The Effect of Supplementation of *Leucaena leucocephala* Leaves on Digestibility of Dry Matter and Organic Matter in Friesian Holstein Dairy Cows Rations

D F Nugroho¹, Y Y Suranindyah¹ and A Astuti²

¹Department of Animal Production, Faculty of Animal Science, Universitas Gadjah Mada, Jl. Fauna No. 3, Bulaksumur, Yogyakarta 55281 - Indonesia
²Department of Animal Nutrition and Feed Science, Faculty of Animal Science, Universitas Gadjah Mada, Jl. Fauna No. 3, Bulaksumur, Yogyakarta 55281 – Indonesia

yuni.suranindyah@ugm.ac.id

Abstract. The study was conducted to measure digestibility of dry matter and organic matter in Holstein Friesian cow ration which was supplemented with *Leucaena Leucocephala* leaves. The experiment was designed followed completely randomized design, consisted of 3 treatments, namely P0, P1 and P2 with 4 replications. Treatment P0 was basal ration, composed of 35% forage + 65% concentrate of total dry matter. Treatment P1 and P2 contained basal ration supplemented by *Leucaena Leucocephala* leaves as much as 10% and 20% of total forage dry matter, respectively. The data on dry matter, organic matter digestibility and nutrient consumption were collected during 14 days. The results showed no significant different of dry matter, organic matter, crude fibre digestibility among rations. Dry matter, organic matter, crude protein, and crude fibre of ration P1 and P2 were higher than P0. In conclusion, there was no effect of *Leucaena Leucocephala* leaves supplementation on dry matter and organic matter digestibility of ration but increased the consumption of dry matter, organic matter, crude protein and crude fiber.

1. Introduction

The productivity of dairy cows in Indonesia is still low, so that could not meet the demand of domestic milk. Indonesia’s dairy sector consist of large-scale production and smallholder units. The small-scale operations, which characterised by low number of cow ownership, account for 77% of fresh milk production in Indonesia [1]. The low productivity of small dairy farm is influenced by several factors, such as feed and livestock raising management. Feed is the major constraint, due to fluctuation of availability and price. [2] reported the high cost and unavailability of protein-rich commercial concentrates resulted in inconsistent and inadequate nutrient for increased milk yield.

In order to overcome the dependence on concentrates and forages which often limited, the dairy feed could be managed by changing the ratio of forage and concentrate. High ratio of forage to concentrate was reported by [3] did not cause decrease in dry matter intake, milk corrected milk, but
increased milk fat content. In terms of feed cost and the conditions of small dairy farmers, [4] recommended to give 70% forage in the ration. Alternative effort to reduce feed cost is by self-formulation of ration using feedstuffs that are easily available around the farm. Agricultural by-product such as rice bran, cassava meal, palm kernel, coconut meal, and urea were recommended as concentrate ingredients [5]. The use of high-quality supplement complementing nutrient in the ration to meet the cow nutritional requirement for maintenance and production [6]. The feed supplement should be easily obtained and has an economical price. *Leucaena leucocephala* leaves is preferable as feed supplements due to containing high protein and available as leguminous tree forages [7]. *Leucaena leucocephala* leaves has been used to increase productivity of livestock in the tropic [8], contained 21 to 25% of crude protein [8]. Amino acids composition in *Leucaena leucocephala* leaves is comparable with that in fish meal and soybean meal [9].

In this study, the dairy cow ration was composed by low percentage grass and high percentage concentrate. *Leucaena leucocephala* leaves was selected to be supplement because of its nutritional content and availability in the farm. Since most of concentrate were agricultural by-products, there is need to investigate its effects in the rumen and digestive tract of dairy cows. This study aims to determine the digestibility of dry matter, organic matter of ration and the effect of *Leucaena leucocephala* leaves supplementation on feed consumption of lactating Friesian Holstein cow.

