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Effect of Different Rumen Undegraded Protein Level on Feed Consumption, Nutrient Digestion, Body Weight and Body Condition Score in Early Lactating Dairy Cattle

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Abstract: The objective of this study was to determine effect of different rumen undegraded protein level on feed consumption, nutrient digestion, body weight and body condition score in early lactating dairy cattle. Ten Friesian Holstein cows were divided into two groups (five animals were used as control and another group as treatment object). Diets were forages and concentrates with ratio of 60:40, DM basis. The cows feed after parturition until 100 days of lactation. The control group concentrate diets containing Crude Protein (CP) 18.55%, Total Digestible Nutrient (TDN) 56.94% and Rumen Undegraded Protein (RUP) 5.10 CP%, while the treatment group concentrate diets containing Crude Protein (CP) 18.83%, Total Digestible Nutrient (TDN) 58,91% and Rumen Undegraded Protein (RUP) 6.17 CP%. Drinking water was given by *ad libitum*. The comparison results between the two conditions (control and treatment) were tested using independent t-test analysis. Results indicated that nutrient intake and digestion (dry matter, organic matter, crude protein, crude fibre and ether extract), body weight and body condition score were not significant. The conclusion is supplementation with different rumen undegraded protein level on early lactating dairy cattle could not increase feed consumption, nutrient digestion, body weight and body condition score.

Keywords: Rumen Undegraded Protein, Feed Consumption and Nutrient Digestion, Body Weight, Body Condition Score, Dairy Cattle

Introduction

The first lactation period which is the first quarter of lactation, also called the first 100 days of lactation, were critical period on dairy cow performances for those with high milk production. The high milk production dairy cow needs an adequate nutrient, especially protein. Microbial protein synthesized in the rumen supplies amino acids to the ruminant in sufficient quantities to support a moderate level of productivity (McAllister *et al*., 1992). Drackley *et al.* (2001), added that the contribution of Amino Acid (AA) to gluconeogenesis has been considered important during early lactation in the dairy cow, but supportive evidence has come from observations either *in vivo* or *in vitro*. Doepel *et al*. (2009), also added that the other important demand for AA is to support milk protein synthesis and this requirement increases greatly at the onset of lactation. Therefore, despite an increased supply of MP through increased DM Intake (DMI) and rations formulated for lactation, these 2 demands create a negative protein balance for cows in early lactation. Invariably, the early lactating cow faces a glucose and amino acid deficiency (Phillips *et al*., 2003). NRC (2001) also explains that to ameliorate this nutrient deficiency, body fat and protein reserves are mobilized to support the energy requirements for high milk production in early lactation. Although body fat deposits are recognized as the major source of energy reserves, the catabolism of both body fat and protein contribute to nutrient requirements at early lactation.

Body protein mobilization is driven by the high demand need to supply amino acids for hepatic gluconeogenesis and for milk protein synthesis during early lactation. Propionate or propionic acid is the major precursor for gluconeogenesis (Drackley *et al*., 2001). However, limited feed intake during early lactation

limits ruminal propionate supply to the liver, raising the requirement for alternative gluconeogenic precursors. Although skeletal muscle is the primary labile source of amino acids and only a few studies have investigated protein metabolism in this tissue during lactation (Komaragiri *et al*., 1998; Phillips *et al*., 2003; Chibisa *et al*., 2008). Skeletal muscle protein mass has been shown to decrease in early lactating dairy cows (Komaragiri *et al*., 1998; Phillips *et al*., 2003). Although the mobilization of protein reserves is necessary to augment the inadequate dietary supply of energy and protein, excessive mobilization can lead to an increased incidence of metabolic disorders and animal health, poor reproductive and lactation performance (Overton *et al*., 1998).

However, at high levels of production, the supply amino acid from microbial protein is often inadequate for optimal productivity (Chalupa, 1975), different from the lactation dairy cow group with low to moderate production that is always sufficient. Efficiency of ruminant production may also be improved by increasing the supply of starch or protein to the small intestine (Owens *et al*., 1986), with methods of energy and protein supplementation or protection of feed ingredients that have high biological value. Soybean meal by treatment with formaldehyde would appear to be a potential method of decreasing rumen degradation of high quality protein and allowing more dietary protein by-pass the rumen to abomasum and lower digestive tract. Widyobroto *et al*. (1995; 2010) added that protein protection (by-pass) by formaldehyde addition or heating could increase the undegraded protein fraction of 50 to 80% and did not decrease its digestibility in the intestinum. Rumen Undegraded Protein (RUP) supplement based on the requirement of rumen microbes on nitrogen precursor has to be calculated to improve nutrient efficiency and milk production; and an increase in RUP level in the ration will increase the use of nutrients by dairy cows, although it also depends on the energy intake (Widyobroto *et al*., 2001). The objective of this study was to determine effect of different rumen undegraded protein level on feed consumption, nutrient digestion, body weight and body condition score in early lactating dairy cattle.

