

Utilization of Mungbean's Green House Fodder and Silage in the Ration for Lactating Dairy Cows

R. Zahera, I. G. Permana, & Despal*

Department of Nutrition and Feed Technology, Faculty of Animal Science, Bogor Agricultural University
Jalan Agatis, Darmaga Campus, Bogor 16680, Indonesia
(Received 24-03-2015; Reviewed 21-05-2015; Accepted 25-06-2015)

ABSTRACT

Green house fodder (GHF) is high quality forage that is produced by hydroponic vertical farming system in green house in short time. Silage is also high quality feed that is available all year rounds. The research aimed to evaluate productivity and nutritive value of mungbean's GHF and its supplementation effect with and without silages based ration on dairy cow performances. The research was divided into two experiments. The first experiment studied the seed density (A1= 1.5 kg/m²; A2= 2.5 kg/m²; A3= 3.5 kg/m²) in bioslurry:ABmix 25:75 media as nutrient solution and used randomized block design. The second experiment studied mungbean's GHF supplementation that used twelve lactating dairy cows with 2 x 2 randomized factorial block design 2 x 2. Factor 1 compared silages utilization (S0= without silages; S1= silages) and factor 2 tested mungbean's GHF supplementation level (G0= 0% DM; G1= 5% DM). The results showed that A1 produced the highest biomass conversion (5.27). GHF had high digestibility and fermentability indicated that GHF had potential as dairy feed. Supplementation of GHF increased nutrient intake. Silage is a high quality feed, so that GHF supplementation did not give significant effects on nutrient digestibility and milk production. It can be concluded that the low seed density (1.5 kg/m²) had high productivity and nutrition quality, and its supplementation increased nutrient intake, but did not affect nutrient digestibility and milk production.

Key words: green house fodder, mungbean, bioslurry, dairy cow, silages

ABSTRAK

Green house fodder (GHF) merupakan hijauan berkualitas tinggi yang dihasilkan dari sistem penanaman vertikal dalam waktu singkat secara hidroponik di rumah kaca. Silase juga merupakan pakan berkualitas yang dapat tersedia sepanjang tahun. Penelitian ini bertujuan untuk melakukan evaluasi produksi dan kualitas nutrisi GHF kacang hijau pada kerapatan berbeda, serta pengaruh suplementasinya pada ransum tanpa dan berbasis silase pada performa sapi perah. Penelitian ini dibagi menjadi dua tahap percobaan. Percobaan ke-1 menguji kerapatan biji (A1= 1.5 kg/m²; A2= 2.5 kg/m²; A3= 3.5 kg/m²) dalam media bioslurry:abmix 25:75 dengan rancangan acak kelompok yang dikelompokkan menjadi 3 kelompok. Percobaan ke-2 menguji suplementasi GHF kacang hijau pada ransum yang berbeda menggunakan 12 ekor sapi perah laktasi dengan rancangan acak kelompok faktorial 2 x 2 yang dikelompokkan menjadi 3 kelompok. Faktor 1 membandingkan penggunaan silase (S0= tanpa silase; S1= silase) dan faktor 2 menguji taraf suplementasi GHF kacang hijau (G0= 0% BK ; G1= 5% BK). GHF dengan kerapatan A1 menghasilkan konversi biomassa tertinggi (5.27). GHF memiliki pencernaan dan fermentabilitas yang tinggi sehingga memiliki potensi sebagai pakan sapi perah. Suplementasi GHF dapat meningkatkan konsumsi nutrisi. Silase merupakan pakan berkualitas tinggi, sehingga suplementasi GHF tidak memberikan pengaruh terhadap pencernaan nutrisi dan produksi susu. Kesimpulannya, kerapatan biji 1.5 kg/m² dapat menghasilkan produktivitas dan kualitas nutrisi yang tinggi dan suplementasinya dapat meningkatkan konsumsi nutrisi, namun tidak berpengaruh terhadap pencernaan nutrisi dan produksi susu.

Kata kunci: green house fodder, kacang hijau, bioslurry, sapi perah, silase

*Corresponding author:
E-mail: despal04@yahoo.com

INTRODUCTION

Dairy farms in Indonesia is mostly traditional dairy farms that have scale of livestock ownership only 6.07 AU, low land ownership (0.44 ha), and milk production 13.5 L/d. Dairy farms in Indonesia only able to meet 20% of national milk requirement (Ditjenak-keswan, 2012). The low of milk production was influenced by genetic, environment, and feed factors. Improved feed management and quality was expected to increase milk production and quality, especially for forage production and quality. Forage is one of effective fiber sources that are utilized by cows to persistence milk fat (Lechartier & Peyraud, 2010; Yang & Beauchemin, 2006). However, the major constrain of forage production are limited forages in dry season and limited land to plant forages. Farmers usually increase concentrates proportion in diet to solve limited forages in dry season. However, it could increase risk of metabolic disorder, such as acidosis (Rustomo, 2008).

The availability of forages could be solved by silage technology that preserved fresh forage at minimal losses (Yitbarek & Tamir, 2009). Silage is forage that is preserved through an ensilage process by using spontaneous labor lactic acid fermentation under anaerobic conditions (Despal *et al.*, 2011). Last research showed that silages for traditional dairy farm could increase milk production. Benchaar *et al.* (2014) reported that giving maize silages in ration of dairy cows until 54% could increase nutrient intake, digestible nutrient, and milk production from 31.9 to 37 kg/d. Maize silage had high *in vitro* digestibility ranged 60.1%-63.1% (Di Marco *et al.*, 2005).

