, this study aimed to know the effect of feeding *Leucaena leucocephala* as supplement in dairy cow rations, to maximise protein intake and minimise nitrogen waste, as reflected in blood urea levels. In this study, the leaves were added also to improve the ration, since the proportion of concentrate was high but low in protein content.

2. Materials and Methods

2.1 Dairy cow samples.

The experiment involved twelve Friesian-Holstein Crossbred cows that had been lactating for five to six months. The cows' body weight ranged between 402 and 542 Kg. The study took place at "Mawar Mekar Farm" in Karanganyar, Central Java, and the cows were kept in individual pens with feed and water troughs.

2.2 Ration and Supplementation treatments.

The rations were formulated based on body weight and milk production, in accordance with National Research Council standards. The maximum dry matter content of the basal ration was 3% of body weight. The treatments consisted of P0, P1 and P2. Treatment P0 was the basal ration, composed of forage and concentrate at a ratio of 40:60 of the total dry matter. Treatments P1 and P2 consisted of basal rations supplemented with *Leucaena leucocephala* leaves at 10% and 20% of the dry matter in the forage, respectively. *Leucaena leucocephala* leaves were wilted before they were fed to the cows. The composition of the feed for each treatment is presented in Table 1. There were four replicate samples for each treatment. The data collection period was 60 days, 14 of which were allocated for adaptation.

Table 1. Composition of feed and nutrient content of dairy cow rations.

Variables	Treatments		
	P0	P1	P2
Average body weight (Kg)	435	472	416
Dry matter requirement of cow*) (Kg)	13.05	14.16	12.49
Feed offered (Kg DM/day)			
Forage	5.22	5.66	4.99
Concentrate	7.83	8.49	7.49
Leucaena leucocephala leaves	0	0.56	0.99
Total dry matter	13.05	14.71	13.47
Total crude protein	1.22	1.32	1.17
Total digestible nutrient	8.24	8.93	7.88

*) 3% of body weight; P0 = basal ration (40% forage and 60% concentrates as a percentage of total DM); P1 = P0 + 10% *Leucaena leucocephala* leaves as a percentage of forage DM, P2 = P0 + 20% *Leucaena leucocephala* leaves as a percentage of forage DM.

2.3 Measuring Nutrient Consumption.

Feed consumption was measured by subtracting the amount of feed offered with the amount remaining feed after 24 hours. Nutrient consumption was determined by multiplying feed consumption by nutrient content (dry matter and crude protein). The nutrient content was analysed using the Proximate Procedure (10).

2.4 Blood Profile Analysis.

Blood samples were taken from the jugular vein of cows on the last day of the data collection period. The blood serum was separated and analysed immediately for glucose and urea concentrations using spectrophotometry at wavelengths of 500 nm and 578 nm, respectively (8).

2.5 Statistical analysis.

The data were statistically analysed using analysis of variance (ANOVA). If significant differences were found between treatments, a mean difference test was performed using Duncan's Multiple Range Test.

3. Results and Discussion

3.1 Nutrient Consumption.

The data on DM and CP consumption were presented in Table 2. Consumption of DM and CP by cows in P1 and P2 were significantly higher than in P0 ($P<0.05$). As shown in Table 2, supplementing the basal ration with *Leucaena leucocephala* leaves increased the DM content of P1 and P2 rations. Therefore, the nutrient availability, particularly for protein in the P1 and P2 rations was higher than in P0. Additionally, the cows' preference for foraging in P1 and P2 meant

that they consumed the forage supplement before the other components of their feed, so that increased CP consumption.

Table 2. Nutrient consumption of dairy cow samples

Variables	Treatments		
	P0	P1	P2
Nutrient consumption (Kg DM /day)			
Dry matter	10.19[a]	11.39[ab]	12.40[b]
Crude Protein	0.96[a]	1.11[ab]	1.13[b]
Total digestible nutrient	6.38[a]	6.66 [ab]	7.32[b]
Nutrient consumption (g/Kg Body Weight)			
Dry matter	23.42[a]	24.13[a]	29.80[b]
Crude protein	2.21[a]	2.35[ab]	2,71[b]
Total digestible nutrient	14.67[a]	14.11[a]	17.60[b]

[a,b] = Different superscripts within rows indicate significant differences ($P<0.05$); P0 = Basal ration (40% forage and 60% concentrates as a percentage of total DM); P1 = P0 + 10% *Leucaena leucocephala* leaves as a percentage of forage DM; P2 = P0 + 20% *Leucaena leucocephala* leaves as a percentage of forage DM.

