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THE IMPACT OF BALANCED ENERGY AND PROTEIN SUPPLEMENTATION TO MILK PRODUCTION AND QUALITY IN EARLY LACTATING DAIRY COWS

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ABSTRAK

Penelitian ini dilakukan untuk mengetahui dampak suplementasi energi dan protein seimbang dengan *high rumen undegraded protein* (HRUP) terhadap produksi dan kualitas susu pada sapi perah awal laktasi. Dua belas ekor sapi Friesian Holstein awal laktasi dibagi menjadi dua kelompok (kontrol dan HRUP). Kelompok kontrol dan HRUP memperoleh pakan basal dengan rasio hijauan dan konsentrat 60:40 (bahan kering), dengan konsentrasi *rumen undegraded protein* (RUP) masing-masing sebesar 27,47% (kontrol) dan 32,78% (HRUP). Pakan diberikan dua kali, pagi dan sore hari. Air minum diberikan secara *ad libitum.* Variabel yang diamati adalah konsumsi nutrien, produksi dan kualitas susu. Data yang diperoleh dianalisis dengan analisis t-test. Hasilnya menunjukkan bahwa konsumsi nutrien, produksi susu dan 4% FCM, produksi dan konsentrasi lemak dan laktosa susu, konsentrasi *solid non-fat* dan *total solid* susu antara kontrol dan HRUP tidak berbeda nyata (P>0,05). Namun, produksi dan konsentrasi protein susu antara kontrol dan HRUP menunjukkan nilai yang berbeda nyata (P<0,05). Disimpulkan bahwa suplementasi energi dan protein seimbang dengan HRUP pada sapi perah awal laktasi tidak memberikan dampak terhadap produksi susu dan 4% FCM, produksi dan konsentrasi lemak dan laktosa susu, *solid non-fat* dan *total solid* susu, namun memberikan dampak terhadap produksi dan konsentrasi protein susu pada sapi perah awal laktasi.

Kata kunci: Suplementasi, High Rumen Undegraded Protein, Produksi Susu, Kualitas Susu, Sapi Perah

ABSTRACT

This research was aimed to determine the impact of balanced energy and protein supplementation with high rumen undegraded protein (HRUP) to milk production and quality in early lactating dairy cows. Twelve early lactating Friesian Holstein cows were divided into two groups (control and HRUP). Both control and HRUP group were fed on a basal diet (forage to concentrate ratio was 60:40; DM basis), with rumen undegraded protein (RUP) levels were 27.47% and 32.78% for control and HRUP, respectively. The experimental diets were given to animals twice daily, morning and afternoon. Water was given by ad libitum. The observed parameters were nutrient intake, quantity and quality of milk production . Data were examined using t-test. Results showed that feed intake, milk production and 4% FCM, milk fat and lactose concentrations, and milk solid non-fat and total solid concentrations were not differed significantly between control and HRUP groups. However, milk protein concentration and production were differed (P<0.05) between controls and HRUP groups. The balanced energy and protein supplementation with HRUP in early lactating dairy cows could impact on milk protein concentration

and production.

Key words: Supplementation, High Rumen Undegraded Protein, Milk Production and Quality, Dairy Cows

INTRODUCTION

The nutrient requirement of dairy cows increases with milk production, but high producing cows in early lactation are in capable to consume sufficient dry matter (DM) to support an optimal milk production. High production dairy cows requires high energy and protein diets during early lactation, because energy and protein are mobilized from body stores to support high milk production (NRC, 2001). The transition period for a dairy cow is from 3 to 2 week prepartum until 2 to 3 week postpartum. The term transition is to underscore the important physiological, metabolic, and nutritional changes occurring in this time frame. This constitutes a turning point in the productive cycle of the cow from one lactation to the next. The manner in which these changes occur and how they are managed are of great importance as they are closely linked to dry matter intake, lactation performance, clinical and subclinical postpartum diseases, and reproductive performance that can significantly affect profitability (Block, 2010).