Limited land to plant forages was caused by high competition of land utilization and land conversion for non-agriculture. This condition indicated the important of effective land utilization. Green House Fodder (GHF) or Hydroponic Fodder is forage that is produced by hydroponic vertical farming system in green house to solve limited land to plant forages. GHF is high quality forages with digestibility of more than 80%. Crude protein, NDF, and ADF conversion of seed to barley fodder were 1.36; 1.68; and 2.28 respectively (Fazaeli *et al.*, 2012) that was potential as a ruminant feed (Fazaeli *et al.*, 2011; Naik *et al.*, 2014).

As ruminant, dairy cows produce methane gas. The gas is one of greenhouse gases. The efforts to mitigate the greenhouse gas emission had been done through feed quality improvement (Antonius *et al.*, 2015) and biogas production (Pathak *et al.*, 2009). So far, dairy farmers are still discouraged to manage cattle waste and produce biogas due to low profit and high investment cost. One of solution to increase farmer income is utilization of biogas by-product, such as bio slurry. Bio slurry is an anaerobic fermented organic material released as a by-product from the biogas plant after production of methane gas and an effective source of organic fertilizer that contained high organic matter (Nasir *et al.*, 2012). Bioslurry could be utilized as nutrient solution to improve productivity of GHF until 25% to substitute nutrient source from ABmix commercial fertilizer.

Productivity and nutrition quality of GHF could be influenced by type of seed. Some types of seeds that were produced by hydroponic system were alfalfa, barley, cowpea, sorghum, wheat (Al-Karaki *et al.*, 2011), and corn (Naik *et al.*, 2012). One of seed that has potential to be germinated in Indonesia is mungbean (*Vigna radiata*). Mungbean's sprout grows fast and contains high protein and crude fiber which are frequently deficient in dairy cow diets. Productivity of mungbean's GHF is influenced by seed conversion to fodder that is influenced by seed density. Currently, there is limited information available on the optimum seed density to produce the best conversion rate of seed to sprout. Information on utilization of mungbean's GHF in dairy cow ration is also limited. The research aimed to evaluate productivity and nutrition value of mungbean's GHF with different seed densities and study the effect of their inclusion in dairy cow's diet on dairy cow performances at Demo Farm Lembang with or without silages based ration.

MATERIALS AND METHODS

Experiment 1. Production and Nutritional Quality of Mungbean's Green House Fodder

Experiment 1 was carried out in Green House of University Farm, at Biological Resources Research Center and Biotechnology, and Dairy Nutrition Laboratory, Bogor Agricultural University. Experiment 1 used randomized block design with 3 treatments divided into 3 groups based on tray position intended to test seed densities (A1= 1.5 kg/m²; A2=2.5 kg/m²; A3= 3.5 kg/m²) in bioslurry:ABmix 25:75 media as nutrient solution. Variation among treatments and their interactions were analyzed by using ANOVA followed by polynomial orthogonal test (Steel & Torrie, 1993).

Mungbean's (*V. radiata*) seed and tray were cleaned first and seeds were soaked with clean water for 24 h before being germinated. After that, seeds were spread in tray based on treatment of seed density. Irrigation was applied 4 times a day for 8 d. Parameters observed were productivity, nutrient composition and conversion, and nutritional quality (*in vitro*).

Sprout height and biomass production were measured at 8 d after germinating. Biomass and nutrient conversion were measured by ratio biomass production and nutrient composition of mungbean's GHF with biomass and nutrient composition of seed that were used (Fazaeli *et al.*, 2012).

Mungbean's seed and GHF were dried and ground to produce meals. The meals were analyzed for their nutrient compositions including moisture, ash, crude protein, ether extract, and crude fiber contents (AOAC 2005). Nutrient composition of mungbean's seed and GHF were measured to know the changes nutrient compositions that were caused by germination (Fazaeli *et al.*, 2012). The meals were also analyzed for *in vitro* digestibility by using Tilley & Terry (1963) methods. Ruminant fermentability including total VFA (steam distillation) and N-NH₃ (micro diffusion Conway) by using method

of Despal *et al.* (2011). Three ruminal fluids were used as inoculant.

Experiment 2. Green House Fodder Supplementation in Dairy Cows Rations

Experiment 2 was carried at Demo Farm, Lembang and Biological Resources Research Center and Biotechnology, Bogor Agricultural University. Mungbean's GHF were germinated for 9 d at the best seed density resulted from experiment 1. One day before harvesting, nutrient supply was stopped to remove fertilizer residues. The whole part of mungbean's GHF were harvested and given to dairy cows.

In vivo study was conducted for 4 wk with 2 wk of preliminary study. Twelve lactating dairy cows were divided into three groups based on months of milking (early, middle, and end lactation). The treatments were distributed among the groups and each group received all the treatments. The treatments consisted of two factors, namely silage utilization (S0= without silages, S1= with silages) and mungbean's GHF supplementation level (G0= 0% DM, G1= 5% DM) that were assigned into a block factorial design. Variation among treatments and their interactions were analyzed by using ANOVA follow by Duncan-test (Steel & Torrie, 1993).

Table 1 and Table 2 showed ration formulations and their nutrient compositions. The cows were fed twice daily. Mungbean's GHF supplementations were given before concentrates as many as 3.5 kg/cow/d (5% DM). Parameters observed in this experiment were nutrient intake, nutrient digestibility, and milk production.

Feed intake was recorded daily and milk production was measured twice daily at 5.00 am and 3.00 pm. Nutrient digestibility was measured by collecting feces for six days at the end of feeding period (Naik *et al.*, 2014). Feces samples were collected as much as 10% of feces total daily. Feces samples were dried, ground, and analyzed for nutrient compositions based on proximate analysis (AOAC, 2005). Nutrient compositions of feed and feces were measured to calculate nutrient digestibility.

