Evaluation partial substitution of fresh forage with silage on dairy milk production in Kunak which added palm kernel meal and *Gracilaria sp* on daily feed

Agustin Herliatika*¹⁾, Idat Galih permana²⁾ and Despal²⁾

¹⁾ Indonesian Research Institute for Animal Production

²⁾ Department of Nutrition and Feed Science, Faculty of Animal Science, Postgraduate School, IPB University, Kampus IPB, Jl. Agatis, Babakan, Kec. Dramaga, Bogor, Jawa Barat, Indonesia, 16680

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ABSTRACT: Kunak is the biggest community for a traditional dairy cattle farmer in West of Java. Providing good qualities and quantities of forage continuously in a year for ruminants, still be one problem in this community caused by different forage production between the dry season and rainy season. High forage production in the rainy season could be stored as silage to provide forage requirement in the dry season. These research examined in 2 experiments. The first experiment aimed to determine the effect partial-substitute of fresh forage uses grass silage on the quantities and qualities of daily milk production. The second experiment aimed to determine the quantities and qualities of dairy cattle milk production, affected by adding *Gracilaria sp* (GS) on partial-substitute of fresh forage uses grass silage and palm kernel-meal (S-PKM) on daily feed. These research uses complete randomized design divided into two treatments (to substitute as much as 0% and 10.08% Dry matter of fresh forage with grass silage) with five replications on the first experiment and three treatments (0%S-PKM-0%GS; 19.51%S-PKM-0%GS; 15.03%S-PKM-2.03%GS) with three replications on the second experiment. The results showed that substituting as much as 10.08% DM of fresh forage uses grass silage does not affect the feed intake (11.56-11.98 Kg DM/head/day), Feed Digestibility (59.37-63.45%), milk protein-production (0.36-0.37 Kg/head/day), milk fat-production (0.54-0.58 Kg/head/day), daily milk production (12.36-12.67 Kg/head/day) in the first experiment. Feed intake (Kg DM /head/day), milk protein-production (Kg/head/day), milk fat-production (Kg/head/day), and daily milk production (Kg/head/day) increase with added 15.03%S-PKM-2.03%GS in the second experiment.

Keywords: *Gracilaria s*; Palm kernel-meal; Seaweed; Silage

*Corresponding Author: tikaagustinherlia@gmail.com

INTRODUCTION

Kunak is the biggest community for a traditional dairy cattle farmer in West of Java. Different conditions between rain and dry season in Tropics caused a problem to provide enough good quality forage continuously in a year. Forage will rotten in rain season caused by high intensity of rain which makes base part of forage trapped into a puddle, but enough water needed for forage growth not available when the dry season comes.

This condition showed that forage storage technology needed to solve those problems. There are many kinds of forage storage technology, such as hay, haylage, and silage. Hay and haylage have disadvantages if compared with silage. Pro-vitamin A contents on hay or haylage are lower than silage, and sensitivity Pro-vitamin A causes this during the drying process. Coppa *et al.* (2011) explained that β -carotene content on pasture forage decreases in the form of hay which is proved by the red-yellow colour of cheese produced from dairy cattle which feeding use hay and concentrate will decrease when compared with dairy cattle which feeding in a pasture. Palm kernel meal is one of the cheap feedstuff with a high content of protein, but information about application this stuff in dairy cattle ration is limited.

This condition encourages us to evaluate the application of this stuff in dairy cattle ration. *Gracilaria sp* is seaweed which produces on a big scale. High ash contents on this stuff identified that seaweed could use as minerals source. This stuff has uses in one of commercial industry and believed can increase milk production, but broad information about the effect of this stuff to increasing milk production still needed.

