The effect of leaf meal in supplements on milk yield and quality of *Friesian Holstein* dairy cows

Ambo Ako, Renny Fatmyah Utamy, Syahdar Baba[1], Hastang[1] and Andi Arif Rahman[2]

Perintis Kemerdekaan KM. 10, 90245 Makasssar, Indonesia
rennyfatmyahutamy@unhas.ac.id
Department of Animal Production, Faculty of Animal Science, University of Hasanuddin, Makassar, South Sulawesi, Indonesia
[1] Department of Social Economy, Faculty of Animal Science, University of Hasanuddin, Makassar, South Sulawesi, Indonesia
[2] Laboratories at the Laboratory of Dairy Cow, Faculty of Animal Science, University of Hasanuddin, Makassar, South Sulawesi, Indonesia

Abstract

This study aimed to determine the effect of leaf meals on the mik production of *Friesian Holstein (FH)* dairy cows. The 15 FH dairy cows were 5–6 years old and 3–5 months in lactation with a range in milk production of 9–12 kg/d. The leaf meal supplements used as feed comprised elephant grass (*Pennisetum purpureum*), leaf meal of Leucaena (*Leucaena leucocephala*), Gliricidia (*Gliricidia sepium*) and Mulberry (*Morus alba*), partially replacing rice bran, coconut cakel, fish meal, maize epidermis, molasses, and minerals. This study used a completely randomized design with five replications for each of the three treatments: feed concentrate without leaf meal (control, CTL), feed concentrate wit 25% leaf meal (LM25) and feed concentrate with 50% leaf meal (LM50). Feeding the leaf meal to FH dairy cows had no effect on total dry matter intake. However, there was a linear increase in milk yield, and a depression in milk fat, as the level of leaf meal in the diet was increased.

Keywords: *Friesian Holstein, Gliricidia, leaf meal, Leucaena, Mulberry*

Introduction

Friesian Holstein (FH) dairy cows are the highest milk producers among dairy cattle species in subtropical and tropical areas (Franzoi et al 2020). Imports account for approximately 80% of the demand for raw milk materials in Indonesia. Milk is produced by the mammary glands of dairy cattle or mammals and could directly be consumed or used as an ingredient for food. Milk is safe and healthy even when its components have not been reduced or other materials have not been added. As an ingredient for foods/drinks, milk has a high nutritional value because it contains the nutrients needed by the human body, such as calcium (Ca), phosphorus (P), vitamins A and B, and riboflavin. It's easy-to-digest composition makes milk a flexible source of food with adjustable fat content to meet the consumer's needs. Milk is a source of food/drink that is needed to improve the health of humans. However, several obstacles must be overcome by the milk industry, such as low production and quality.

The low production and quality of dairy cow's milk are influenced by several factors, one of which is feed management. Feeding addressed the needs of life maintenance, production, and reproduction. Adequate cattle feeding could increase the production and quality of their milk. The feed must contain essential nutrients, such as dry matter (DM), ash, crude protein (CP) content, crude fiber (CF) content, fat, and extracted ingredients without nitrogen (beta-N). Feeding could be in the form of forage as the main feed and concentrate as additive feed (Despal et al 2019). Feed concentrate is obtained from cereals, grains, agro-industrial byproducts, minerals, and forages such as grasses and legumes. Enrekang District is a center for dairy cattle where Mulberry (*Morus alba*), Gliricidia (*Gliricidia sepium*) and Leucaena (*Leucaena leucocephala*) are indigenous and affordable. Farmers will benefit when the milk production and quality of their dairy cattle can be maximized by providing concentrates that are sourced from these three raw materials and could be used as substitutes for commercial feed concentrates.

Mulberry, belonging to the Moraceae family, is widely known as a fast-growing plant found in various climatic, topographical, and soil conditions. Historically, in Asia, for the traditional treatment of various diseases such as infections and internal medicine, mulberries are very useful (Teng-Gen Hu et al 2019). (Kandylis et al 2009) stated that Mulberry leaves are very useful as a feed source of protein in sheep feed. Gliricidia (*Gliricidia sepium*) is a legume tree found in areas with dry land and can grow well in dry seasons. However, this species may have limitations in productivity, palatability, presence of toxic substances, and adaptability (Akinbamijo O O et al 2006; Atta Krah A and Reynolds, 1989). (Rusdy M et al 2019) The supplementation of Gliricidia up to more than 45% could improve the performance of Bali cattle. (David M Mbugua et al 2008) stated that this legume contains alkaloids and tannins, which compound protein binders are acting as antinutritional substances. However, the amount of these compounds in Gliricidia is not as high as that in *Calliandra calothrysus*.