RESULTS AND DISCUSSION

Experiment 1. Production and Nutrition Quality of Mungbean's Green House Fodder

Mungbean's GHF productivity including sprout height, biomass production and conversion can be seen in Figure 1. Plant height weren't influenced by seed density, however high seed density (3.5 kg/m²) increased biomass production and low seed density (1.5 kg/m²) increased biomass conversion (P<0.05). Increased seed density could increase biomass production, while it could decrease biomass conversion. Increased biomass production due to increased amount of seed that used, however nutrient, water, and light competitions on high seed density caused the decreased nutrient conversion. Plant competition could inhibit sprout growth that was germinated in green house because of the low nutrient availability (Knochel *et al.*, 2010).

Nutrient compositions of mungbean's GHF were not influenced by seed density. However, there were different nutrient compositions of mungbean's seed and mungbean's GHF (Table 3). Dry matter of mungbean's GHF was lower than mungbean's seed (21.77% vs 89.86%). Dry matter loss was due to the increased water uptake during germination process. Water is one of the basic requirements for seed germination and seedling growth as it is essential for enzyme activation, reserve storage breakdown, and nutrient translocation (El-Karaki *et al.*, 2011).

Ash, crude protein, ether extract, and crude fiber of mungbean's GHF were higher than initial seed, except NFE of mungbean's GHF was lower than initial mungbean's seed. Nutrient changes of mungbean's GHF could be also affected by germination process.

Table 1. Feed and nutrient composition of treatment diets (% dry matter basis)

Feed ingredients	S0		S1	
	G0	G1	G0	G1
Concentrates ^{*)}	68	64	61	58
Elephant grass	32	31	22	21
Maize silage			17	16
Mungbean's green house fodder (GHF)		5		5
Total	100	100	100	100
Nutrient composition (%)				
Ash	11.49	11.38	11.39	11.29
Crude protein (CP)	16.47	17.52	15.56	16.62
Ether extract (EE)	5.42	5.22	5.73	5.52
Crude fiber (CF)	16.80	16.6	16.25	16.09
Nitrogen free extract (NFE)	49.83	49.28	51.07	50.47
Total digestible nutrient (TDN)	66.89	67.39	67.54	67.98

Note: ^{*)}S0= used concentrate A; S1= used concentrate B; G0= 0% DM mungbean's GHF; G1; 5% DM mungbean's GHF; TDN estimated by formula (Sutardi, 2001): TDN = 2.79 + 1.17 CP + 1.74 EE - 0.295 CF + 0.810 NFE.

Table 2. Feed and nutrient composition of concentrates (% dry matter basis)

Feed Ingredient	Concentrate A	Concentrate B
Mako	73.50	96.70
Boiled soybean		3.30
Tofu by-product	26.50	
Total	100.00	100.00
Nutrient composition (%)		
Ash	8.46	10.01
Crude Protein	17.00	16.94
Ether Extract	7.13	7.42
Crude Fiber	10.66	8.37
Nitrogen Free Extract (NFE)	56.75	57.25
Total digestible nutrient (TDN)	79.42	77.90

Note: TDN estimated by formula (Sutardi, 2001): TDN = 2.79 + 1.17 CP + 1.74 EE - 0.295 CF + 0.810 NFE.

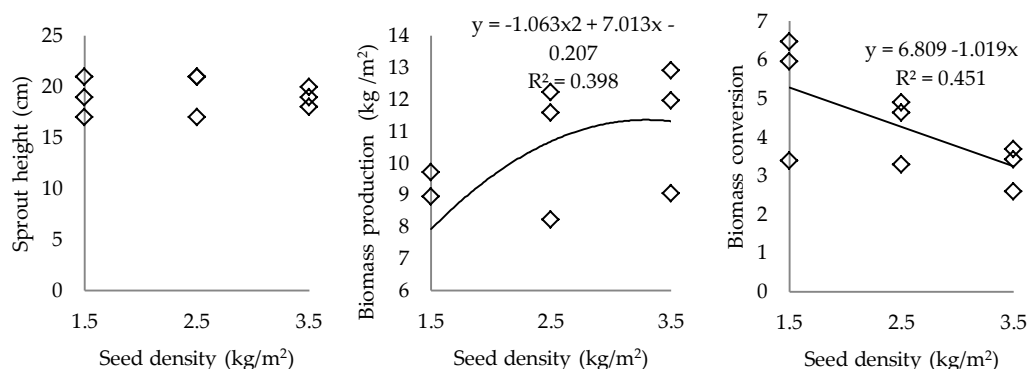


Figure 1. Relationship between seed density and green house fodder (GHF) productivity

Table 3. Nutrient composition of seed and mungbean’s green house fodder (GHF)

Nutrient composition	Mungbean seed	Seed density		
		A1	A2	A3
Plant height (cm)	-	19.00±2.00	19.67±2.31	19.00±1.00
Biomass prod (kg/m²)	-	7.92±2.48	10.68±2.15	11.31±2.01
Conversion (g GHF/g seed)	-	5.27±1.65	4.27±0.86	3.23±0.57
Dry matter (DM) (%)	89.86	21.94±1.33	21.01±0.49	22.36±1.38
Ash (%DM)	4.49	7.27±0.32	6.97±0.20	7.15±0.16
Crude protein (CP) (%DM)	23.38	34.71±2.06	35.41±0.63	36.11±2.40
Ether extract (EE) (%DM)	0.70	1.09±0.10	1.35±0.16	1.15±0.15
Crude fiber (CF) (%DM)	7.67	12.02±1.38	11.85±0.40	12.76±1.73
Nitrogen free extract (NFE) (%DM)	63.76	44.91±3.43	44.43±0.82	42.83±4.20
Total digestible nutrient (TDN)	82.22	73.04±2.22	73.56 ± 0.38	72.00±2.69

Note: A1= 1.5 kg/m²; A2= 2.5 kg/m²; A3= 3.5 kg/m²; TDN estimated by formula (Sutardi, 2001); TDN= 25.6 + 0.530 CP + 1.70 EE - 0.474 CF + 0.732 NFE.