MATERIALS AND METHODS

Research Design

These research were conducted in Kunak using complete randomized design and examined in 2 experiments. Ten Frisian

Holstein (431.20 ± 59.92 Kg), The day in milk between 90-360 days, parity number between 3-5 for the first experiment which consisted two treatments (0% grass silage and 10.08% grass silage) with five replications for six weeks (the first week for adaptation and the last week for collecting data). Nine Frisian Holstein (404.87 ± 28.74 Kg), the day in milk between 90 to 300 days, parity number between 1-4 for the second experiment which consisted three treatments (0% S-PKM-0% GS; 19.51% S-PKM-0% GS; 15.03% S-PKM-2.03% GS) with three replications for six weeks (the first week for adaptation and the last week for collecting data).

Silage Preparation

Elephant grass chopped approximately 3cm using *chopper machine*. Molasses were added as much as 2% from the wet weight of elephant grass. PKM was added on silage in the second experiment (Elephant grass: PKM is 70.61:29.39). Both single elephant grass or mixture with PKM loads into a drum which added PKM in the base of the drum to absorb excess water production during ensilage process. Those silages were stored (≥ 2 weeks) in anaerobic condition.

Fleish Score

Fleish score measured use Indikut *et al.* (2009) to determine the silage quality depends on pH and dry matter (DM) of silage. This measure used to predict the shelf life of silage. Formula to calculate Fleish score is:

$$FS = 220 + (2 \times DM (\%) - 15) - (40 \times pH)$$

Feed Formulation

Feedstuffs used in these experiments were analyzed proximate compositions (AOAC 2005) in Laboratorium Pusat Penelitian Sumberdaya Hayati dan Teknologi IPB then formulated depends on feed nutritions which give daily in Kunak. Feed formulation for these researches showed in Table 1.

Milk Production and Qualities Measurement

Milk production was measured every day in the last week. Qualities of milk were measured using Lactoscan S Milk Analyzer by Milko Tronic Ltd

Manure Scoring

Manure score before and after the comparison of treatments to evaluate

digestibility of new feed formulation. Manure score depends on high of fresh manure, colour, sound when falling, texture and particles left after water washing.

In Vitro Digestibility

Measurement of in vitro digestibility used Tilley and Terry (1963) method. Formula to calculate dry matter digestibility after incubation is

$$\frac{\text{DM Sample} - (\text{DM Residue} - \text{DM Blanko of Rumen})}{\text{DM Sample}} \times 100\%$$

Formula to calculate organics matter digestibility after incubation is:

$$\frac{\text{Organics matter of Sample} - (\text{DM Residue} - \text{Ash Residue})}{\text{Organics matter (OM) of the sample}} \times 100\%$$

Table 1. Feed formulation in the first and the second experiment

	Experiment 1		Experiment 2		
	R0	R1	R0	R1	R2
<i>Feedstuffs (%)</i>					
Elephant grass silage	0.00	10.08	0.00	0.00	0.00
<i>Gracilaria sp</i>	0.00	0.00	0.00	0.00	2.03
Elephant grass silage + PKM	0.00	0.00	0.00	19.51	15.03
Tofu dregs	25.18	25.90	39.39	37.77	40.11
Concentrate	34.27	34.67	16.95	16.33	17.37
Grass land	30.34	21.54	0.00	0.00	0.00
Elephant grass	10.21	7.80	28.55	21.52	18.92
Paddy straw	0.00	0.00	15.11	4.87	6.54
<i>Nutrient composition (%)</i>					
Dry Matter (DM)	40.42	39.52	30.06	28.39	30.32
Ash	8.53	9.17	9.74	9.05	9.75
Crude protein (CP)	10.86	11.33	14.20	14.79	14.55
Ether extract (EE)	5.12	5.32	5.44	5.29	5.41
Crude fiber (CF)	12.95	15.26	21.99	21.77	21.53
Total Digestibility Nutreint (TDN)	79.00	76.66	70.06	70.47	70.17

Volatile Fatty Acid and NH₃

VFA (*Volatile Fatty acids*) measured use *Steam Distillation* Methode (General Laboratory Procedure, 1966). NH₃ (ammonia) measured use Conway (1957).

