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THE EFFECTS OF SYNCHRONIZATION OF CARBOHYDRATE AND PROTEIN SUPPLY IN SUGARCANE BAGASSE BASED RATION ON BODY COMPOSITION OF SHEEP

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ABSTRAK

Penelitian bertujuan untuk mengkaji pengaruh ransum berbasis bagase dengan sinkronisasi pasokan energi dan nitrogen terhadap komposisi tubuh domba. Penelitian terdiri dari dua tahap. Tahap pertama menggunakan dua ekor domba ekor tipis jantan dewasa berfistula rumen bertujuan untuk menyusun tiga formulasi ransum perlakuan dengan indeks sinkroni yang berbeda. Ransum perlakuan diformulasikan dengan indeks sinkroni yang berbeda, masing-masing yaitu level indeks sinkroni 0,37; 0,50; 0,63. Penelitian tahap kedua bertujuan untuk mengkaji pengaruh pemberian ransum perlakuan yang diformulasikan pada tahap pertama terhadap komposisi tubuh domba dengan menggunakan lima belas ekor domba ekor tipis jantan. Ransum perlakuan juga diformulasikan secara isoenergi, isonitrogen dan isoNDF. Komposisi tubuh domba diukur pada minggu 0, 4 dan 8 periode perlakuan dengan metode urea space. Level indeks sinkroni tidak berpengaruh nyata terhadap konsumsi pakan, rasio asetat propionat dan konsentrasi glukosa darah, akan tetapi berpengaruh nyata (P<0,05) terhadap kecernaan bahan kering. Level indeks sinkroni yang berbeda tidak berpengaruh nyata terhadap persentase protein, lemak dan air tubuh meskipun bobot badan domba sedikit meningkat selama periode penelitian.

Kata kunci :indeks sinkronisasi,bagase, komposisi tubuh, domba

ABSTRACT

The objective of this research was to study the effects of synchronization of carbohydrate and protein supply in sugarcane bagasse based ration on the body composition of sheep. The study was consisted of two steps of experiment. The first step of experiment used two rumen cannulated adult rams to create formulation of three diets with different synchronization index, namely 0.37; 0.50 and 0.63 respectively. The experimental diets were designed to be iso-energy, iso-nitrogenous and iso-neutral detergent fibre (iso-NDF). The second step of experiment was to determine the body composition of sheep fed the experimental diets, which were created in the first experiment. The body composition of fifteen rams were determined on week 0; 4; and 8 of experimental period, these were accomplished using the technique of urea dilution. The alteration of synchronization index did not affect on feed intake, ratio of ruminal acetate to propionate and serum glucose concentration, but dry matter (DM) digestibility was affected (P<0.05) by the treatment of synchronization index in the diet. The alteration of synchronization index in the diet did not affect on the percentage of body protein, fat and water significantly, though body weight of sheep gained slightly during the experimental period.

Keywords : bagasse, body composition, sheep, synchronization index

INTRODUCTION

The effect of synchronization of carbohydrate and protein supply in a rice wine residue based ration on protein metabolism parameters was studied in Holstein steers (Piao *et al*., 2012). Kaswari *et al*. (2007) reported the relationship between the synchronization index and the microbial protein synthesis in the rumen of dairy cows. Chumpawadee *et al*. (2006) clarified the effect of synchronizing the rate of dietary energy and nitrogen release on protein metabolism parameters in beef cattle. The effect of synchronization of nutrient supply to the rumen and dietary energy source on the growth of lambs was studied by Richardson *et al*. (2003). Schmidely *et al*. (1996) studied the potential effects of the synchronization of release of nitrogen and carbohydrates of the concentrate on some metabolic parameters in the dry pregnant goat. There is a little information concerning with the body composition of sheep fed on sugarcane bagasse based diet with different synchronization index.

A diet with higher synchronization index should allow more efficiently use of nutrients by rumen microbes, increase microbial protein and fermentation end products, and thus more increase available protein in the small intestine (Yang *et al*., 2010; Hall and Huntington, 2008). It is postulated that diet with high synchronization index may increase protein proportion of body composition in sheep. The objective of this study was to examine the body composition of sheep fed sugarcane bagasse based diets with different synchronization index. This was accomplished by using the technique of urea dilution.

MATERIALS AND METHODS

This study was consisted of two steps experiments. The first step was formulation of three sugarcane based-experimental diets with different synchronization index, and the second step was feeding trial using the experimental diets.