The source of dietary crude protein (CP) and energy fed to dairy cows influences the utilization of nitrogen and energy in the rumen and the flow of nutrients to the small intestine. Microbial synthesis in the rumen is incapable of providing sufficient protein to the high producing cows, and recommendation has been developed for undegraded intake protein or rumen undegraded protein (RUP) and high quality of essential amino acid profile of bypass protein (NRC, 2001). Because ruminal undegraded protein may increase the total amount of essential amino acid that is delivered to the small intestine and modify their profile (Calsamiglia *et al*., 1995; Calsamiglia *et al*., 2007; Ahari *et al*., 2011), adequate supply of protein to the small intestine of lactating dairy cows is essential for optimum milk production. Roseler *et al*. (1993) and Kohn (2007) reported that the ration lease excess degraded protein in the rumen will have high endogenous urea concentration in blood, milk and urine. This high concentration of urea will lead to fertility problem, decline of energy availability, environmental pollution and economic losses.

Milk protein production efficiency was influenced by the ratio of protein and energy availability for milk production (Santos *et al*., 1998; Mahr-un-Nisa, 2008). Besides, this was also influenced by the level of milk production and stage of lactation period. Flis and Wattiaux (2005) and Gulati *et al*. (2005) report that increased in the level of RUP in the ration had a positive effect on milk production and milk protein and fat concentrations (Chaturvedi and Walli, 2001) in lactating cows during early lactation. The purpose of this research was to examine the influence of balanced energy and protein supplementation with HRUP on milk production and quality in early lactating dairy cows.

MATERIALS AND METHODS

This research used 12 early lactating Friesian Holstein cows after parturition with an average live body weight of ± 445 kg and in the 2nd or 3rd lactating seasons. The animals were randomly divided into two equal and similar groups and fed on a basal diet (Table 1). The animals were housed in individually, permanent enclosure models stanchion barn with cement floors. Six cows were as a control group and other six cows were as HRUP group. King grass and concentrate were distributed two times a day at 09:00 am and 02.00 pm with the proportion of 60:40 (DM basis). King grass was chopped size 15 to 20 cm and given 3 hours after concentrate distribution. The concentrate ingredients formulation and nutrient compositions of experimental diets for each groups were described in Table 1. Drink water were given by *ad libitum*.

The research was conducted for 3 months or 100 day, i.e. 10 day of adaptation period and 90 day of collection period. Milking was done twice a day, at 05:00 am and 01:00 pm. The milk production was recorded daily, and samples of milk were taken 5% of total production both in the morning and afternoon every two once weeks. Each sample of milk was composed of each cow, and was subjected to the determination of protein (Kjeldahl method), fat (Babcock method), lactose (Nelson method), solid non-fat, and total solid (AOAC, 2006) contents. At the beginning and end of the study, the cow was weighed before morning feeding. Analysis of samples was conducted in Laboratory of Dairy Science and Milk Industry, Faculty of Animal Science Gadjah Mada University.

The data of nutrient intake, milk production and milk quality (fat, protein, lactose, solid non-fat, and total solid) were examined using t-test analysis at P<0.05. All the statistical analysis was performed using Statistical Program for Social Science or SPSS version 16.0.

RESULTS AND DISCUSSION

Feed and Nutrient Intake

Chemical composition of feed ingredients concentrates consist of: G-Pro, soy bean meal-HCHO, kapok seed meal, copra meal, corn gluten feed, wheat pollard, palm kernel meal, coffee husk, corn tumpi, cassava waste, molasses, and mineral mix; and forages ~~is~~ was King grass. Content ingredients and nutrient compositions of experimental diet are shown in Table 1.