Data Analysis

Data of feed intake and feed characteristics were analyzed use ANOVA (Analysis of Variance) and compared with average different on experiment 1 and

Tukey HSD on experiment 2. Data of silage production and qualities were analyzed use ANOVA and compared with average different.

Data of dairy cattle performances were analyzed use ANCOVA (Analysis of Covariance) and compared with average different on experiment 1 and Sidak Test or Contrast Test. All data analyzed at $\alpha=0.05$ in SPSS 16.0.

RESULT AND DISCUSSION

This research produces elephant grass silage with and without PKM. The result from both silages production shows that both silages have good physical and ensilage quality. Total of spoilage in this research is lower than another study in Brazil. Silage production in Brazil which uses banker with double plastics layer, according to Bernardes dan do Rego (2014) will cut $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, and all silage as much 32.3%, 18.8%, 19.6%, and 29.2% respectively, caused by spoilage. This research showed that not more than $\frac{1}{4}$ (Table 2) silage cut

caused by spoilage which depends on the uses the drum for ensilage process, so the stability of anaerobic condition could hold longer than uses double-layer plastics. Single grass Silage pH on this research is lower than mixture grass and PKM silage which probably due to different fibre structures between grass and PKM. %NDF and % ADF on elephant grass are both 44.00% DM and 27.40% DM, respectively (Ajayi 2011), whereas on palm kernel 78.40%BK and 53.40%BK respectively Wyngaard, Meeske, and Erasmus (2005).

Table 2. Silage production and quality

Parameters	Elephant grass silage	Elephant grass silage +PKM
<i>Physical quality</i>		
Weight of load (Kg)	67.73±3.14	90.33±2.86
Weight of unload (Kg)	67.43±1.77	92.82±3.63
Colour	Yellowish green	Dark yellowish-green
Odour	Acid	Weak acid
Spoilage (%)	0.00-11.11	0.00
<i>Ensilage quality</i>		
pH	3.75±0.32b	4.50±0.08a
OM degradation (%)	7.80±3.50b	46.24±2.78a
CP degradation (%)	29.59±2.67b	45.12±2.75a
Fleish Score	86.20±12.84a	69.60±3.27b
<i>Utility</i>		
Fermentability in rumen		
N-NH ₃ (mM)	10.71±2.29b	14.51±1.11a
Total VFA (mM/gr BK)	134.22±22.80	112.69±21.09
Digestibility (%)		
Dry matter	44.61±7.31	51.00±6.51
Organics matter	99.39±0.10	99.49±0.12

Different letters show significant differences between columns (ANOVA with $\alpha=5\%$) in the same row

The higher NDF and ADF contents on palm kernel than elephant grass caused palm kernel more challenging to digest by microorganisms during ensilage process, so acids produced by microorganisms lower on the mixture of grass and PKM silage and final pH on this silage would higher than single grass silage. pH value for corn silages in Normandy, Prancis are 4 or 3.8 according to Richard *et al.* (2009), 4.8 for grass silage

according to Van Gastelen *et al.* (2015), 4-6.67 for grass silages according to Ali *et al.* (2014) and 4.3 for grass silage according to Rego *et al.* (2008). pH values for two kinds silage uses in this research showed a normal level according to some literature before. Added 2% molasses on silages process could decrease silages pH rapidly. Li M *et al.* (2014) showed that pH of elephant grass silage is 4.64, whereas added 2% molasses

on ensilages process could decreasing pH silage until 4.35. Protein degradation (%) on ramie leaves (DM=18%) silages which supplemented with cassava meal, pollard and coarse grinding corn (targeting DM mixture=32%) were 28.10%, 20.50% and 23.80% respectively, but on ramie leaves (DM=11.4%) silages which supplemented with cassava meal, pollard and corn (targeting DM mixture=32%) were 15.42%, 3.93% and 4.73% respectively (Despal *et al* 2011). VFA (mM) on ramie leaves silages

which supplemented with cassava-meal, pollard and corn were 127.70, 164.20 and 135.00 respectively, and N-NH₃ (mM) were 13.2, 19.4 and 11.2 respectively (Despal *et al* . 2011). Single grass silage and mixture grass and PKM silage showed that VFA and N-NH₃ contents (Table 2) were closed to literature. Definition of fleigh scores is 85-100%, 60-80%, 55-60%, 25-40%, and <20% are outstanding quality, good quality, moderate quality, satisfying quality and worthless, respectively Indikut *et al*. (2009).