First Step

The aim of the first step of experiment was to create three sugarcane based diets with respective 0.37; 0.50; and 0.63 of synchronization indexes. Two adults thin tail local cross bred rams were used in the first experiment. Sheep were fitted with permanent rumen fistula and were housed individually in the metabolic cages. The experimental animals received a ration (12% CP; 62 %TDN; 55%NDF) daily at a maintenance level. The determination of ruminal degradation characteristics of feedstuffs were conducted after two weeks of dietary adaptation.

Approximately 5 grams of feedstuff sample was placed in a nylon bag with-mean pore size of 45 µm. The nylon bags were then placed into rumen of sheep approximately 30 min after morning feeding. After 0, 2, 4, 6, 12, 24, 48 h the bags were retrieved from rumen and were washed using washing machine until the rinse water became clear. Zero-hour bags were not incubated in the rumen but were washed in the same manner as incubated bags. After being washed, bags were dried at 60 ^{o}C for 48 hours and weighed.The dried residues were analysed for dry matter (DM), organic matter (OM) and crude protein (CP) contents.

The synchronization index was calculated according to Sinclair *et al*. (1993), where an asynchronization index of 1.0 represents perfect synchronization between nitrogen and energy supply throughout the day, while the values of <1.0 indicated the degree of asynchronization. Table 1 shows the nutrient composition and ingredients of three experimental diets in the form of total mixed rations (TMR), which were designed to have synchronization index at 0.37; 0.50; 0.63; respectively. The experimental diets were also designed to be iso-energy and iso-nitrogenous.

Urea was also included in the data-base and it was assumed that 95% of urea N was degraded in the first hour after feeding, with the remaining 5% of urea N degraded at a rate of 0.5/h (Sinclair *et al*., 1995). Sugarcane molasses was assumed that 100% N and OM were degraded in the first hour post feeding.

Second Step

This step of experiment was aimed to determine the body composition of sheep fed sugarcane based diets with different synchronization index. Fifteen thin tail local cross bred rams with the body weight average of 18 kg and aged at 12 monts were used in the second experiment. Animals were divided into three groups and fed three sugarcane based diets with different synchronization index (Table 1). Sheep were housed individually in metabolic cages and drinking water was available at all time. The determination of sheep's body condition were

Table 1. Ingredients and Composition of Experimental Diets

	Synchronization Index of Experimental Diet		
	0.37	0.50	0.63
	--------------------------- % --------------------------		
Ingredients (based on 100% DM)			
Sugarcane bagasse	25.0	25.0	25.0
Rice bran	2.5	4.0	5.6
Molasses	2.0	4.0	7.0
Copra meal	2.5	6.0	16.3
Urea	0.7	0.5	0.2
Palm frond meal	16.5	9.0	1.0
Coffe seed shell	2.3	2.0	3.8
Onggok/ dried cassava	30.2	15.5	2.2
Wheat pollard	1.1	15.5	23.0
Groundnuts shell	1.6	3.5	3.6
Corn	5.8	4.5	0.5
Soybean meal	11.3	10.0	11.3
Salt	0.5	0.5	0.5
Chemical compositions			
Crude protein	12.06	12.17	12.95
Crude fiber	25.30	24.60	25.32
Extract ether	3.37	3.44	3.70
Neutral detergent fiber	54.80	55.97	55.98
Carbohydrate	81.03	79.85	77.40
Non Structural Carbohydrate	26.22	23.89	21.43
Total digestible nutrients[1)]	62.05	62.93	62.96

[1)] Calculated according to Hartadi *et al*. (2005)

conducted at week 0; 4; and 8 of feeding trial period, these were accomplished by using the technique of urea dilution (Hanna, 2010; Baiti *et al*., 2013). Prior to commencements of the urea dilution technique, the live body weight of sheep were determined by using the digital scale with an accuracy of 0,01 kg.

In the urea dilution technique, a solution of urea of 200 g per liter (0.65 mg per live body weight) was injected into the jugular vein of sheep through a cannula at a rate of 120 ml/min. Blood samples were taken into heparinized test tubes before injection and 12 min after the mid-time of the injection period. They were put immediately on ice and separated within 2 h, and the plasma was stored at -20°C for analysis. Urea space (US) was calculated by the following equation: US = $D/(C_{12} - C_0)$, where US = urea space (liters); D = dose (grams of urea), and $(C_{12} - C_0)$ = the change in urea concentrations (gram per liter) in plasma between samples that were taken before and 12 min after urea injection.