The feed and nutrient intakes of both groups did not affected by the treatment (Table 2). This result was similar to the study of Widyobroto *et al*. (2010), the increase of RUP in the ration did not influenced the intake of DM. The intake of organic matter (OM) was improved as decreasing RUP amount in the current study. These observations were in accordance with those of Kiran and Mutsvangwa (2007), the increasing dietary rumen degraded protein (RDP) from 60% to 70% of CP increases the OM intake (ranging from 1.2 to 1.4 kg/d) in growing lambs. The dietary RDP may promote intake by enhancing gastrointestinal motility (Egan and Moir, 1965). Parakkasi (1995) stated, most factor that may affect~~s~~ the feed consumption is feed quality. The Consumption of OM is positively correlated with dry matter intake (DMI).

There are many information on the effects of forages : concentrates (F:C) ratio on DMI, growth performance and production in housing-feeding cows. In this study, the ratio of F:C were 60:40, with RUP value of 27.47% and 32.78% for control and HRUP groups, respectively. Both diets showed a normal cow performance. Cantalapiedra-Hijar *et al*. (2009) reported that DMI is not affected by the increasing ratio of concentrate in the diet from 30% to 70% in goats. Aguerre *et al*. (2011) found that increasing F:C ratios (47:53, 54:46, 61:39, and 68:32) in the diet had no effect on DMI of Holstein cows. A similar result was observed by Agle *et al*. (2010), no change in DMI of lactating dairy cows fed diets contained 52% and 72% concentrate feeds. In contrast, Desnoyers *et al*. (2008) reported that DMI of dairy goats was increased (2.69 to 2.88 kg/d) with increasing the percentage of concentrate in the diet from 30% to 60%. Murphy *et al*. (2000) noted that cows fed 30:70 diets of F:C ratio had a significantly higher DMI than cows fed 50:50 diets.

Dietary fibre content (CF) had no influence on OM intake in this trial. Commonly, an increase in dietary CF can be achieved by increasing the level of concentrates. Therefore, the results of the current study were comparable with those obtained by Cantalapiedra-Hijar *et al*. (2009) and Ramos *et al*. (2009), who found no effect of dietary concentrate : forage ratios (30:70 and 70:30) on OM intake in both goats and sheep fed above maintenance. The differences in CF of the diets were mainly due to the variance in CF concentrations. However, Allen (2000) noted that no effect of CF ranging from 25% to 40% was found on DM intake in dairy cows, although feed intake generally decreases with increasing CF. CF in concentrate was high (coffee husks and corn tumpi), hence the need/requirement of fiber still can be fulfilled. This means that the intake of forages was low, the negative effect in the digestive process was not happened since the concentrates given still have high structural carbohydrates. This condition could be used as a reference by farmers, especially in the dry season where the forages were difficult to get and relatively expensive. Miller (1979) reported that the energy could affect the efficiency of the ration used, excess energy in ration, and also caused decrease ration efficiency used and tended to be accumulated in the body fat. One of the disadvantage was the excess of the amino acids is increased further and these need to be deamination and excreted, with consequent reduction in the energy value of the diet and increased pollution. The high protein intake was caused by concentrate level in ration with high protein content. However, the ratio of energy : protein in the diet should create a better protein efficiency. Thus, a better protein efficieny may protect feed protein from the ruminal degradation. In this study, the balanced intake of energy and protein of both diets were more than enough to fulfill the need of maintenance and production.

Milk Production and Quality

The result of production and milk quality is

Table 1. Concentrate Ingredients Formulation and Nutrient Compositions of Experimental Diet

Concentrates Formulation	Group	
	Control	HRUP
	----------------(%DM)----------------	
Ingredients		
G-Pro	8.0	3.0
Soy bean meal-HCHO	-	9.0
Kapok seed meal	6.0	6.0
Copra meal	14.0	12.0
Corn gluten feed	10.7	10.0
Wheat pollard	16.7	14.0
Palm kernel meal	13.4	13.0
Coffee husk	14.3	11.0
Corn tumpi	3.3	7.0
Cassava waste	-	4.0
Molasses	8.3	6.0
Mineral mix	5.3	5.0
Total	100	100
Analyzed compositions	-------------------(%)-------------------	
DM	88.24	89.06
OM	87.93	88.37
CP	18.55	18.83
CF	16.81	16.06
EE	5.10	4.70
RUP[a]	27.47	32.78
RDP[a]	63.55	60.84
TDN[b]	56.94	58.91