Materials and Methods

Animal and Material Study

This study was conducted in dairy cow units farm Department of Agriculture Yogyakarta Province, Indonesia. Analysis of feed and faeces samples was conducted in Laboratory of Dairy Science and Milk Industry and Laboratory of Nutritional Biochemistry, Faculty of Animal Science Universitas Gadjah Mada.

This study used 10 early lactation Friesian Holstein cows, after parturition with an average live body weight of 400 to 500 kg, age cows 3.5 to 5 years, lactating periods 2nd to 3rd, average milk production in foregoing lactation was 10 L/head/day and cows in permanent enclosure models stanchion barn with cement floors and rubber mat. The diets were forages and concentrate especially formulated using the same materials (Table 1). Forages used is *Pennisetum purpuphoides* and material commercial concentrate is Copra meal, CGM, Pollard, Palm kernel meal, Kapok seed meal, Coffee husk, Corn tumpi, Cassava waste, Molasses, G-Pro and Mineral mix. The diets ratio for forage and concentrates were 60:40, DM basis. The cows were fed 100 days during lactation. Drinking water was given by *ad libitum*.

Feed and Faecal Sample Collection and Preparation

The diets ingredients or sample were composited for each collection period and dried in a 55°C forced-air oven. Then analyzed to determine the content Dry Matter (DM), Organic Matter (OM), Crude Protein (CP), Crude Fibre (CF) and Ether Extract (EE). Faeces were sampled daily during each collection period (14 days). Faeces sample were composited for each collection period and analyzed for DM, OM, CP, CF and EE. The dried feed and faeces samples were used for chemical or nutrient analysis.

Body Weight and Body Condition Score

Body Weight (BW) and Body Condition Score (BCS) were calculated as the average of measurements performed of first and last week, before morning meal and after am milking during the study. The assessment of BCS was determined by observed cows on the vertebral column (back), waist, hunch, roof of tail, hip bone, waist horn and ribs as point. Body condition score for dairy cows use a scale 1 to 5, with scale 1: being emaciated, scale 2: Thin, scale 3: Averages, scale 4: Fats and scale 5: Obese (Wildman *et al*., 1982; Rochijan, 2014). The BCS of each animal was evaluated by the same person and was done by some people to reduce the subjectivity.

Data Analysis

The data on feed consumption, nutrient digestion, body weight and body condition score were tested using independent samples t-test analysis at $P<0.05$, with Statistical Program for Social Science (SPSS) version 16.0.

Results and Discussion

Nutrient Composition of Feed Ingredients Concentrates

Nutrient composition of concentrates feed presented in Table 1, consists of: Concentrate and soybean meal-HCHO; and forages is *Pennisetum purpuphoides*. The control group concentrate containing crude protein (CP) 18.55%, Total Digestible Nutrient (TDN) 56,94% and Rumen Undegraded Protein (RUP) 5.10 CP%, while the treatment group concentrate containing Crude Protein (CP) 18.83%, Total Digestible Nutrient (TDN) 58,91% and Rumen Undegraded Protein (RUP) 6.17 CP%.

Feed Consumption and Nutrient Digestion

The average feed and nutrient consumption of dairy cows during the study was presented in Table 2. The mean of feed and nutrient consumption collected from early lactating dairy cows did not differ among diets in both groups. This was similar to the study of Widyobroto *et al*. (2010; Widyobroto, 2013; Rochijan, 2014) which found that the increase of RUP level in the ration was not influenced by Dry Matter Intake (DMI) in ration. Organic Matter Intake (OMI) can be improved with decreasing RUP level in the current study. The high protein intake was caused by concentrates in ration has high protein content.