Leucaena is a tree shrub that contains active substances such as alkaloids, saponins, flavonoids, tannin, mimosine, leukanin, protein, fat, Ca, P, iron, and vitamins A and B. The flavonoids in Leucaena have anti-inflammatory properties. Flavonoids in the form of aglycone are nonpolar, and those in the form of glycoside are polar (Setiawan and Felix 2014). (Garcia et al 1996) reported that Leucaena contains the median chemical composition for Leucaena leaf meal [g 100 g^{-1} dry matter (DM basis)] was calculated to be 4.15 nitrogen (N), 29.2 crude protein (CP), 19.2 crude fibre (CF), 10.5 ash, 1.01 tannin (Tn), 1.9 calcium (Ca), 0.23 phosphorous (P), 0.34 magnesium (Mn), 1.7 potassium (K), respectively. Leucaena contains high amounts of protein and is commonly used as feed cattle. It is the most widely used as a tree legume as a valuable fodder shrub in increasing livestock production in the tropics (Khamseekhiew et al 2001).

Leaf meal supplement comprising Mulberry, Gliricidia and Leucaena have a high content of protein are thought to have the same nutritional value as commercial feed concentrates. Thus, this study aimed to examine the potential of leaf meal supplement composed of the leaf flour of Mulberry leaf, Gliricidia leaf and Leucaena leaf as a substitute for commercial feed concentrates and its effect on the DM intake, milk yield and quality, also fee conversion of the total diet in terms of DM intake per liter of milk FH dairy cows.

Materials and methods

This study was conducted in Tallang Baba Sub-Village, Cendana Village, Cendana District, Enrekang Regency, South Sulawesi, Indonesia. The fifteen FH dairy cows of 5–6 years in lactation with a lactation period of 3rd–5th was used for in vivo study months and an average production of 9–12 kg/d. Elephant grass (*Pennisetum purpureum*) was used as the main feed. Feedstuff of feed supplement consisted of the leaf flour of Mulberry, Leucaena and Gliricidia added with rice bran, coconut cake meal, fish meal, corn epidermis, molasses and minerals.

This study used a complete random design (CRD) with five replications for each of the three treatments: feedstuff commercial without leaf meal in the supplement (control, CTL), leaf meal in supplement with as much as 25% leaf meal (LM25) and leaf meal in supplement with as much as 50% leaf meal (LM50). Feeding of elephant grass and leaf meal in the supplement were as much as 8 and 7 kg DM/day, respectively. Feeding of the composition and nutritional value of feed ingredients for each treatment are presented in Table 1.

Elephant grass and drinking water were given ad libitum to the cows in the morning and afternoon. The parameters measured were DM intake, milk yield and quality. DM intake was obtained from the amount of one-day consumption (24 h). The adaptation period lasted for 7 days. The fee conversion was measured by the total diet in terms of DM intake per liter of milk.

The CP, fat, lactose, Ca, and P of milk were analyzed. CP concentration was analyzed by the Indirect Kjeldahl method (method 991.23; AOAC International, 2005) while fat was by the Babcock method (method 989.04; AOAC International, 2005), lactose by Nelson Somogy method (Sudarmadji et al 1984), Ca and P by Atomic Absorption Spectrophotometric and Colorimetric methods (method 991.25; AOAC International, 2005).