DM = Dry matter; OM = Organic matter; CP = Crude protein; CF = Crude fibre; EE = Ether extract; RUP = Rumen undegraded protein; RDP = Rumen degraded protein; TDN = Total digestible nutrient.

[a] = The results of the analysis in sacco degradation and formula of Widyobroto *et al*. (1997)

[b] = The results of the formula of Hartadi *et al*. (2005).

presented the Table 3. The result showed that milk production and 4% FCM (fat corrected milk), milk fat concentration and production, milk lactose concentration and production, SNF and TS concentrations were similar between control group and HRUP groups. However, milk protein concentration and production were differed ($P<0.05$) between control group and HRUP groups. Production and composition of milk varies with the uptake of nutrients by the mammary gland, and this is influenced by mammary blood flow and utilization of nutrients by mammary gland (Kume and Tanabe, 1993). Most research suggested that increasing energy intake increases both concentration and production of protein in milk, and milk production is improved by increasing CP intake (DePeters and Cant, 1992).

Table 2. Nutrient Intake of Dairy Cows Receiving Control and HRUP Supplementation

Nutrient (kg DM/head/d)	Ration	
	Control	HRUP
Forages		
DM	7.15	7.09
OM	6.21	6.16
CP	0.67	0.66
CF	2.35	2.34
TDN	4.09	4.05
Concentrate		
DM	4.49	4.45
OM	3.95	3.93
CP	0.83	0.84
CF	0.75	0.71
TDN	2.53	2.62
Total intake		
DM	11.64	11.54
OM	10.15	10.10
CP	1.50	1.50
CF	3.10	3.05
TDN	6.63	6.67

DM = Dry matter; OM = Organic matter; CP = Crude protein; CF = Crude fiber; TDN = Total digestible nutrient.

The balanced intake of energy and protein with rumen undegraded protein supplementation may increase the amount of protein in the small intestine. The increased protein supply to the intestine was expected to meet the protein needs for milk production, thus increasing milk production in this study. This was similar to the work of Petit and Tremblay (1995), the strategy to increase the amount of proteins which can reach in the small intestine is to increase microbial protein synthesis or RUP supplementation. In this study, the supplementation of RUP in diet was intended to increase the amount of protein reaching in the small intestine. The increasing of RUP intake will increase the total amount of protein in the small intestine (Widyobroto, 1992).

The increase ~~of~~ in milk production in this research was in line with the tendency of the decline of fat milk. The decrease of fat milk was due to the low fiber in the ration with supplementation of RUP, hence decreased of resulting in low pH and ammonia production. This was similar to the results of Hristov *et al.* (2004a, 2004b), the energy source of feed material easily fermented in the rumen can decrease rumen ammonia concentration by reducing the production of ammonia, or by increasing ammonia uptake for microbial protein synthesis. The energy easily fermented in the rumen will lower the ammonia production continously but as a whole efficiency of ammonia used for milk protein synthesis, this will only increase with by increasing ammonia uptake by rumen microbes.

The average milk production was higher in cow with HRUP supplementation resulting in the low variation of daily production. Figure 1 showed that daily milk production in cows with HRUP supplementation was increased consistently compared to the control group. This phenomenon is quite interesting to further scrutiny during the period of lactation, so that the persistence of milk production during lactation period can be evaluated.