The DMI has special importance to meet nutrient requirement of early lactating dairy cows to maintain their health and productivity (production and reproduction). Dietary Fibre Content (CF) in ration had no influence on DM and OM intake in this trial. Commonly, an increase in dietary CF and Crude Protein (CP) can be achieved by increasing the level of concentrates. Therefore, the results of the current study are comparable with those obtained by Cantalapiedra-Hijar *et al*. (2009; Ramos *et al*., 2009), who found no effect of dietary concentrate : forage ratios (30:70 and 70:30) on OMI in both goats and sheep fed above maintenance. However, Allen (2000) noted that no effect of CF ranging from 25 to 40% was found on DMI in dairy cows, although feed intake generally decreases with increasing CF. Protein and energy intake from control and treatment rations were more than enough to fulfill the need of maintenance and productivity (production and reproduction) and if the protein intake in the rations is excessive then it will be a waste for the environment derived from urine and faecal. This wasn't similar to the results of study by Encinias *et al*. (2005), that there was no difference in DMI on lactating dairy cows fed Brome grass hay (9.6% CP) which is undegraded protein supplementation.

The average nutrient digestion of dairy cows was presented in Table 3. The mean nutrient digestion collected from early lactation dairy cows did not differ in both groups on DM, OM, CP, CF and EE digestion. Feed protection that has high biological value with formaldehyde treatment tended to have a greater effect on digestibility of cereal protein than that of cereal starch (Huhtanen *et al*., 1985; Morgan *et al*., 1989). Nevertheless, a reduction in the concentration of Volatile Fatty Acids (VFA) associated with microbial amino acid metabolism suggested that protein in the formaldehyde-treated feeds was more resistant to microbial degradation. With increase resistance to microbial digestion, the amount of NPN reaching the duodenum will to be increased with formaldehyde-treated feed supplementation. Higher amount of NPN at the duodenum with these diets will to increase amounts of individual amino acids at the duodenum as compared to control diet. However, with the exception of glutamine, formaldehyde treatment did not alter the amino acid compositions of duodenal digest. A decrease in the susceptibility of dietary protein to microbial attack usually reduces the quantity of microbial N reaching the small intestine and depresses the efficiency of microbial protein synthesis (McCarthy *et al*., 1989; Hussein *et al*., 1991). Bunnakit and Khampa (2011) reported that DMI and OM digestibility in Thai Native x Brahman cattle increased linearly while the level of RUP increased. In another study, the use of protein source with lower rumen degradability promotes an increase in the flow of nutrients and changes in the digestive parameters of the omasum, but compromise the production or microbial efficiency in dairy goats (Felisberto *et al*., 2011).

Table 1: Feed concentrate and nutrient compositions of experimental diet

		Group	
Feed concentrates		Control	Treatment
Ingredients (%DM)	Commercial concentrate	100.00	91.00
	Soybean meal-HCHO	-	9.00
	Total	100.00	100.00
Analyzed compositions	Dry matter (%)	88.24	89.06
	Organic matter (%)	87.93	88.37
	Crude protein (%)	18.55	18.83
	Crude fibre (%)	16.81	16.06
	Ether extract (%)	5.10	4.70
	RUP (CP%)	5.10	6.17
	RDP (CP%)	11.79	11.46
	TDN (%)	56.94	58.91

RUP = Rumen Undegraded Protein; RDP = Rumen Degraded Protein; TDN = Total Digestible Nutrient

Table 2: Feed and nutrient consumption of dairy cows receiving control and treatment

	Ration (kg DM/head/day)					
	Forages		Concentrate		Total consumption	
Nutrients consumption	Control	Treatment	Control	Treatment	Control	Treatment
Dry matter[ns]	7.15	7.09	4.49	4.45	11.64	11.54
Organic matter[ns]	6.21	6.16	3.95	3.93	10.15	10.10
Crude protein[ns]	0.67	0.66	0.83	0.84	1.50	1.50
Crude fibre[ns]	2.35	2.34	0.75	0.71	3.10	3.05
Ether extract[ns]	0.20	0.21	0.13	0.10	0.33	0.31

ns: Non significant (P>0.05)

Table 3: Nutrient digestion of early lactation dairy cows receiving control and treatment

	Group ration (%)	
Nutrient digestion	Control	Treatment
Dry matter[ns]	55.43±2.73	60.23±1.42
Organic matter[ns]	66.29±2.65	67.15±1.51
Crude protein[ns]	74.32±1.52	73.99±1.77
Crude fibre[ns]	41.35±3.79	50.93±1.79
Ether extract[ns]	62.95±2.40	62.76±0.95

ns: Non significant (P>0.05)

Table 4: Average of body weight and body condition score in dairy cows

	Group	
Parameters	Control	Treatment
Body Weight (BW):		
First week of experiment[ns]	450.83±85.29	430.67±46.54
Last week of experiment[ns]	469.67±76.14	454.33±37.98
Average of BW[ns]	449.06±78.32	431.50±39.20
Body Condition Score (BCS):		
First week of experiment[ns]	3.17±0.26	3.29±0.19
Last week of experiment[ns]	3.17±0.62	3.38±0.31
Average of BCS[ns]	3.09±0.26	3.25±0.22

ns: Non significant (P>0.05)

