Betel leaf (*Piper betle* Linn.) meal supplementation enhances milk production and composition in Ettawa crossbred dairy goats

Asep Sudarman*, *Muli* Asia, and *Dwierra* Evvyernie

Department of Animal Nutrition and Feed Technology, Faculty of Animal Science, IPB University, Bogor, Indonesia, 16680

Abstract. Subclinical mastitis (SCM), characterized by reduced milk yield, poor milk quality, udder inflammation, and increased somatic cell counts, is a major concern in dairy goat production. To mitigate the reliance on antibiotics, this study explored betel leaf (*Piper betle* L.) meal (BLM) as an alternative antibacterial feed additive. The effects of BLM on milk production and metabolic parameters in Ettawa Crossbred dairy goats were evaluated. Dietary treatments employed two groups (n = 6): a basal diet (T0) and the basal diet supplemented with 1.4% BLM (T1). Milk yield, milk composition (fat, protein, solid non-fat, total solids), and plasma glucose and triglyceride levels were assessed. Independent samples t-tests revealed that dietary 1.4% BLM significantly increased milk yield ($P < 0.05$), milk fat ($P < 0.05$), and total solids ($P < 0.05$). In contrast, BLM supplementation did not significantly affect milk protein, solid non-fat, glucose, or triglyceride concentrations ($P > 0.05$). These results suggest that 1.4% BLM can enhance milk yield and specific milk solid components in Ettawa Crossbred dairy goats, without compromising metabolic status.

1. Introduction

Peranakan Ettawa (PE) goats are prized in Indonesia for both meat and milk production. Nevertheless, subclinical mastitis remains a pervasive challenge, characterized by raised somatic cell counts (SCC) and reduced milk yield without overt clinical signs [1]. Standard antibiotic therapies carry risks, including antimicrobial resistance, drug residues, and potential toxicity. Such concerns highlight the need for natural alternatives that promote udder health while maintaining productivity [2].

Betel leaf (*Piper betle* Linn.) has long been used in traditional Indonesian medicine for its antimicrobial, anti-inflammatory, and antioxidant properties [2]. Its phytochemical profile includes essential oils (notably eugenol and hydroxychavicol), saponins, tannins, and flavonoids, compounds known to inhibit mastitis-causing pathogens such as *Staphylococcus* spp. and to modulate rumen fermentation [2, 4]. Moreover, in vitro

* Corresponding author: asudarman@apps.ipb.ac.id

studies using cattle have shown that incorporating betel leaf meal (BLM) into concentrate diets at 2% enhances volatile fatty acid (VFA) production and reduces protozoa numbers [2]. The antimicrobial effects of BLM on *Staphylococcus* spp. [2] suggest its utility in mastitis control, while its ruminal effects may support milk synthesis by modulating fermentation end products [2, 5]. Despite promising in vitro and bovine data, limited information exists on *P. betle* supplementation in dairy goats—particularly PE goats—regarding under health, lactational performance, and metabolic parameters. This study aimed to (1) evaluate the effect of dietary BLM on subclinical mastitis incidence (via SCC and CMT), (2) quantify changes in milk yield and composition (fat, protein, total solids, solids-non-fat), and (3) assess blood glucose and triglyceride concentrations in lactating PE goats. We hypothesized that BLM inclusion would reduce SCC, enhance milk production and fat synthesis, and not adversely affect blood metabolites, thereby providing a natural strategy to mitigate subclinical mastitis in dairy goat.

2. Materials and methods

The research was conducted at a small dairy goat farm in Bogor Regency, West Java. Six lactating PE goats (2–4 lactation periods, 3–5 months lactation length, 40–60 kg body weight) were used. Goats were individually housed with feeding and watering facilities. They were divided into two groups: T0 (control, without betel leaf powder) and T1 (with 1.4% betel leaf meal in concentrate). The basal diet consisted of forage (field grass) and concentrate (tempe waste mixed with commercial concentrate) provided 12.25% crude protein (CP), 62.76% TDN. Betel leaf meal were bought from herbal trader; BLM (1.4%) was thoroughly mixed with concentrate before feeding. Feeding trial lasted for 6 weeks and feed was given twice daily (morning and evening) in equal proportion, with water provided *ad libitum*.

Milk samples (100 mL) were collected from each teat during morning milking and stored in sterile bottles for analysis. Subclinical mastitis was tested using IPB-1 reagent [5]. Blood samples (3 mL) for glucose and triglyceride analysis were collected from jugular vein at the end of the study. Measured parameters included milk production, milk composition (fat, protein, total solids, solids-not-fat), and blood metabolites (glucose and triglyceride). The study used an independent sample t-test with two treatments and six replicates (each test as an experimental unit). Data were analyzed using SPSS 22.0.