Although the response of cow with balanced energy and protein supplementation on milk production and milk constituent was quite good compared with control, but the production level was still under optimum level compared with results in developed countries (± 9.0 L/head/day). Santos *et al.* (1998) reported that the low production of dairy cows (4500 kg/lactation) is able to meet protein needs for microbial protein synthesis. In contrast, the high production of dairy cows (9000 to 14000 kg/lactation) requires a sufficient source of undegraded protein to be used directly in the intestine. The results of this research was similar to Hristov *et al*. (2004a, 2004b), dry matter intake, milk production, fat and milk protein are not statistically different between rations containing high rumen degraded protein (HRDP) and those with sufficient RDP. Furthermore, Dunlap *et al.* (2000) stated that there is tendency of higher nitrogen (N) excretion in urine, blood plasma and milk urea nitrogen concentrations resulted from HRDP ration than that of RDP ration. The value of efficiency N in milk is decreased in the HRDP rations. The RDP ration for lactating cow was not efficiently used for microbial protein synthesis and most excreted with the secretion of N urine. The increase of CP or RDP concentration in the ration would decrease

Table 3. Average Milk Production, 4% FCM and Milk Quality Dairy Cows Receiving Control and HRUP Supplementation

Parameters	Group		Statistic
	Control	HRUP	
Milk production (L/head/day)	10.71 ± 1.64	12.39 ± 2.88	ns
Production 4% FCM (kg/head/day)	9.29 ± 1.17	10.49 ± 2.45	ns
Milk fat (%)	3.05 ± 0.19	2.88 ± 0.17	ns
Milk fat production (kg/head/day)	0.14 ± 0.01	0.15 ± 0.03	ns
Milk protein (%)	2.57 ± 0.15	3.02 ± 0.12	*
Milk protein production (kg/head/day)	0.12 ± 0.02	0.16 ± 0.04	*
Milk lactose (%)	5.90 ± 0.33	5.62 ± 0.48	ns
Milk lactose production (kg/head/day)	0.28 ± 0.05	0.29 ± 0.02	ns
Solid non fat (%)	8.47 ± 0.26	8.63 ± 0.42	ns
Total solid (%)	11.53 ± 0.37	11.52 ± 0.42	ns

* = Significant (P<0.05); ns = Non significant (P>0.05).

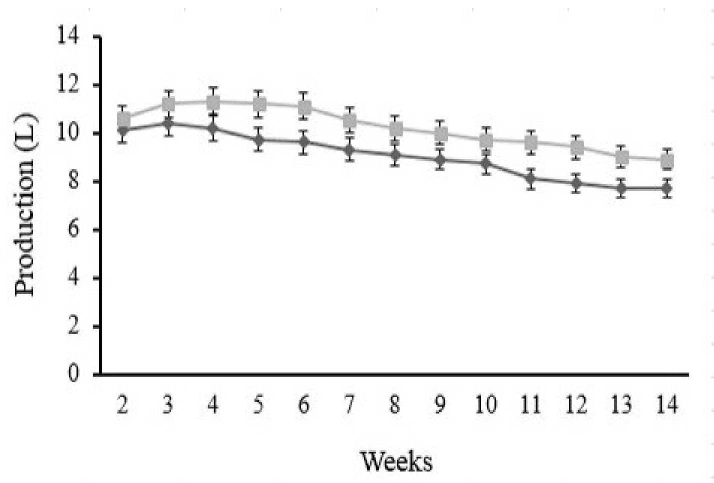

Figure 1. Average Milk Production of Dairy Cows Receiving Control and HRUP Supplementation (14 Weeks of Collection Period). —◆— Control, —■— HRUP

efficiency of N conversion from the ration to milk protein and less efficient used of rumen ammonia N for milk protein synthesis.

CONCLUSION

The conclusion is balanced energy and protein supplementation with HRUP to milk production and quality in early lactating dairy cows would not impact on milk production and 4% FCM, milk fat and lactose concentration and production, milk solid non-fat and total solid concentration. However, this would be impact on milk protein concentration and production in early lactating dairy cows.

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