Table 1. Composition and nutrition value of the treatments

Treatments, Feedstuff, % DM basis	Composition, %	‡Nutritive Value, %						
		CP	CF	TDN	Cf	Ca	P	Ash
CTL								
Rice bran[1]	35	3.23	4.58	19.33	2.84	0.05	0.22	3.08
Coconut cake meal[2]	20	4.24	2.42	4.28	2.80	0.01	0.08	1.19
Shrimp waste meal[3]	15	6.09	2.36	0	0.89	1.04	0.17	2.51
Corn epidermis[4]	24	1.94	3.85	12.23	5.32	0.06	0.02	0.45
Molasses[1]	5	0.11	0.01	2.73	0.002	0	0	0
Mineral[1]	1	0	0	0	0	0.04	0.01	0
Total	**100**	**15.63**	**13.25**	**38.58**	**11.86**	**1.23**	**0.52**	**7.21**
LM25								
Leucaena leucocephala leaf meal[1]	5	0.96	0.66	1.88	0.18	0.06	0.009	0.13
Gliricidia sepium leaf meal[2]	10	2.04	1.19	4.91	0.36	0.09	0.01	0.75
Morus alba leaf meal[3]	10	1.70	1.47	3.76	0.45	0.26	0.03	1.33
Rice bran[1]	25	2.30	3.27	13.81	2.02	0.04	0.16	2.20
Coconut cake meal[2]	14	2.97	1.70	2.99	1.96	0.01	0.05	0.83
Shrimp waste meal[3]	10	4.06	1.57	0	0.59	0.69	0.11	1.67
Corn epidermis[4]	20	1.62	3.21	10,19	4.43	0.05	0.02	0.35
Molasses[1]	5	0.11	0.01	2.73	0.002	0	0	0
Mineral[1]	1	0	0	0	0	0.04	0.01	0
Total	**100**	**15.79**	**13.12**	**40.3**	**10.02**	**1.27**	**0.43**	**7.28**
LM50								
Leucaena leucocephala leaf meal[1]	10	1.92	1.33	3.76	0.36	0.12	0.01	0.27
Gliricidia sepium leaf meal[2]	20	4.09	2.39	9.83	0.72	0.18	0.03	1.51
Morus alba leaf meal[3]	20	3.41	2.95	7.53	0.90	0.52	0.07	2.66
Rice bran[1]	17	1.56	2.22	9.39	1.37	0.02	0.11	1.49
Coconut cake meal[2]	7	1.48	0.85	1.49	0.98	0.006	0.02	0.41
Shrimp waste meal[3]	5	2.03	0.78	0	0.29	0.34	0.05	0.83
Corn epidermis[4]	15	1.21	2.40	7.64	3.32	0.03	0.01	0.26
Molasses[1]	5	0.11	0.01	2.73	0.002	0	0	0
Mineral[1]	1	0	0	0	0	0.04	0.01	0
Total	**100**	**15.84**	**12.96**	**42.39**	**7.97**	**1.30**	**0.35**	**7.46**

Source: [1](Dicky Pamungkas et al 2010); [2](Jaworski et al 2014); [3] (Syahrir et al 2009) ; [4](Dicky Pamungkas et al 2010)

The data collected were entered and organized in the excel spread sheet and then it was analyzed using descriptive statistics and GLM-Multivariate (SPSS, version 21).

Results and discussions

Influence of leaf meal in supplement on dry matter intake, milk yield, and fee conversion

Mean values for DM intake, milk yield, and fee conversion of cows fed a basal diet of Elephant grass and supplements are presented in Table 2 as follows:

Table 2. Mean values for DM intake, milk yield, and fee conversion of cows fed a basal diet of Elephant grass and supplements

Parameters	CTL	LM25	LM50	SEM	*p*
DM intake, kg/d					
Elephant grass	7.50	6.59	7.50	0.48	0.13
Supplement	6.92	6.95	7.00	0.06	0.54
Total DM	14.42	13.54	14.50	0.47	0.12
Milk yield, kg/d	10.44	11.32	12.26	0.93	0.19

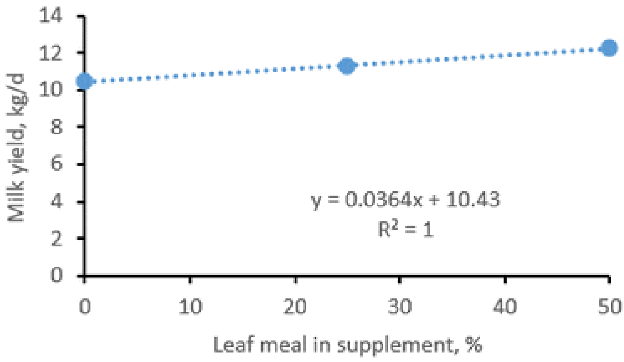

Figure 1. Milk yield was increased when leave meals were incorporated in the concentrate supplement