Table 3. Nutrient consumption and ration fermentability

Nutrient intake (kg/head/day)	Experiment 1*		Experiment 2 ⁺		
	R0	R1	R0	R1	R2
DM	11.98±0.58	11.56±0.03	11.64±0.21b	11.29±0.61b	14.45±0.00a
Ash	1.02±0.05	1.06±0.00	1.12±0.04b	1.01±0.04b	1.40±0.00a
CP	1.31±0.05	1.33±0.00	1.66±0.06b	1.68±0.10b	2.10±0.00a
EE	0.63±0.03	0.65±0.00	0.64±0.04b	0.60±0.05b	0.79±0.00a
CF	1.55±0.05b	1.79±0.00a	2.54±0.05b	2.44±0.10b	3.08±0.00a
TDN	9.47±0.48a	8.85±0.03b	8.18±0.27b	7.97±0.48b	10.17±0.00a
Fermentability					
N-NH ₃ (mM)	6.83±0.97	7.18±1.28	7.85±0.92	8.91±1.19	9.34±1.46
Total VFA (mM/gr DM)	138.91±16.30	152.77±12.91	148.26±8.42	121.70±27.07	132.43±22.43
Digestibility (%)					
Dry matter	63.45±8.59	59.37±6.62	60.94±5.53	66.15±5.57	67.73±5.96
Organics matter	99.57±0.08	99.53±0.11	99.54±0.09	99.59±0.10	99.60±0.08

Different letters show significant differences between columns (ANOVA with $\alpha=5\%$) in the same row; *advanced test use average different ⁺advanced test use Tukey HSD

Single grass silage quality is excellent, whereas the quality of mixture-silage of grass and PKM is good (Table 2). This value uses to predicted lifetime storage of silage. Silage with a high value of FS to be predicted has long-lifetime storage than the low one. Percentage of PKM uses in R1 dan R2 experiment 2 (5.73% and 4.42% DM respectively) is present on the tolerant level. According to Wyngaard, Meeske, Erasmus (2005), feeding 0-40% DM PKM for Jersey does not show significant differences on feed intake, milk production, qualities of milk (fat, protein, and lactose), so does with feeding 0-15% DM PKM for Holstein (Carvalho *et al*. 2006). This research showed that feeding PKM in level 5.73%

and 4.42% DM could improve feed digestibility (non-significant on in vitro test (Table 3), but could increasing manure score on in vivo (Table 4).

Meanwhile, increasing manure score could be identified as a negative effect of added PKM in daily feed. High NDF (Neutral Detergent Fiber) and ADF (Acid Detergent Fiber) contents in PKM could be the reason for low digestibility of feed. Those contents make more feed passed digest tract as faeces, and texture faeces formed more solid than before, so manure score increasing. However, milk production and qualities (Kg/head/day) showed the positive effect with added PKM (Table 4), so a negative assessment about added PKM

in daily feed could be ignored. There is no different body weight and BCS before and after treatment (Table 4). It is identified that feed formulation uses (Table 1) in these researches could accomplishing all nutrients required for dairy cattle which used in these

researches. Milk contents and production in experiment 1 showed no significant different value, whereas added 4.42% DM PKM and seaweed in experiment 2 could improved milk production and qualities (Kg/head/day).