Additional blood sampling was also conducted to study the incremental increase of blood glucose after feeding in each sheep. This observation was conducted three days after commencement of urea dilution technique experiment. Blood sampling were taken before and three hours after feeding. Three days after this blood sampling, sample of rumen liquor was taken in each sheep by using the stomach tube. This rumen liquor sample was then used for acetate and propionate analysis. The samples of rumen liquor were taken before and 2 hours after feeding.

Chemical and Statistical Analyses

Content of proximate components and neutral detergent fiber of feeds were analyzed according AOAC (1995) and Van Soest *et al*. (1991), respectively. Blood urea concentration was assayed according to the method of Berthelot (AOAC, 1995). Serum glucose concentration was determined using a glucose assay kit (Glucose liquicolor, Human Geselschaft fur Biochemica und Diagnostica Gmbh, Taunusstein, Germany). Concentrations of acetate and propinoate in rumen liquor were analyzed according to method of gas chromatography (AOAC, 1995).

The dietary treatment was allotted according to a completely randomized design with five replicates of each treatment, and one way analyse of variance was used to test the data.

RESULTS AND DISCUSSION

Feed Intake and Digestibility

The different synchronization index for sugarcane bagasse based diets did not affect significantly on daily consumption of DM, CP, NDF and carbohydrate (Table 1). The experimental diets were formulated to have similar ingredient and nutrient content but differed in value of synchronization index (Table 1). All sheep consumed the same amount of nutrients at the same time, thus avoiding effects of ingredient characteristics and intake level on the synchronization of supplies from ruminal product of carbohydrate and nitrogen degradations (Piao *et al*., 2012).

Table 2 shows that the DM digestibility of the diet with a synchronization index at 0.50 was higher ($P<0.05$) compared with those of diets with synchronization index at 0.37 and 0.63. The higher synchronization index was expected to have higher nutrient digestibility in gastrointestinal tracts, because of supply from ruminal product of carbohydrate and nitrogen degradations are improved (Yang *et al*., 2010; Chumpawadee *et al*., 2006). However, it is not clear why the DM digestibility of the diet with a synchronization index at 0.63 was the lowest (Table 2). The alteration of synchronization index in diet did not affect on the apparent feed digestibility in steers (Piao *et al*., 2012), beef cattle (Rotger *et al*., 2006), and lactating dairy cows (Chanjula *et al*., 2004).

Ruminal Fermentability of Feed Carbohydrate and Blood Serum Glucose

Ratio of ruminal acetate to propionate was unaffected by alteration of synchronization index in the diet (Table 2), although the DM digestibility was improved by the alteration of synchronization index. Sugarcane bagasse is well known as a source of fiber in balancing ruminant diet, and all diets were designed to contain the same amount of sugarcane bagasse (Table 1). Chumpawadee *et al*. (2006) reported that increasing the synchronization index in diet may improve the DM digestibility but the ruminal VFAs concentrations remain unchanged. There are greater fluctuations of VFAs concentrations over feeding times in goat when fed grass or alfalfa hay (Cantalapiedra-Hijar *et al*., 2009).

Treatment of synchronization index in the diet did not affect significantly on serum glucose concentrations before and after feeding in sheep (Table 2). The magnitude effect of feeding on increasing blood glucose concentration may be smaller in ruminant than in monogastric animal because ruminant mostly rely on hepatic glucose output (Achmadi, 2012). The unchanged serum glucose level may be related to ruminal VFAs concentrations. The value of ratio of non-glucogenic to glucogenic VFAs may be used to measure carbohydrate feed utilization, because propionate is a main precursor of hepatic glucose production (Orskov, 2002).