Germination required high organic matter for metabolism and energy requirement of the growing, so plant produced lower organic matter and higher ash composition than their seeds (Fazaeli *et al.*, 2012). Crude protein composition of mungbean’s GHF could be increase by increased nitrogen supplementation from nutrient solution during germination (Naik *et al.*, 2012). Germination of legume seed is able to improve protein composition (Ghavidel & Prakash, 2007). Increased ether extract could be due to the production of chlorophyll associated with plant growth that is recovered in ether extract (Fazaeli *et al.*, 2012). Enhanced crude fiber could be due to cellulose and hemicelluloses synthesis during germination (Naik *et al.*, 2012). The changes of polysaccharides in the cell wall such as cellulose, glucose and mannose are caused by the increase in the cellular structure of the plant during germination (Rumiyati *et al.*, 2012). Decreased NFE of mungbean’s GHF is caused by the increased composition of organic matter, such ash, crude protein, and crude fiber (Fazaeli *et al.*, 2012).

Low seed density (1.5 kg/m²) increased nutrient conversion (Figure 2). Enhanced seed density caused the decreased nutrient conversion that could be caused by plant competition to uptake nutrient, water, and lighting. This competition caused the low nutrient availability of high seed density (Knochel *et al.*, 2010). Nutrient conversion is affected by several factors, such

as management, type and quality of seed, amount and frequency of irrigation, nutrition solution, temperature, humidity, density and position of lights, seed density on each tray, and the number of days allowed to grow (Fazaeli *et al.*, 2012).

In vitro digestibility and ruminal fermentability can be seen in Figure 3. Digestibility determines the relation between compositions of nutrients and energy that are available for ruminants (Forejtová *et al.*, 2005). *In vitro* digestibility is an indicator of feed degradation by rumen microbes and digested by digestive enzymes in post rumen. *In vitro* digestibility is not influenced by seed density. Hydroponic fodder was high quality forage that had high digestibility. Fazaeli *et al.* (2012) reported that barley hydroponic fodder had 81.86% *in vitro* organic matter digestibility. *In vitro* dry and organic matter digestibilities of mungbean’s GHF were 76.22% and 74.91%, respectively. Digestibility value of more than 70% indicated that mungbean’s GHF had a high digestibility and a great potential as a dairy feed.

Ammonia and VFA total concentrations are indicators of feedstuffs fermentability in the rumen. Ammonia concentrations were increased by high seed density (3.5 kg/m²) (P<0.05). Enhanced seed density could increase ammonia concentration. Ammonia concentrations were influenced by crude protein composition (Cherdthong & Wanapat, 2013; Joo *et al.*, 2005). The range of ammonia