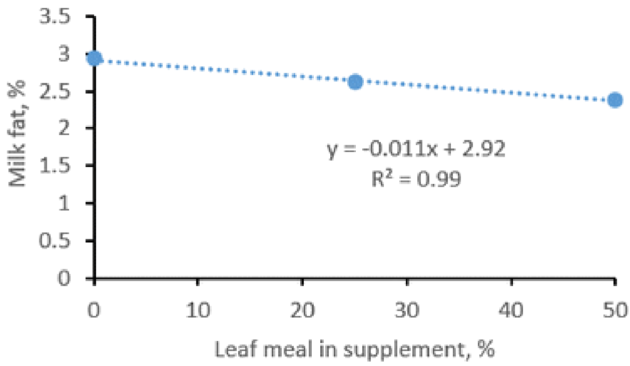

Figure 2. The milk fat content was reduced with a linear trend when leave meals were introduced into the concentrate supplement

We cannot explain the depression in fat content of the milk as the proportion of leaf meal in the concentrate supplement was increased (Table 3; Figure 2).

There was a positive correlation between milk yield and leaf meal. The leaf meal is the potential feed in enhancing milk yield. Feeding 1% of the leaf meal can increase milk yield by 0.925 kg/d (Figure 1). The combination of leaf meals supports higher milk yield because the combination is rich in bypass protein which is the factor determining the production response to this nutritional change. There was a decrease in the use of feedstuff ingredients such as rice bran, coconut cake meal, shrimp waste meal, and corn epidermis by 25% in LM25 and 50% in LM50, respectively in green concentrate. Also, the green concentrate meets the nutritional need of lactating FH dairy cows to produce milk (Pineda et al 2022). Therefore, green concentrate could be used as a substitute for commercial concentrate to meet the nutritional requirements of livestock to maintain or increase milk yield. Furthermore, (Ambo Ako 2019) stated that green biomass is a high protein source which is very potential as a basal diet.

Effect of leaf meal in supplement on the quality of milk

The effects of leaf meal in the supplement on the contents of CP, fat, lactose, Ca and P of cow milk are presented in Table 3.

Table 3. Effect of leaf meal supplement on the milk quality of FH dairy cow

Parameters, %	CTL	LM25	LM50	SEM	*p*
Crude protein	2.67	2.41	2.69	0.12	0.09
Fat	2.93^{a}	2.62^{ab}	2.38^{b}	0.20	0.03
Lactose	3.43	3.44	3.27	0.15	0.29
Calcium	0.13	0.12	0.12	0.03	0.94
Phosphorus	0.09	0.08	0.08	0.009	0.28

^{ab} *Different superscripts in the same row indicate a significant difference (p< 0.059)*

The leaf meal had a significant effect on fat content (*p*< 0.05) but not on CP, lactose, Ca and P content (*p*> 0.05). The fat content of the milk from the cows fed with CTL was significantly higher (*p*< 0.05) than that from the cows fed with LM50. This might be due to the high level of rice bran in CTL (Table 1). Stødkilde et al (2019) reported that diet influences the fat content. Abdi Hassen et al (2022) also stated that feed supplementation increased the fat content of milk. This means that the fatty acids in the feed can be directly transferred to the milk fat formation system, production and quality of milk.

Conclusion

Replacing 50% of the concentrate supplement with leaf meals from Mulberry, Gliricidia and Leucaena increased the milk production by 20% without increasing the total dry matter intake. However, the fat content of the milk was depressed by inclusion leaf meal in the diet.

Reference

Akinbamijo O O, Adediran S A, Nouala S and Seeker, J 2006 Moringa fodder in ruminant nutrition in the Gambia. trees for life Journal-a Forum on beneficial trees and plants. Publication of International Trypanotolerance Centre, Banjul T, Volume 6, Article #4

Ambo Ako 2019 Ilmu Ternak Perah Daerah Tropis. PT Penerbit IPB Press, Bogor

AOAC 2005 Official Methods of Analysis, 18th ed. p 989-991.

Abdi Hassen, Petros Chavula, Siraj Shek Mohammed and Abrahim Dawid 2022 The effect of feed supplementation on cow milk productivity and quality: a brief study. International Journal of Agriculture and veterinary Sciences. Volume 4, Article #1, pp 13–25.