3. Results and discussion

3.1. Subclinical mastitis and betel leaf efficacy

The diagnosis of subclinical mastitis using IPB-1 reagent [1] revealed that treated goats (T1.1) initially exhibited higher mastitis scores (++), likely reflecting pre-existing infections. Post-treatment, these scores improved to negative (-) in the left teat, suggesting therapeutic efficacy (Table 1). Control groups (T0.2, T0.3) maintained (+) reactions, indicating persistent mild clotting. Somatic cell counts (SCC) exceeding 1,200,000 cells/mL (Table 2) confirmed subclinical mastitis, aligning with established thresholds [6]. Elevated SCC correlates with udder infections, lactation stage, and milking practices.

Betel leaf powder reduced subclinical mastitis infections compared to controls. Phenolic compounds (chavicol: 5.1–8.2%; eugenol: 26.8–42.5%) acted as antimicrobials, lowering SCC by inhibiting mastitis-causing bacteria [7].

Table 1. Samples of Ettawa crossbred goat teats based on the degree of mastitis.

No. Goat	Initial		Final		Treatment
	Teat				
	Right	Left	Right	Left	
T0.1	-	-	-	-	without betel leaf flour (control)
T0.2	+	+	+	+	without betel leaf flour (control)
T0.3	+	+	+	+	without betel leaf flour (control)
T1.1	-	++	-	+	with 1.4% betel leaf flour
T1.2	-	-	-	-	with 1.4% betel leaf flour
T1.3	-	-	-	-	with 1.4% betel leaf flour

Note: The positive symbol (+) indicates the degree of mastitis (mastitis score) suffered

Table 2. Correlation of IPB-1 reagent scores with somatic cell counts*.

IPB-1 Score	Average Somatic Cell Count per ml	Reaction Result Description
Negative (-)	0-200.000	No thickening, homogeneous
Little (T)	200.000-400.000	Slightly thickened
Positive 1 (+)	400.000-1.200.000	Emergence of a slightly thickened mass
Positive 2 (++)	1.200.000-5.000.000	Formation of a thick mass
Positive 3 (+++)	>5.000.000	Formation of a mass that resembles gelatin and is difficult to move

*Source: [8]

3.2. Milk production

Milk production in the treated group (T1: 906.6 mL/day/teat) was higher than controls (T0: 744.9 mL/day/teat), though statistically was not significant (Table 3). The higher milk production of T1 may reflect reduced SCC and under health improvement, as SCC inversely correlates with yield [9]. However, the lower milk production of T0 suggests variability in infection severity, consistent with lactation-stage impacts [10]. Notably, high milk yield elevates mastitis risk by 6.52 times, as hyper-secretory udders are more susceptible to pathogen invasion [11].

Table 3. Effect of adding betel leaf flour on average milk production.

Treatment*	Milk production (mL/day/teat)
T0	744.9±893.7
T1	906.6±489.8

*T0 = control, without giving betel leaf flour, T1 = betel leaf flour 1.4% of concentrate

3.3. Milk composition enhancement

Betel leaf supplementation significantly increased milk fat (7.52% vs. 5.55%) and total solids (16.97% vs. 14.51%) ($P<0.05$) (Table 4). This aligns with studies showing that phytogenic additives enhance rumen fermentation, boosting acetate production—a key precursor for milk fat synthesis [12]. Forage-derived volatile fatty acids (VFAs) drive fat synthesis, and betel leaf's antimicrobial properties likely preserved rumen health, optimizing VFA profiles [13]. Protein and solids-not-fat remained unchanged, suggesting betel leaf specifically modulates lipid metabolism without altering nitrogen utilization.

Table 4. Effect of adding betel leaf flour on the average milk composition (Fat, Protein, Dry matter and Solid non-fat) at the end of treatment (%).

Parameters	Treatment*	
	T0	T1
Fat (%)	5.55±0.41b	7.52±1.36a
Protein (%)	3.78±0.59	4.67±1.88
Dry matter (%)	14.51±1.51b	16.97±2.17a
Solid non-fat (%)	8.95±1.26	9.45±0.89

*T0 = control, without giving betel leaf flour, T1 = betel leaf flour 1.4% of concentrate; Different letters in the same row indicate significant differences ($P<0.05$).

3.4. Blood metabolite stability

There were no significant differences in blood glucose (52.76–55.61 mg/dL) or triglycerides (14.18–18.15 µg/mL) were observed (Table 5), indicating betel leaf's metabolic safety. Similar results were reported by [14], where herbal additives in ruminant diets did not disrupt glucose homeostasis. This underscores betel leaf's suitability as a non-toxic, natural intervention for mastitis management.