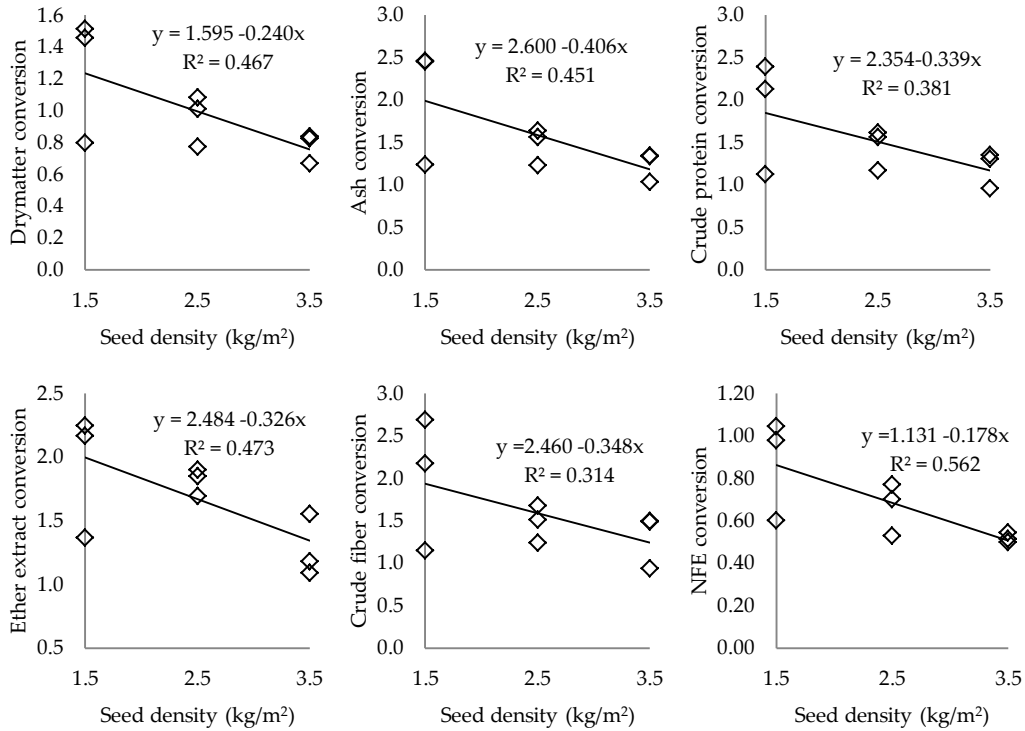


Figure 2. Relationship between seed density and nutrient conversion

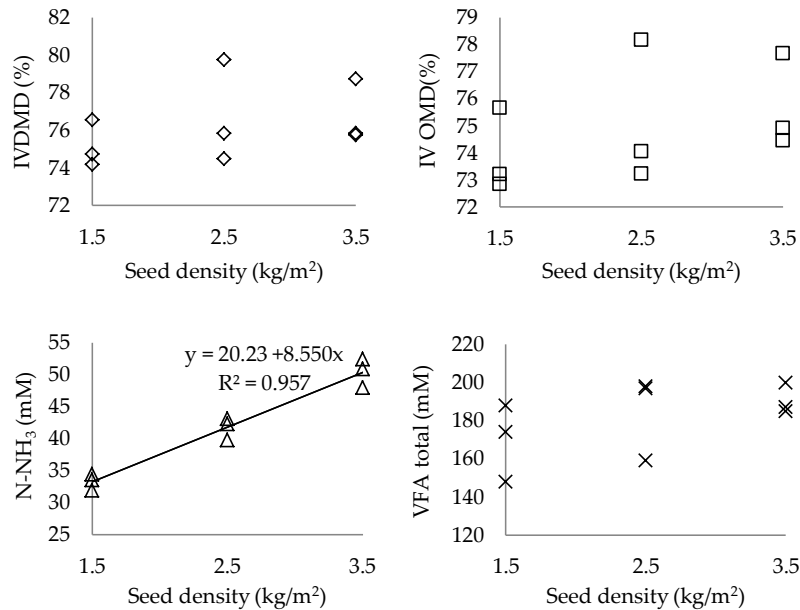


Figure 3. Relationship between seed density and nutrition quality

concentrations of mungbean's GHF was 33.30-50.40 mM with high crude protein ranged of 34.71-36.11%DM. The high concentrations of ammonia indicated that protein content in feed could be degraded easily by rumen microbes (Despal *et al.*, 2011). The high ammonia concentrations caused mungbean's GHF could not be given in high proportion in dairy cow diets due to the high degradable protein could cause excess ammonia concentrations that couldn't be utilized for microbe proteins synthesis if it wasn't offset by availability of carbon

(Despal *et al.*, 2011) that eventually could increase nitrogen excretion (Agle *et al.*, 2010).

Total VFA totals weren't not influenced by seed density; however there was a tendency of to increased total VFA total. Total VFA totals of mungbean's GHF ranged from 170.04 to-190.55 mM. The high production of total VFA total indicated high organic matter that was degraded easily by rumen microbes (Joo *et al.*, 2005). The high total VFA total of mungbean's GHF was associated with due to the high organic matter content,

especially degradable protein and NFE that . It was also indicated by the high ammonia concentrations of mungbean's GHF.

Experiment 2. Mungbean's Green House Fodder Supplementation in Dairy Cow Rations

Experiment 2 evaluated the effects of mungbean's GHF supplementation with and without silages based ration on dairy cow performances. Nutrient intake of dairy cows in this experiment was presented in Table 4. Mungbean's GHF supplementation influenced nutrient intake of dairy cows ($P<0.05$). Nutrient intake of dairy cows supplemented with mungbean's GHF were higher than those without mungbean's GHF supplementation due to mungbean's GHF contained high nutrient composition and its supplementation did not decrease intake of another feedstuffs (Astuti *et al.*, 2009). Silages utilization also influenced nutrient intake ($P<0.05$), however did not affect CP intake. Nutrient intake of maize silage-based rations were higher than without maize silages due to maize silage is complex feedstuff contained whole part of maize (Di Marco *et al.*, 2005), with dry matter (25.71%) that was higher than elephant grass (13.13%). Dry matter of maize silage in this experiment was within the range reported by Sariçiçek & Kiliç (2009), i.e. 25.17%-28.74%.

Dry matter intake in this experiment was in the range reported by Astuti *et al.* (2009), i.e. 14.09-17.44 kg/d/cow. However, CP intake was higher than reported by Astuti *et al.* (2009), i.e. 1.25-1.88 kg/d/cow. CP intake this experiment showed the high value of intake, i.e. 16-17%DM. Huhtanen & Hetta (2012) reported that 16.8% of CP resulted in average milk yield of dairy cows by 24.5 kg/d.

Nutrient digestibility in this experiment is presented in Table 5. Mungbean's GHF supplementation did not affect nutrient digestibility of dairy cows. Nugroho *et al.* (2015) also reported that there was no significant different in nutrient digestibility between with and without hydroponic fodder supplementation. Increasing nutrient intake on mungbean's GHF supplementation with roughly the same digestibility indicating a higher digestible nutrient and could increase nutrients availability for dairy cows (Despal, 2007).

Silages utilization influenced nutrient digestibility ($P<0.05$), however did not decrease CP and CF digestibility. This effect could be due to the quality of maize silage that was higher than that of elephant grass and nutrient degradability of maize silage was improved due to ensilage process. Maize silage contained corn as additive of silage that stimulated fermentation of lactic acid bacteria (Sariçiçek & Kiliç, 2009) by the supplementation of soluble carbohydrates (Despal *et al.*, 2011; Yitbarek & Tamir, 2014). Silage with corn additive resulted in high organic matter digestibility (73.6%) (Despal *et al.*, 2011). Di Marco *et al.* (2005) also reported maize silage resulted *in vitro* digestibility ranged 60.1%-63.1%.

Nutrient digestibility in this experiment showed high value of digestibility. Naik *et al.* (2014) reported that dry and organic matter of dairy cows fed hydroponic fodder were 65.39% and 68.47%, respectively. Nutrient intake and digestibility have positive correlation with milk yield. Huhtanen *et al.* (2009) reported that 73.3% organic matter digestibility resulted in average milk yield of 26.7 kg/d.