2. Material and methods

This experiment was done from May to June 2019 in Mawar Mekar dairy farm at the village of Sengon Kerep, Gedong, Karanganyar, Central Java. Twelve lactating Friesian Holstein cows, in 3 to 4 months lactation stage were used in the experiment. Body weight of the cows were 400 to 450 kg. Dairy cow ration composed by Elephant grass (*Pennisetum purpureum*), concentrate mix (Table 1), mineral and *Leucaena leucocephala* leaves as supplement. The rations were P0, P1 and P2. Each ration was examined with 4 replications. Dairy cows in P0 were given basal diet. The components of basal diet were 35% forage + 65% concentrates based on dry matter. Ration P1 and P2 consisted of basal diet + *Leucaena leucocephala* leaves supplement at the level of 10% and 20% of total of forage dry matter, respectively. All cows received feed as 3% of body weight in dry matter base. *Leucaena leucocephala* leaves was withered for 6 hours before feeding time, intended to reduce poisoning components and feather loss [10]. Drinking water was provided ad libitum.

In-vivo digestibility assessment of the rations were done in 21 days, divided into 7 days adaptation and 14 days collection period. The cow was placed the barn completed with individual feed through and water container. Feeding trial and observation were done to collect data of feed consumption, weight of faeces and urine, chemical composition of feed, refused feed and faeces (dry matter, organic matter, crude protein and crude fibre). Feed consumption was measured as feed given subtracted by refused feed after 24 hours. Faeces from each defecation was weighed using bucket then collected during 24 hours. The same way was done for urine. Samples of feed, refused feed and faeces were taken daily during collection period. Composited samples were used to determined chemical composition followed proximate analysis [11]. Chemical analysis was done in the laboratory of Animal Nutrition, Universitas Gadjah Mada, Yogyakarta. The value of in-vivo digestibility was calculated using formula:

\[
\text{Dry matter digestibility (\%) = } \frac{(\text{feed dry matter x feed consumption})-(\text{faeces weight x faeces dry matter})}{\text{feed dry matter x feed consumption}} \times 100\%
\]

The same formula was applied to calculate organic matter, crude protein and crude fibre digestibility. Data were statistically analysed used completely randomized design (CRD) and to determine differences among treatments the analysis was continued by Duncan’s multiple range test (DMRT) in the case of means significantly difference.
3. Results and discussion

Nutrient content of all components in concentrate was shown in Table 1. Fifty % of the ingredients have low crude protein (4.32 to 5.55%) and high crude fibre (25.87 to 34.51%). The final formulation formed concentrate containing 10.32% crude protein and 59.10% total digestible energy (TDN). Referred to the composition, this concentrate was not included as either protein or energy source. According to [12] protein source concentrate should contain at least 20% CP.

Table 1. Nutrient content in feed components of dairy cow ration during experiment

| Nutrients content (%)                                                                 | Dry matter | Crude protein | Extract ether | Crude fibre | Ash | Nitrogen free extract | Total digestible nutrient |
|--------------------------------------------------------------------------------------|------------|---------------|---------------|-------------|-----|-----------------------|--------------------------|
| P. purpureum                                                                         | 21.2       | 9.57          | 2.25          | 32.5        | 14.96| 40.72                 | 54.68                    |
| Rice bran                                                                            | 89.44      | 4.91          | 2.24          | 25.87       | 13.97| 53.01                 | 59.72                    |
| Tofu waste                                                                           | 88.75      | 15.57         | 3.99          | 15.23       | 3.67 | 61.54                 | 73.18                    |
| Coconut meal                                                                         | 87.82      | 14.42         | 11.37         | 7.09        | 6.09 | 61.03                 | 86.47                    |
| Coffe bean hull                                                                      | 87.12      | 5.55          | 0.94          | 28.28       | 7.64 | 57.59                 | 57.20                    |
| Wheat pollard                                                                        | 87.43      | 10.7          | 4.17          | 7.34        | 4.47 | 73.32                 | 79.27                    |
| Poultry litter waste                                                                 | 87.88      | 4.32          | 0.82          | 34.51       | 21.51| 38.84                 | 50.16                    |
| L. leucocephala leaves                                                                 | 30.00      | 26.00         | 4.10          | 20.90       | 8.40 | 40.50                 | 70.10                    |

\[1\] was calculated following formula reported by [13] cit [14].