The results showed that the more *Leucaena leucocephala* leaves were supplemented, the more protein was consumed. This phenomenon occurred because the addition of leguminous leaves made the ration more palatable. In addition, the high supply of degraded nitrogen from *Leucaena leucocephala* leaves promotes rumen microbial activity. The increase in fermentation and feed output rates in the rumen caused the cows to consume more feed. The result indicated that supplementation with *Leucaena leucocephala* leave is beneficial to increase protein consumption in cow, especially in this study where the diet containing high levels of concentrate with low protein content. In this study, the protein content of the concentrate was low, only 10.14%.

Although dry matter consumption was higher in P1 and P2 than in P0, the results showed no significant difference in digestibility, as reported by (2). This can be explained through two mechanisms: first, increased dry matter consumption without increased digestibility indicates an increase in the rate of passage. When feed moves more quickly through the digestive tract, there is less time available for microbes to degrade cellulose (fiber). Second, although *Leucaena leucocephala* leaves is a source of protein, at high level feeding, residual anti-nutritional factors such as mimosin and tannin gave inhibitory effect on the digestibility (11).

3.2 Blood glucose concentration.

The results showed that blood glucose concentration was around 53.50 to 55.10 mg/dL (Table 3.) and did not differ significantly between treatments. The range of blood glucose concentration in dairy cow is 50.31 to 54.37 mg/dL (12), 28.81 to 50.34 mg/dL (13) and 52 to 67 mg/dL (14).

The concentration of blood glucose in lactating dairy cows is strictly controlled because glucose is crucial for the production of milk lactose. The blood glucose in this study indicated there was energy competition in the cow samples. Although the consumption of DM and CP in P1 and P2 was higher than in P0, there was no significant difference in blood glucose levels, and actually the lowest level was in P2. The cows in P2 consumed more protein than those in P1 and P0. However, the carbohydrates in the ration may be not available for synchronizing the use of rumen-degradable protein. This resulted in excess ammonia-N. The conversion of ammonia to urea in the liver required energy (15). The energy used to remove excess nitrogen is in competition with the energy necessary for milk production and maintaining glucose levels (16). Research on the relationship between protein and energy levels and rumen fermentation kinetics emphasizes that energy balance is crucial for protein utilization (16). Blood glucose of dairy cows in this study indicates that energy is allocated to overcome excess nitrogen, rather than to improve energy for lactose production.

Table 3. Blood glucose and blood urea nitrogen concentration of dairy cow samples

	Treatments		
Variables	P0	P1	P2
Blood glucose (mg/dL)	55.1	54.9	53.5
Blood urea nitrogen (mg/dL)	15.40[a]	20.10[b]	26.50[c]

[a,b] = Different superscripts within rows indicate significant differences ($P<0.05$); P0 = Basal ration (40% forage and 60% concentrates as a percentage of total DM); P1 = P0 + 10% *Leucaena leucocephala* leaves as a percentage of forage DM; P2 = P0 + 20% *Leucaena leucocephala* leaves as a percentage of forage DM.

3.3 Blood Urea Nitrogen (BUN).

Blood urea nitrogen (BUN) levels increased in line with the amount of *Leucaena leucocephala* leaves supplementation. The levels increased from 15.40 mg/dL in P0 to 20.10 mg/dL and 26.50 mg/dL in P1 and P2 ($P<0.01$). The increase in BUN observed in treatments P1 and P2 was due to the high rumen degradable protein content of the *Leucaena leucocephala*. High BUN concentrations indicated that the amount of nitrogen in the form of ammonia from rumen degradable protein degradation in the rumen has exceeded the microbes' capacity to synthesis microbial protein (7). This excess ammonia is absorbed into the liver and converted into urea, a process that wastes energy and protein. The efficiency of microbial protein synthesis depends on the availability of rapidly fermentable carbohydrates as the sources of energy, which must be synchronised with the breakdown of rumen degradable protein in the rumen (6,7). Supplementation of *Leucaena leucocephala* leaves at the level of 20% of forage DM possibly caused high amount of rumen degradable protein in the rumen, so that exceed the microbes' ability to bind it into microbial protein. This condition resulted in the rapid accumulation of ammonia nitrogen. This accumulation increases the absorption of ammonia into the blood, which is then converted into urea, causing an increase in blood urea (8). The average concentration of blood urea nitrogen were 13.98 mg/dL in low yield dairy cow and 12.77 mg/dL for high yield