Body Composition of Sheep

Percentage of body components of sheep remained similar throughout experimental period, although the body weight of sheep gained slightly (Table 2). Although the microbial protein synthesis was not determined in this experiment, the improvement of supply from ruminal product of carbohydrate and nitrogen degradations could be expected to increase microbial protein synthesis which in turn increasing post ruminal protein availability for synthesis of sheep body protein. However, the alteration of synchronization index in the diet did not change the percentage of body protein. It is suggested that

Table 2. Results of Experiment[1)]

Parameters	Synchronization index of experimental diet		
	0.37	0.50	0.63
	-------------------------	%	---------------------------
Feed Consumption[2]			
Dry matter, g/d/BW$^{0.75}$	71.36 ± 7.99	72.75 ± 8.79	70.12 ± 12.31
Crude protein, g/d/ BW$^{0.75}$	8.60 ± 0.96	8.85 ± 1.07	9.08 ± 1.59
Neutral detergent fiber, g/d/ BW$^{0.75}$	39.10 ± 4.38	40.72 ± 4.92	39.25 ± 6.89
Carbohydrate, g/d/ BW$^{0.75}$	57.82 ± 6.48	58.09 ± 7.02	54.29 ± 9.53
Dry matter digestibility, %	58.60 ± 2.01[b]	62.68 ± 1.25[a]	53.78 ± 2.86[c]
Ratio of Ruminal C2 to C3			
Before feeding	1.91 ± 0.06	1.96 ± 0.10	1.82 ± 0.10
Two hour after feeding	4.32 ± 0.13[a]	3.52 ± 0.01[b]	3.38 ± 0.19[b]
Consentration of serum glucose			
0 weeks			
Before feeding, mg/dL	61.70 ± 6.88	67.34 ± 4.59	67.92 ± 6.61
Three hours after feeding, mg/dL	65.28 ± 5.54	70.40 ± 4.72	71.24 ± 7.85
4 weeks			
Before feeding, mg/dL	62.82 ± 8.85	63.60 ± 4.65	59.26 ± 6.56
Three hours after feeding, mg/dL	63.72 ± 8.62	64.36 ± 3.78	60.92 ± 5.52
8 weeks			
Before feeding, mg/dL	65.10 ± 6.86	63.66 ± 5.59	63.48 ± 5.02
Three hours after feeding, mg/dL	72.32 ± 2.68	70.50 ± 5.38	70.58 ± 7.40
Body Weight, kg			
0 weeks	18.12 ± 2.25	18.24 ± 1.86	18.36 ± 2.49
4 weeks	19.24 ± 2.43	20.20 ± 2.48	20.08 ± 2.18
8 weeks	23.4 ± 2.47	23.00 ± 3.15	20.40 ± 1.22
Body composition			
0 weeks			
Body water,%	59.63 ± 0.73	59.09 ± 0.26	59.42 ± 0.54
Body protein,%	10.20 ± 0.82	10.30 ± 0.42	10.34 ± 0.54
Body fat,%	19.28 ± 0.97	20.00 ± 0.35	19.56 ± 0.85
4 weeks			
Body water,%	59.16 ± 0.43	58.99 ± 0.49	59.13 ± 0.74
Body protein,%	10.32 ± 0.73	10.65 ± 0.50	10.68 ± 0.37
Body fat,%	19.90 ± 0.57	20.13 ± 0.66	19.92 ± 0.96
8 weeks			
Body water,%	58.55 ± 0.20	58.98 ± 0.42	59.14 ± 0.47
Body protein,%	11.07 ± 0.32	11.10 ± 0.56	10.76 ± 0.33
Body fat,%	20.70 ± 0.26	20.14 ± 0.56	19.92 ± 0.62

[1)]Values are means of 5 sheep±SD; [2)] Average values of 7 days observations in each sheep (mean±SD; n = 5); [a,b] Means within a row with different superscripts are significantly different (P<0.05).

sheep have reached a period of maturity, thus the growth of muscle protein is not predominant. Although there is a little information concerning with the effect of alteration of synchronization index in diet on the body composition in ruminant.

The unchanged body water and fat contents may contribute to a discrepancy of the body protein content. If body protein content increases as the treatment of synchronization index in diet, the content of body water and/or fat will decrease. Tomlinson *et al*. (1997) reported that increasing portion of rumen undegradable protein in a diet did not decrease percentage of body fat, thereby body protein percentage remained unchanged, though body weight of heifer gained according to the portion of dietary protein. Nonaka *et al*. (2006) clarified that deprivation of drinking water in cattle and buffalo causes a decrease in body weight and fat percentage but percentage of body protein remains unchanged.

CONCLUSION

Although body weight gained slightly throughout experimental period, the body composition of sheep was not affected by alteration of synchronization index in the diet. For the study is required with some consideration: ingredients of total mixed ration and physiological phase of animal.

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