Atta Krah A and Reynolds L 1989 Utilization of pasture and fodder shrubs in the nutrition of sheep and goats in the humid tropics of West Africa. FAO Animal Production and Health Paper (FAO). Etude FAO: Production et Sante Animales (FAO). No. 70.

David M Mbugua, Eratus M Kiruiro and Alice N Pell 2008 In vitro fermentation of intact and fractionated tropical herbaceous and tree legumes containing tannins and alkaloids. Animal Feed Science and Technology. Volume 146, Article #1–2, pp 1–20.

Despal, Idar Galih Perman, Toto Toharmat and Dwierra Evviernie Amirroennas 2019 Pemberian Pakan Sapi Perah. PT Penerbit IPB Press, Yogyakarta

Dicky Pamungkas, Eko Marhaeniyanto, Agustina Wea and Karolus Eduardus Suhana 2010 Substitusi rumput gajah dengan tumpi jagung dan kulit kopi terhadap penampilan sapi Peranakan Ongole. Buana Sains. Volume 10, (1), pp 29–39.

Franzoi M, Manuelian C L, Penasa M and De Marchi M 2020 Effects of somatic cell score on milk yield and mid-infrared predicted composition and technological traits of Brown Swiss, Holstein Friesian, and Simmental cattle breeds. Journal of Dairy Science, Volume 103, Article No #1, pp 791–804.

Garcia G W, Ferguson T U, Neckles F A and Archibald K A E 1996 The nutritive value and forage productivity of Leucaena leucocephala. Animal Feed Science and Technology, Volume 60, Article #2, pp 29–41.

Jaworski N W, Shoulders J, González-Vega J C, and Stein H H 2014 Effects of using copra meal, palm kernel expellers, or palm kernel meal in diets for weanling pigs. The Professional Animal Scientist, Volume 30, Article #2, pp 243–251.

Kandylis K, Hadjigeorgiou I And Harizanis P 2009 The nutritive value of mulberry leaves (Morus alba) as a feed supplement for sheep. Tropical Animal Health and Production. Volume 41, Article #1, pp 17–24.

Khamseekhiew B, Liang J B, Wong C C and Jalan Z A 2001 Ruminal and intestinal digestibility of some tropical legume forages. Asian-Australasian Journal of Animal Sciences. Volume 14, Article #3, pp 321–325.

Pineda A, Cardoso F C, Murphy M R, and Drackley J K 2022 Effects of dietary energy density and feeding strategy during the dry period on feed intake, energy balance, milk production, and blood metabolites of Holstein cows. JDS Communications. Volume 3, pp 403-407.

Rusdy M, Baba S, Garantjang S and Syarif I 2019 Effects of supplementation with Gliricidia sepium leaves on performance of Bali cattle fed elephant grass. Livestock Research for Rural Development. Volume 31, Article #84. Retrieved February 2, 2023, from http://www.lrrd.org/lrrd31/6/muhru31084.html

Setiawan Dalimartha and Felix Adrian Dalimartha 2014 Tumbuhan sakti atasi asam urat. Penebar Swadaya Grup, Jakarta.

Stødkilde L, Damborg V K, Jørgensen H, Lærke H N and Jensen S K 2019 Digestibility of fractionated green biomass as protein source for monogastric animals. Animal, Volume 13, Article #9, pp 1817–1825.

Sudarmadji S, Haryono B and Suhardi 1984 Prosedur Analisa untuk Bahan Makanan dan Pertanian. Liberty, Yogyakarta

Syahrir S, Wiryawan K G, Parakkasi A, Winugroho M and Sari O N P 2009 Efektivitas daun murbei sebagai pengganti konsentrat dalam sistem rumen in vitro. Media Peternakan. Volume 32, Article #2, pp 112-119.

Teng-Gen Hu, Peng Wen, Robert J Linhardt, Sen-Tai Liao, Hong Wu, Yu-Xiao Zou 2019 Mulberry: A review of bioactive compounds and advanced processing technology. Trends in Food Science & Technology. Voluume 83, pp 138–158.

Received 18 December 2022; Accepted 26 February 2023; Published 1 March 2023