cows (17), while (18) found in Holstein Friesian were 26.50 mg/dL and 23.60 mg/dL, in average was 25.10 mg/dL. Concentration of blood urea nitrogen as 26.50 mg/dL in P2 suggests that the utilization of nitrogen was not efficient. The cows in P1, which received *Leucaena leucocephala* leaves as much as 10% of forage DM produced moderate blood urea nitrogen levels. This result indicated better synchronization between rumen degradable protein and energy available in the ration. Blood urea nitrogen is used to evaluate nitrogen status in dairy cows, therefore the nitrogen status of dairy cows which received *Leucaena leucocephala* leaves as 10% of forage DM was better than that of 20% DM supplementation. Lactating dairy cows in tropical regions generally have a rumen microbial population which capable of degrading a toxic derivative of mimosin (19, 20). The highest BUN level caused by P2 can be interpreted as an indirect effect of mimosin in *Leucaena leucocephala*.

4. Conclusion

In conclusion, supplementing the ration of lactating dairy cows with *Leucaena leucocephala* leaves significantly increases DM and CP consumption, particularly in rations containing a high proportion of low-protein concentrates. There was no effect on blood glucose levels, but blood urea nitrogen levels increased significantly. Supplementing with *Leucaena leucocephala* leaves at 10% of forage DM is effective in maintaining blood glucose within the physiological range with a moderate level of blood urea nitrogen.

5. Ethics approval

This article is has ethical approval from The Faculty of Veterinary Universitas Gadjah Mada No. 0019/EC-FKH/Eks/2019.

References

[1] Nugroho DF dan Ratnaduhita A 2022. AGRISAINTIFIKA. Jurnal Ilmu-Ilmu Pertanian 6 122-129
[2] Nugroho DF et al 2020 IOP Conference Series Conf. Series 478, 012008
[3] Angelis AD, Gasco L, Parisi G and Daniel PP 2021. Animals 29 2230
[4] Zapata-Campos CC, Garcí´a-Martí´nez, Salinas-Chavira J, Ascacio-Valde´s JA, Medina-Morales MA, and Mellado M 2020. Emirates Journal of Food and Agriculture 32 723-730
[5] Syamsi AN, Suhartati FF and Suryapratama W 2019. Jurnal Agripet. Pastura 2 47-52.
[6] Özmen M and Bug˘dayci KE 2025. KSU J. Agric Nat 28 1616-1626.
[7] Widyawati SD 2010. Sains Peternakan 8 8-14
[8] Ram JJ, Atreja PP, Chopra RC and Chhabra A 1994. Trop Anim Health Prod. 26199-206 [9]Ferreira SH, Zapparoli, Mussi CC and Maiorka PC 2025. Journal of Applied Toxicology [10]AOAC. 2005. Official Methods of Analysis of AOAC INTERNATIONAL 18th Edition, Horwitz, W. Editor. AOAC INTERNATIONAL SUITE 500 481 North Frederick Avenue Gaithersburg, Maryland 20877-2417, USA
[9] [11]Chater S. 1986 International Livestock Centre for Africa. https://hdl.handle.net/10568/4513
[10] Maurya SK and Singh OP 2016. Journal of Animal Research 6 167-170
[11] Panzaru C, Dolis¸ MG, Radu-Rusu RM and Davidescu MA 2024. Animal Science and Biotechnologies 57 62-167 [14]Pawlin´ski B, Gołębiewski M, Trela M and Witkowska-Piłaszewicz O 2023. Sci Rep 131414
[12] [15]Rasool F Z, Nizamani A, Ahmad KS, Parveen F, Khan SA and Sabir N 2022. PLoS One. May 11 0263605. [16]Montaya-flores MD, Molina-botero IC, Arango J, Romano JL, Soloria FJ, Fernando C and Carlos J 2020. Animals 13 300
[13] Soza I, Leyton L, Corea E, and Elizondo-Salazar J 2010.
[14] Nozad SR Ali-Gholi G, Moghadam, S. Asri-Rezaei, Babapour A and Ramin S 2012. Veterinary Research Forum 3 55–59
[15] Widodo FF., Wahyono, Sutrisno S 2012. Animal Agricultural Journal. [20]Permana IG, Arif SIZ, Pambudi FR, Despal and Rosmalia A 2025. American Journal of Animal and Veterinary Sciences. 20 192.203