Body Weight and Body Condition Score

The mean of Body Weight (BW) and Body Condition Score (BCS) on early lactating dairy cattle did not differ in both groups (P>0.05). The average BW and BCS of dairy cows during the study were presented in Table 4. An indicator of energy balance status is BCS. If dairy cows are too fat at calving and diets are not provided ad libitum or not well formulated, cows will lose more body condition. This change in Body Condition (BCS) well correlates with cumulative Negative Energy Balance (NEB) and lipid mobilization stored in the body (Domecq *et al*., 1997a; 1997b), full stop, BCS might be used as indicator of energy balance during early lactation (DeVries and Veerkamp, 2000). Taylor and Field (2004) reported that after parturition, cows hardly provide adequate nutrient for milk production due to limited feed consumption, so the lipid was mobilized to fulfill the needs of nutrient. Van Knegsel *et al*. (2007) added that glucogenic diets in comparison with lipogenic diets, resulted in deposition of energy in the body. These findings show that glucogenic nutrients such as RUP supplements in the study, lead to improve BCS due to decreased body tissue mobilization by increasing DMI. The replacement of RDP with RUP supplements in lactating cows, improved energy balance and led to 9% increases in amount of NEl consuming (Santos *et al*., 1999).

Dry Matter Intake has special importance to meet nutrient requirement of early lactating dairy cows to maintain their health and productivity (production and reproduction). According to Nathalie *et al*. (2004), low DMI and deficiency in nutrient supply (especially protein and amino acids), could led to immunosuppression and incidence of metabolic disorders consisted of decline in the value of BCS, ketosis, fatty liver and displaced abomasum (Drackley *et al*., 2001; Duffield *et al*., 2009). Thus, diets that have higher levels of CP and RUP are effective in maintaining cows productivity (production and reproduction) and BCS value (NRC, 2001). Early lactating dairy cows in first days of lactation period (especially immediately after parturition) will lose appetite, because of increased level of estrogen

in blood plasma (Ingvartsen, 2006). If the feed intake provided is insufficient, either in terms of quantity or quality, then the cow will utilize the nutrients available within its body by mobilizing the stored energy within their body tissues. As the consequence of this mobilization, the cow will lose so much BW and decline in BCS value, which will affect the cow production and reproduction performance postpartum (Mundingsari, 2006; Rochijan *et al*., 2014). NRC (2001) recommended high concentration of CP for high levels of milk production, therefore, because of low DMI in early lactating dairy cows, this amount of CP must meet in the form of high concentrate of RDP and RUP in diets (Khorasani *et al*., 1996).

Ipharraguerre and Clark (2005) reported that decreasing DMI in early postpartum period causes declining in passage rate and consequently protein degradability in the rumen increases, thus will decrease ruminal outflow of non-ammonia nitrogen, non-ammonia non microbial nitrogen and follow that entering of essential amino acids into small intestine, which has an impact on the decline of BCS. However, using feed ingredients containing a rich source of leucine in diets of early lactating dairy cows could be an effective factor in maintaining protein reserves of body and consequently improve BCS changes. Likewise, branched chain amino acids have several roles in whole body metabolism and could influence insulin secretion. Amino acids could influence secretion of metabolic hormones, especially prolactin and insulin (Lal and Chugh, 1995; Gamsworthy *et al*., 2008) and leucine directly stimulates mRNA level of insulin in pancreas cells (Docherty and Clark, 1994). Increasing dietary CP from calving day to 150 DIM had led to increased energy consumption, BW and BCS of dairy cows had numerically increased that were in agreement with the findings (Law *et al*., 2009).

Conclusion

The conclusion is supplementation with different rumen undegraded protein level on early lactating dairy cattle could not increase feed consumption, nutrient digestion, body weight and body condition score.

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Author's Contribution

Budi Prasetyo Widyobroto: Designed the experiments, analyzed the data and contributed to the writing of the manuscript.

Rochijan: Designed and performed the experiments, analyzed the data and contributed to the writing of the manuscript.

Fajar Satrio Pradana: Performed the experiments, analyzed the data and contributed to the writing of the manuscript.

Lies Mira Yusiati: Performed the experiments and analyzed the data.

Ethics

All the authors have approved the manuscript and agree with submission to the esteemed journal. There are no conflicts of interest to be declared.

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