Table 4. Dairy cattle performances

Parameters	Experiment 1		Experiment 2		
	R0	R1	R0	R1	R2
<i>Manure score</i>					
Before treatment	2.21±0.39	2.30±0.18	2.57±0.37	2.31±0.70	2.35±0.17
After treatment	2.70±0.18	2.66±0.12	2.06±0.10 ^b	2.39±0.10 ^a	2.35±0.11 ^a
<i>Bodyweight</i>					
Before treatment	413.34±30.59	396.39±27.27	444.14±93.81	444.35±38.06	405.10±50.79
After treatment	430.60±31.25	411.41±16.43	444.38±97.50	457.04±37.05	415.93±53.14
<i>BCS (Body Condition Score)</i>					
Before treatment	3.20±0.45	3.00±0.00	3.33±0.58	3.00±0.00	3.00±0.00
After treatment	3.20±0.45	3.00±0.00	3.33±0.58	3.00±0.00	3.00±0.00
<i>Milk Production (Kg/head/day)</i>	12.36±2.59	12.67±2.50	7.67±2.25 ^b	10.07±0.59 ^{ab}	13.81±1.35 ^a
Parameters	Experiment 1		Experiment 2		
	R0	R1	R0	R1	R2
<i>Milk contents (Kg/head/day)</i>					
Fat	0.54±0.14	0.58±0.07	0.35±0.09 ^b	0.52±0.11 ^b	0.68±0.02 ^a
Protein	0.36±0.07	0.37±0.06	0.22±0.07 ^b	0.30±0.03 ^{ab}	0.41±0.03 ^a
Lactose	0.53±0.10	0.55±0.09	0.32±0.10 ^b	0.45±0.05 ^{ab}	0.61±0.04 ^a
SNF (Solid Non Fat)	0.96±0.18	1.00±0.16	0.58±0.18 ^b	0.81±0.08 ^{ab}	1.10±0.08 ^a
Salt	0.08±0.01	0.08±0.01	0.05±0.01 ^b	0.07±0.01 ^{ab}	0.09±0.01 ^a
Total Solid	1.49±0.30	1.57±0.22	0.93±0.27 ^b	1.33±0.19 ^{ab}	1.78±0.10 ^a
Density (Kg/L)	1.028±0.001	1.028±0.001	1.027±0.002	1.028±0.001	1.038±0.001
<i>Milk Production (Liter/head/day)</i>	12.18±2.18	12.78±2.44	7.47±2.19 ^b	9.80±0.56 ^{ab}	13.44±1.32 ^a
<i>Milk contents (%)</i>					
Fat	4.35±0.69	4.64±0.57	4.62±0.53	5.12±0.84	4.98±0.47
Protein	2.89±0.09	2.93±0.14	2.83±0.21	3.00±0.14	2.96±0.11
Lactose	4.31±0.14	4.37±0.21	4.22±0.31	4.46±0.20	4.40±0.17
SNF (Solid Non Fat)	7.79±0.25	7.91±0.37	7.64±0.56	8.07±0.36	7.97±0.30
Salt	0.65±0.02	0.66±0.03	0.64±0.05	0.67±0.03	0.67±0.03
Total Solid	11.75±0.70	12.54±0.89	12.26±1.07	13.19±1.19	12.95±0.76

- Different letters show significant differences between columns (ANOVA with $\alpha=5\%$) in the same row with advanced test use Sidak test.
- Superscript show a significant difference between columns (ANOVA with $\alpha=5\%$) in the same row with advanced test use Contrast test.

Milk qualities (%) on R2 does not change because increasing milk contents (Kg/head/day) followed by increasing milk production, so the relative probability of milk qualities (%) still constant. R1 in experiment 2 showed no significant difference in milk production and qualities but tended to increase (Table 4).

CONCLUSIONS

Partial-substitute of 10,08% DM grass silage could use to manage enough supplies of good-quality forage for dairy cattle in Kunak without changing the performance of dairy cattle. Adding palm kernel meal and seaweed in grass silage in partial-substitute of fresh forage could improve the performance of dairy cattle (milk production and qualities).

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