The value of energy in concentrate was comparable to total digestible nutrient in grass, therefore this type of concentrate acceptable to replace partly of grass in the ration. Feed digestibility is part of nutrients that are not excreted in faeces and is assumed to be nutrients absorbed by the body of livestock [15]. Digestion level shows the amount of feed that was digested in a certain time [16]. Digestibility of dry matter in the ration containing 65% concentrate and 35% grass was found around 64 to 70% whereas for organic matter digestibility was 63 to 70%. In compare to grass, the ration digestibility dry matter was higher than the effective rumen degradable dry matter in grass as 420g/kg, comparable to 42% [17]. In this study the proportion of concentrate in the ration, as 65% was counted higher than commonly dairy ration formulation as 40% to 60% [18]. Other studies have shifted the proportion of concentrate to 45% (Machado et al., 2014) and 70% (Chen et al., 2015). [19] reported that depressions in digestibility for dry matter, were greater on the low forage diet. The result disagreed with above statement because the digestibility of high proportion concentrates in this study counted to be high. However, the value less than concentrate digestibility in cattle as 78% [20]. Digestibility of feed was affected by several factors, such as particle size, soaking, processing grain and associative effect of feed, which is known as the effect of one feed to influence the digestibility of other feed. The example of this factor is protein facilitate rumen microorganisms that break down complex carbohydrate [21] Dairy ration in this study, was observed to have low level protein but high crude fibre. Therefore it has possibility to influence digestion in the rumen. As described by [21] High crude fibre content of mixed diets decreases their digestibility. The higher the percentage of crude fibre in a ration, the lower is the digestibility of dry matter and all other nutrients.

Results in Table 2 indicated no effect of supplementation Leucaena leucocephala leaves on the digestibility of dry matter, organic matter and crude fibre of the ration (P1 and P2). The effect of supplementation was significant (P<0.05) the digestibility of crude protein. The previous report by [7] showed that Leucaena leucocephala leaves can be used as an alternative source of protein to increase body weight and milk production. Result of this study different with similar study in goat ration. Increasing level of Leucaena leucocephala supplementation in the ration was reported did not affect dry matter intake but decreased digestibility of dry matter [22] In goat, the secondary compounds similarly to mimosine in Leucaena leucocephala affect the nutritive value of forages and animal
consumed them. This factor may decrease their nutritional value as sole feed but increased their value as supplemental feed to low quality forages as well as agricultural by-product [23]. Study in dairy goat, the utilization of Leucaena leucocephala leaves as total mixed ration did not influence apparent digestibility, average daily gain and feed conversion ratio but improved the voluntary dry matter and nutrients intake. Toxicity was also not found in goat [24]. In this study used dairy cow, there was no significant improvement of feeding supplement, even though the level of Leucaena leucocephala leaves reached 20% of total forage. This non-significant result was possibility due to the different response of secondary compound in the rumen of dairy cow which is different with in goat and because of low level of supplementation. The similar study by [25] showed that effect of supplementation Leucaena leucocephala leaves at the level of 15% and 20% dry matter basic improved dry matter intake and milk yield of dairy cow. Supplementation Leucaena leucocephala leaves was benefit to increase nutrient consumption as indicated in the result of Tabel 2.