Milk production in this experiment is presented in Table 6. Mungbean's GHF supplementation did not affect milk production, however milk production tended

Table 4. Nutrient intake of dairy cows supplemented with mungbean's green house fodder (GHF) in different diets (kg/cow/d)

Nutrient intake	GHF supplementation	Silages utilization		Average
		S0	S1	
Dry matter	G0	14.14±0.01	14.92±0.02	14.53±0.55 ^b
	G1	14.94±0.01	15.71±0.02	15.33±0.55 ^a
	Average	14.54±0.56 ^b	15.32±0.56 ^a	
Organic matter	G0	12.52±0.01	13.22±0.02	12.87±0.50 ^b
	G1	13.24±0.01	13.94±0.03	13.59±0.50 ^a
	Average	12.88±0.51 ^b	13.58±0.51 ^a	
Crude protein	G0	2.33±0.00	2.32±0.01	2.33±0.01 ^b
	G1	2.62±0.00	2.61±0.01	2.62±0.01 ^a
	Average	2.47±0.21	2.47±0.21	
Ether extract	G0	0.79±0.00	0.86±0.01	0.82±0.04 ^b
	G1	0.81±0.00	0.87±0.00	0.84±0.04 ^a
	Average	0.80±0.01 ^b	0.86±0.01 ^a	
Crude fiber	G0	2.38±0.00	2.42±0.00	2.40±0.03 ^b
	G1	2.48±0.00	2.53±0.01	2.51±0.03 ^a
	Average	2.43±0.07 ^b	2.47±0.07 ^a	
Nitrogen free extract	G0	7.17±0.00	7.69±0.01	7.43±0.37 ^b
	G1	7.48±0.01	8.00±0.02	7.74±0.37 ^a
	Average	7.32±0.22 ^b	7.85±0.22 ^a	

Note: Means with different superscripts differ significantly ($P<0.05$). S0= without silages; S1= with silage; G0= 0% DM mungbean's GHF; G1= 5% DM mungbean's GHF.

Table 5. Nutrient digestibility of dairy cows supplemented with mungbean's green house fodder (GHF) in different diets (%)

Nutrient digestibility	GHF supplementation	Silages utilization		Average
		S0	S1	
Dry matter	G0	71.51±2.69	73.05±0.25	72.28±1.09
	G1	71.48±2.28	73.39±1.13	73.22±1.35
	Average	71.50±0.02 ^b	73.22±0.24 ^a	
Organic matter	G0	72.67±2.23	74.68±0.22	73.67±1.42
	G1	72.55±2.05	74.93±0.87	73.74±1.68
	Average	72.61±0.09 ^b	74.80±0.18 ^a	
Crude protein	G0	77.75±3.01	78.39±0.57	78.07±0.45
	G1	77.40±2.77	79.33±0.31	78.37±1.37
	Average	77.57±0.24	78.86±0.67	
Ether extract	G0	90.98±1.31	94.54±1.72	92.76±2.51
	G1	89.69±1.32	93.55±1.01	91.62±2.72
	Average	90.34±0.91 ^b	94.04±0.70 ^a	
Crude fiber	G0	65.56±1.64	66.54±1.12	66.05±0.69
	G1	64.85±2.25	66.99±3.49	65.92±1.51
	Average	65.20±0.50	66.76±0.32	
Nitrogen free extract	G0	71.93±2.99	74.15±0.99	73.04±1.57
	G1	72.10±2.06	74.20±1.20	73.15±1.48
	Average	72.01±0.13 ^b	74.17±0.04 ^a	
Total digestible nutrient	G0	71.76±1.93	73.43±0.15	72.59±1.18
	G1	71.34±1.74	73.39±0.71	72.36±1.45
	Average	71.55±0.30 ^b	73.41±0.03 ^a	

Note: Means with different superscripts differ significantly ($P < 0.05$). S0= without silages; S1= with silage; G0= 0% DM mungbean's GHF; G1= 5% DM mungbean's GHF.

Table 6. Milk production of dairy cows supplemented with mungbean's green house fodder (GHF) in different diets (L/cow/d)

GHF supplementation	Silages utilization		Average
	S0	S1	
G0	18.19±3.25	19.73±3.43	18.96±1.09
G1	19.12±4.39	19.77±3.43	19.44±0.46
Average	18.66±0.66 ^b	19.75±0.03 ^a	

Note: Means with different superscripts differ significantly ($P < 0.05$). S0= without silages; S1= with silage; G0= 0% DM mungbean's GHF; G1= 5% DM mungbean's GHF.

to increase, especially in cows without silages based ration ($P = 0.209$). This effect was due to the higher nutrient intake, especially dry matter, crude protein, and NFE intake. Milk production has positive correlation with dry matter intake (Hristov *et al.*, 2005; Huhtanen & Hetta, 2012). Intake of NFE influence milk production due to the increased glucose production as a lactose precursor that eventually increased milk production (Kittivachra *et al.*, 2007).

Silages utilization influenced milk production ($P < 0.05$). Maize silage-based rations resulted higher milk production than without silages due to the high nutrient intake and digestibility. Milk production also had positive correlation with nutrient intake and digestibility (Huhtanen *et al.*, 2009). Keady *et al.* (2008) reported that substitution of grass silage to maize silage could increase milk production by 0.8 kg/d. Benchaar *et al.* (2014)

also reported that the use of maize silages in dairy cow diets up to 54% could increase milk yield from 31.9 to 37 kg/d. This result indicated that maize silage could improve milk production of dairy cows.

Silages based ration is a high quality feed, so that the non-significant effect of mungbean's GHF supplementation in silage based ration on milk production was caused by genetic and environment factors of dairy cows in Indonesia that could not produce milk production more than 20 L/cow/d. Genetic improvement of Friesian Holstein dairy cattle in Indonesia should be done through genetic selection to get superior breeding dairy cattle on milk production and protein according to the conditions cultivation in farmers and Indonesia's tropical climate (Anggraeni, 2012). Dairy cows in traditional farm (Demo Farm Lembang) could reach an average production of more than 15 L/cow/d. Milk production could be affected by the ratio of forage and concentrates that were used. The high ratio of concentrates in this study was one of the factors that lead to higher milk production. Neveu *et al.* (2013) reported that feeding with forages and concentrates ratio of 40:60 could produce higher milk production of 41.7 kg/cow/d compared with a ratio of 60:40 was only 39.7 kg/cow/d. Based on environmental factors, environmental conditions in Lembang was at thermoneutral zone. This condition could increase milk production, while the outside of thermoneutral zone caused heat stress, increased physiological status and decreased milk production (Wheelock *et al.*, 2010).