Table 5. Blood glucose and triglyceride levels of goats fed betel leaf flour.

Treatment*	Glucose (mg/100 ml)	Triglycerides (µg/ml)
T0	52.76±8.85	18.15±9.79
T1	55.61±3.34	14.18±6.44

*T0 = control, without giving betel leaf flour, T1 = betel leaf flour 1.4% of concentrate

4. Conclusion

Betel leaf flour shows significant potential in improving milk quality and reducing subclinical mastitis without causing negative metabolic effects. Specifically, a 1.4% concentration of betel leaf powder in feed concentrate boosts milk fat and total solids content, all while maintaining consistent milk production. The effectiveness of betel leaf flour lies in its phenolic compounds, offering a promising and sustainable alternative to synthetic antimicrobials. This aligns well with the growing global demand for organic livestock farming practices.

References

[1] M. Sudarwanto, Pereaksi IPB-1 sebagai pereaksi alternatif untuk mendeteksi mastitis subklinis. Media Veteriner. **5**: 1 (1998).
[2] A.A. Yamin, A. Sudarman, D. Evvyernie, In vitro rumen fermentation and anti-mastitis bacterial activity of diet containing betel leaf meal (Piper betle L.). Media Peternakan,1 **36**: 137 (2013). https://doi.org/10.5398/medpet.2013.36.2.137.
[3] A.B. Caburian, M.O. Osi, R.E. Belardo, Antimicrobial activity of the volatile oil from the leaves of Piper betle Linn. Silliman Journal, **56**: 75 (2015).
[4] A. Santra, S. Konar, A. Mandal, S.K. Das, Rumen fermentation pattern, enzyme profile and ciliate protozoal population in betel (Piper betle) leaves fed lactating crossbred cows. Indian Journal of Animal Sciences,2 **86**: 515 (2016). https://doi.org/10.56093/ijans.v86i5.58507.
[5] A. Sudarman, I.Y. Marcelina, A. Jayanegara, Feed additive of betel leaves meal (Piper betle L.) use on ruminants as one of methane mitigation efforts. Proceedings of the 1st International Seminar on Animal Nutrition and Feed Technology, July 2016. Bangkok, Thailand (2016).
[6] I.R. Dohoo, K.E. Leslie, Evaluation of changes in somatic cell counts as indicators of new intramammary infections. Prev. Vet. Med. 1991; **10**:225–237. doi: 10.1016/0167-5877(91)90006-N.
[7] A. Sudarman, D. Supriadin, A. Jayanegara, 2017. Pemberian tepung daun sirih (*Piper betle* L.) dalam waktu lama untuk mengobati mastitis subklinis pada sapi perah laktasi pasca puncak produksi. *Buletin Peternakan.* **41**(1):8-14
[8] M. Sudarwanto, E. Sudarnika, Hubungan antara pH susu dengan jumlah sel somatis sebagai parameter mastitis subklinis. *Media Peternakan*. **31**:107113 2008)
[9] P. Hortet, H. Seegers, Calculated milk production losses associated with elevated somatic cell counts in dairy cows: review and critical discussion. Vet Res. **29**:497 (1998).
[10] G. Koop, T. van Werven, H. J. Schuiling, M. Nielen, The effect of subclinical mastitis on milk yield in dairy goats. J Dairy Sci. 2010 Dec; **93**(12):5809-17. doi: 10.3168/jds.2010- 3544
[11] H. Seegers, C. Fourichon, F. Beaudeau, Production effects related to mastitis and mastitis economics in dairy cattle herds. *Vet. Res.* **34**(5), 475–491 (2003).
[12] C. Benchaar, T. A. McAllister, P. Y. Chouinard, Digestion, ruminal fermentation, ciliate protozoal populations, and milk production from dairy cows fed cinnamaldehyde, quebracho condensed tannin, or Yucca schidigera saponin extracts. *Journal of Dairy Science*, **91**(12), 4765–4777 (2008).
[13] A. K. Patra, J. Saxena, Dietary phytochemicals as rumen modifiers: a review of the effects on microbial populations. *Antonie van Leeuwenhoek* **96**, 363–375 (2009). https://doi.org/10.1007/s10482-009-9364-1.
[14] M. Wanapat, S. Kang, P. Khejornsart, S. Wanapat Effects of plant herb combination supplementation on rumen fermentation and nutrient digestibility in beef cattle. Asian-Australasian Journal of Animal Sciences, **26**, 1127–1136 (2013).