Table 2. Nutrient consumption and digestibility of rations in the experiment

|                | P0       | P1       | P2       |
|----------------|----------|----------|----------|
| Digestibility (%) |          |          |          |
| Dry matter     | 64.70 ± 2.27<sup>ns</sup> | 66.01 ± 0.88<sup>ns</sup> | 69.95 ± 5.44<sup>ns</sup> |
| Organic matter | 63.88 ± 1.66<sup>ns</sup> | 65.46 ± 4.33<sup>ns</sup> | 69.67 ± 2.69<sup>ns</sup> |
| Crude protein  | 72.99 ± 1.25<sup>a</sup> | 75.61 ± 2.03<sup>ab</sup> | 78.54 ± 2.87<sup>b</sup> |
| Crude fibre    | 63.88 ± 1.66<sup>ns</sup> | 65.46 ± 4.33<sup>ns</sup> | 69.67 ± 2.68<sup>ns</sup> |
| Consumption (kg/head/day) |          |          |          |
| Dry matter     | 10.19 ± 0.59<sup>a</sup> | 11.39 ± 1.00<sup>ab</sup> | 12.40 ± 1.08<sup>b</sup> |
| Organic matter | 9.38 ± 0.79<sup>a</sup>  | 9.55 ± 0.87<sup>ab</sup> | 9.79 ± 1.25<sup>b</sup> |
| Crude protein  | 1.07 ± 1.10<sup>a</sup>  | 1.35 ± 1.17<sup>ab</sup> | 1.33 ± 0.23<sup>b</sup> |
| Crude fibre    | 2.13 ± 0.10<sup>a</sup>  | 2.54 ± 0.23<sup>ab</sup> | 2.84 ± 0.29<sup>b</sup> |
| Energy (TDN)   | 6.67 ± 0.72<sup>ns</sup> | 6.63 ± 0.73<sup>ns</sup> | 7.08 ± 0.61<sup>ns</sup> |

P0 = basal ration
P1 = basal ration + Leucaena leucocephala leaves 10% of forage dry matter
P2 = basal ration + Leucaena leucocephala leaves 20% of forage dry matter
a,b = mean in the same row with different (P<0.05 )
ns = non significant

Orage quality can impact dry matter (DM) intake, diet energy density, dietary grain and protein supplementation amounts, feed costs, lactation performance, and cow health. Forage quality is highly variable among and within forage types [26].

4. Conclusion
There was no effect of supplementation Leucaena Leucocephala leaves as much as 10% and 20% of total forage dry matter on digestibility of dry matter and organic matter of dairy cow ration. The effect of supplementation increase the consumption of dry matter, organic matter, crude protein and crude fibre. High proportion concentrate could replace forage because of having similarity content of crude protein and crude fibre.

Acknowledgments
Authors grateful to Recognisi Tugas Akhir (RTA) Program, Universitas Gadjah Mada, for supporting fund to improve research and publication. We thank our colleagues from Mawar Mekar dairy farm who provided insight and expertise that greatly assisted the research.

References
[1] Abdi A, Slette J and Meylinah S 2012 Indonesia Dairy and Products Annual Indonesia Dairy and Products Annual Report 2012.
[2] Ngongoni N T, Mapiye C, Mwale M and Mupeta B 2006 Factors affecting milk production in the smallholder dairy sector of Zimbabwe Livestock Research for Rural Development 18(6) 89

[3] Aguerre M J, Wattiaux M A, Powell J M, Broderick G A and Arndt C 2011 Effect of forage-to-concentrate ratio in dairy cow diets on emission of methane, carbon dioxide, and ammonia, lactation performance, and manure excretion Journal of Dairy Science 94(6) 3081–3093 https://doi.org/10.3168/jds.2010-4011

[4] Sanh M V, Wiktorsson H and Ly L V 2002 Effects of natural grass forage to concentrate ratios and feeding principles on milk production and performance of crossbred lactating cows Asian-Australasian Journal of Animal Sciences 15(5) 650–657

[5] OECD-FAO 2015 Agricultural Outlook 2014-2023 (Rome: FAO)

[6] Agus A, Astuti A and Munawar A 2001 Penggunaan biji jagung rebus sebagai suplemen energi dalam ransum sapi perah laktasi terhadap kinerja produksi dan komposisi susu Buletin Mediangama 11(2) 27-36

[7] Alam M G S, Rahman M A, Khatun M and Ahmed J U 2009 Feed supplementation and weight change, milk yield and post-partum oestrus in Desi cows The Bangladesh Veterinarian 26(2) 39-47

[8] Khamseekhiew B, Liang J B, Wong C C and Jalan Z A 2001 Ruminal and intestinal digestibility of some tropical legume forage Asian-aust. J.Anim. Sci. 14(3) 321-325

[9] Jayanegara A and Sofyan A 2008 Penentuan aktivitas biologis tannin beberapa hijauan secara in vitro menggunakan ‘Hohenheim Gas Test’ dengan polietilen glikol sebagai determinan Med. Pet. 31 44-52