CONCLUSION

Mungbean's GHF with low seed density (1.5 kg/m²) produced the highest biomass conversion. High digestibility and fermentability of mungbean's GHF indicated it could be utilized as dairy feed. Cows fed with silages based ration showed higher nutrient intake, digestibility, and milk production than those fed without silages. Mungbean's GHF supplementation (5% DM) increased nutrient intake, but did not affect nutrient digestibility and milk production.

REFERENCES

- Agle, M. A., N. Hristov, S. Zaman, C. Schneider, P. M. Ndegwa, & V. K. Vaddella. 2010. Effect of dietary concentrate on rumen fermentation, digestibility, and nitrogen losses in dairy cows. *J. Dairy. Sci.* 93 :4211–4222. <http://dx.doi.org/10.3168/jds.2009-2977>
- Anggraeni, A. 2012. Perbaikan genetik sifat produksi susu dan kualitas susu sapi Friesian Holstein melalui seleksi. *Wartazoa* 22: 1-11.
- Al-Karaki, G. N. & M. Al-Hashimi. 2011. Green fodder production and water use efficiency of some forage crops under hydroponic conditions. *ISRN Agronomy*. 10:1-5.
- Antonius, K. G. Wiryawan, A. Thalib, & A. Jayanegara. 2015. Digestibility and methane emission of ration based on oil palm by products supplemented with probiotics and banana stem: an *in vitro* study. *Pakistan Journal of Nutrition*. 14:37-43. <http://dx.doi.org/10.3923/pjn.2015.37.43>
- AOAC. 2005. Official Methods of Analysis of AOAC International. 18th ed. Assoc. Off Anal. Chem., Arlington.
- Astuti, A., A. Agus, & S. P. S. Budhi. 2009. Pengaruh penggunaan high quality feed supplement terhadap konsumsi dan kecernaan nutrisi sapi perah awal laktasi. *Buletin Peternakan* 33: 81-87.
- Benchaar, C., F. Hassanat, R. Gervais, P. Y. Chouinard, H. V. Petit, & D. I. Massé. 2014. Methane production, digestion, ruminal fermentation, nitrogen balance, and milk production of cows fed corn silage- or barley silage-based diets. *J. Dairy. Sci.* 97:961–974. <http://dx.doi.org/10.3168/jds.2013-7122>
- Cherdthong, A. & M. Wanapat. 2013. Manipulation of *in vitro* ruminal fermentation and digestibility by dried rumen digesta. *Livest. Sci.* 153:94–100. <http://dx.doi.org/10.1016/j.livsci.2013.02.008>
- Despal, I.G. Permana, S.N. Safarina, & A.J. Tatra. 2011. Penggunaan berbagai sumber karbohidrat terlarut air untuk meningkatkan kualitas silase daun rami. *Med. Pet.* 34:69-76. <http://dx.doi.org/10.5398/medpet.2011.34.1.69>
- Despal. 2007. Suplementasi nutrisi defisien untuk meningkatkan penggunaan daun rami (*Boehmeria nivea*, L. Gaud) dalam ransum domba. *Med. Pet.* 30:181-188.
- Di Marco, O. N., M. S. Aello, S. Arias. 2005. Digestibility and ruminal digestion kinetics of corn silage. *Arq. Bras. Med. Vet. Zootec.* 57:223-228. <http://dx.doi.org/10.1590/S0102-09352005000200014>
- Ditjenak-Keswan (Direktorat Jendral Peternakan and Kesehatan Hewan). 2012. Bersama membangun persusuan nasional. <http://ditjenak.pertanian.go.id/berita-337-bersama-membangun-persusuan-nasional.html> [7 Maret 2015].
- Fazaeli, H., H. A. Golmohammadi, A. A. Shoayee, N. Montajebi, & S. H. Mosharraf. 2011. Performance of feedlot calves fed hydroponics fodder barley. *Journal Agriculture Science Technology*. 13:367-375.
- Fazaeli, H., H. A. Golmohammadi, S. N. Tabataboyee, & M. Asghari-Tabrizi. 2012. Productivity and nutritive value of barley green fodder yield in hydroponic system. *World Applied Sciences Journal* 16:531-539.
- Forejtová, J., F. Lád, J. Třináctý, M. Richter, M. Gruber, P. Doležal, P. Homolka, & L. Pavelek. 2005. Comparison of organic matter digestibility determined by *in vivo* and *in vitro* methods. *Czech Journal of Animal Science* 50:47–53.
- Ghavidel, R.A. & J. Prakash. 2007. The impact of germination and dehulling on nutrients, antinutrients, *in vitro* iron and calcium bioavailability and *in vitro* starch and protein digestibility of some legume seeds. *J. Food Sci. Technol.* 40:1292–1299. <http://dx.doi.org/10.1016/j.lwt.2006.08.002>
- Hristov, N., W. J Price, & B. Shafii. 2005. A meta-analysis on the relationship between intake of nutrients and body weight with milk volume and milk protein yield in dairy cows. *J. Dairy Sci.* 88:2860–2869. [http://dx.doi.org/10.3168/jds.S0022-0302\(05\)72967-2](http://dx.doi.org/10.3168/jds.S0022-0302(05)72967-2)
- Huhtanen P, & M Hetta. 2012. Comparison of feed intake and milk production responses in continuous and change-over design dairy cow experiments. *Livest. Sci.* 143:184–194. <http://dx.doi.org/10.1016/j.livsci.2011.09.012>
- Huhtanen, P., M. Rinne, & J. Nousiainen. 2009. A meta-analysis of feed digestion in dairy cows: 2. The effects of feeding level and diet composition on digestibility. *J. Dairy Sci.* 92:5031–5042. <http://dx.doi.org/10.3168/jds.2008-1834>
- Joo, J. W., G. S Bae, W. K Min, H. S Choi, W. J Maeng, Y. H Chung, & M. B Chang. 2005. Effect of protein sources on rumen microbial protein synthesis using rumen simulated continuous culture system. *Asian-Australas. J. Anim. Sci.* 18:326-331. <http://dx.doi.org/10.5713/ajas.2005.326>
- Keady, T. W. J, D. J. Kilpatrick, C. S. Mayne, & F. J. Gordon. 2008. Effects of replacing grass silage with maize silages, differing in maturity, on performance and potential concentrate sparing effect of dairy cows offered two feed value grass silages. *Livest. Sci.* 119:1–11. <http://dx.doi.org/10.1016/j.livsci.2008.02.006>
- Kittivachra, R., R. Sanguandeeikul, R. Sakulbumrungsil, P. Phongphanphanee. 2007. Factors affecting lactose quantity in raw milk. *J. Sci. Technol.* 29:937-943.
- Knochel, D. G., C. Flagg, & T. R. Seastedt. 2010. Effect of plant competition, seed predation, and nutrient limitation on seedling survivorship of spotted knapweed. *Biol. Invasions.* 12:3771-3784. <http://dx.doi.org/10.1007/s10530-010-9769-9>
- Lechartier, C., & L. Peyraud. 2010. The effects of forage proportion and rapidly degradable dry matter from concentrate on ruminal digestion in dairy cows fed corn silage-based diets with fixed neutral detergent fiber and starch contents. *J. Dairy Sci.* 93:666–681. <http://dx.doi.org/10.3168/jds.2009-2349>
- Naik, P. K., R. B. Dhuri, B. K. Swain, & N. P. Singh. 2012. Nutrient changes with growth of hydroponic fodder corn. *Indian Journal of Animal Nutrition.* 29:161-163.
- Naik, P. K., R. B. Dhuri, M. Karunakaran, B. K. Swain, & N. P. Singh. 2014. Effect of feeding hydroponics maize fodder on digestibility of nutrients and milk production in lactating cows. *Indian Journal of Animal Science.* 84:880-883.
- Nasir, A., M. U. K. Halid, S. Anwar, C. Arslan, M. J Akhtar, & M. Sultan. 2012. Evaluation of bio-fertilizer application to ameliorate the environment and crop production. *Pakistan Journal of Agriculture Science.* 49:527-531.
- Neveu, C., B. Baurhoo, & A. Mustafa. 2013. Effect of feeding extruded flaxseed with different forage:concentrate ratios on the performance of dairy cows. *J. Dairy Sci.* 96:1–9. <http://dx.doi.org/10.3168/jds.2012-6189>
- Nugroho, H. D., I. G. Permana, & Despal. 2015. Utilization of bioslurry on maize hydroponic fodder as a corn silage supplement on nutrient digestibility and milk production of dairy cows. *Med. Pet.* 38:70-76. <http://dx.doi.org/10.5398/medpet.2015.38.1.70>