[10] Laconi B and Widiyastuti T 2010 Kandungan Xantofil daun lamtoro (Leucaena leucocephala) hasil detoksifikasi mimosin secara fisik dan kimia Media Peternakan 33(1) 50-53

[11] AOAC 2002 AOAC Official Method 999.10 Lead, Cadmium, Zinc, Copper, and Iron in Foods Atomic Absorption Spectrophotometry after Microwave Digestion. Gaithersburg, MD, Edition 18

[12] Hartadi H, Reksohadiprojo S, and Tillman A D 2005 Tabel Komposisi Pakan untuk Indonesia Cetakan kelima (Yogyakarta: Gadjah Mada University Press)

[13] Sutardi T 2001 Landasan Ilmu Nutrisi (Bogor: Fakultas Peternakan, IPB-Press)

[14] Widodo F, Wahyono and Sutrisno 2012 Kecernaan bahan kering, kecernaan bahan organik, produksi VFA dan NH₃ pakan komplet dengan level jerami padi berbeda secara in vitro Animal Agricultural Journal 1(1) 215 –230

[15] De-Marcio M, Martinez S, Hernandez F, Madrid J, Gai F, Rotolo L, and Schiavone A 2015 Nutritional value of two insect larval meals (Tenebrio molitor and Hermetia illucens) for broiler chickens: Apparent nutrient digestibility, apparent ileal amino acid digestibility and apparent metabolizable energy Animal Feed Science and Technology https://doi.org/10.1016/j.anifeedsci.2015.08.006

[16] Van Soest P J 2006 Rice straw, the role of silica and treatments to improve quality Animal Feed Science and Technology https://doi.org/10.1016/j.anifeedsci.2006.01.023

[17] Ramirez R G, González-Rodriguez H, Morales-Rodriguez R, Cerrillo-Soto A, Juárez Reyes A, García-Dessommes G J and Guerrero-Cervantes M 2009 Chemical composition and dry matter digestion of some native and cultivated grasses in Mexico Czech Journal of Animal Science 54(4) 150 –162

[18] Mertens D R 2009 Maximizing forage use by dairy cows Proc. 27th WCDS - Adv. Dairy Technol. 21 303–319

[19] Colucci P E, Chase L E and Van-Soest P J 1982 Feed intake, apparent diet digestibility, and rate of particulate passage in dairy cattle J Dairy Sci 65 1445-1456
[20] O’Mara F P, Coyle J E, Drennan M J, Young P and Caffrey P J 1999 A comparison of digestibility of some concentrate feed ingredients in cattle and sheep Animal Feed Science and Technology 81(1–2) 167–174 https://doi.org/10.1016/S0377-8401(99)00082-6

[21] Sufyan A B 2018 Factors Affecting Digestibility of Feed (Pakistan: Faculty of Veterinary Sciences, Bahauddin Zakariya University Multan) http://ecoursesonline.iasri.res.in/mod/page/view.php?id=126309

[22] Haque N, Toppo S, Saraswat M L and Khan M Y 2008 Effect of feeding Leucaena leucocephala leaves and twigs on energy utilization by goats Anim. Feed Sci. Tech

[23] Harun N L A, Alimon A R, Jahromi M F and Samsudin A A 2017 Effects of feeding goats with Leucaena leucocephala and Manihot esculenta leaves supplemented diets on rumen fermentation profiles, urinary purine derivatives and rumen microbial population Journal of Applied Animal Research 45(1) 409-416 doi: 10.1080/09712119.2016.1205499

[24] Khabane L 2011 Milk Goat Feeding Systems Using Leucaena Leucephala in Total Mixed Ration. Partial Fulfilmen Of The Requirements For The MSc (Agric): Animal Science. Univ. Van Pretoria

[25] Suphawadee Y, Hiep T and Thang C M 2015 Effects of Leucaena leucocephala supplemental levels in the diet for dairy cattle on animal productivity and enteric methane production J. Animal Husbandry Sciences and Technics (JAHST) 8 197

[26] National Research Council 2001 Nutrient Requirements of Dairy Cattle 7th (Washington DC: National Academy Press)