- Pathak, H., N. Jain, A. Bhatia, S. Mohanty, Navindu, & Gupta.** 2009. Global warming mitigation potential of biogas plants in India. *Environmental Monitoring and Assessment*. 157:407-418. <http://dx.doi.org/10.1007/s10661-008-0545-6>
- Rumiyati, P. Anthony, James, & V. Jayasena.** 2012. Effect of germination on the nutritional and protein profile of Australian sweet lupin (*Lupinus angustifolius* L.). *Food and Nutrition Sciences*. 3:621-626. <http://dx.doi.org/10.4236/fns.2012.35085>
- Rustomo, B.** 2008. Feeding complete feed containing different acidogenic value and effective fiber affect rumen acidosis depression. *Animal Production*. 10:102-109.
- Sarıçiçek, B. Z. & Ü. Kiliç.** 2009. The effects of different additives on silage gas production, fermentation kinetics and silage quality. *Ozean Journal of Applied Sciences*. 2:11-18.
- Steel R. G. D., & J. H. Torrie.** 1993. *Prinsip dan Prosedur Statistika Suatu Pendekatan Biometrik*. Terjemahan: B. Sumantari. Ed ke-3. Gramedia, Jakarta.
- Sutardi, T.** 2001. Revitalisasi Peternakan Sapi Perah Melalui Penggunaan Ransum Berbasis Limbah Perkebunan dan Suplemen Mineral Organik. Laporan Penelitian Riset Unggulan Terpadu. LPPM Institut Pertanian Bogor, Bogor.
- Tilley, J.M.A., & R.A.Terry.** 1963. A two stage techniques for the *in vitro* digestion of forage crops. *J British. Grassl. Soc.* 18: 104-111. <http://dx.doi.org/10.1111/j.1365-2494.1963.tb00335.x>
- Wheelock, J. B., R. P. Rhoads, M. J Vanbaale, S. R. Sanders, & L. H. Baumgard.** 2010. Effects of heat stress on energetic metabolism in lactating Holstein cows. *J. Dairy Sci.* 93:644 (Abstr). <http://dx.doi.org/10.3168/jds.2009-2295>
- Yang, W.Z., & K. A. Beauchemin.** 2006. Physically effective fiber: method of determination and effects on chewing, ruminal acidosis, and digestion by dairy cows. *J. Dairy Sci.* 89:2618-2633. [http://dx.doi.org/10.3168/jds.S0022-0302\(06\)72339-6](http://dx.doi.org/10.3168/jds.S0022-0302(06)72339-6)
- Yitbarek, M. B., & B. Tamir.** 2014. Silage additives: review. *Journal of Applied Sciences*. 4:258-274. <http://dx.doi.org/10.4236/ojapps.2014.45026>