PERFORMANCE OF GARUT BREED RAMS FED BY RATION CONTAINING DIETARY ADDITIONS OF CATION-ANION DIFFERENCE AND FATTY ACID CONTENTS

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Abstract

This study was carried out to evaluate the effect of dietary cation-anion difference (DCAD) and fish oil supplementations on dry matter intake (DMI), dry matter digestibility (DMD) and organic matter digestibility (OMD), weight gain, as well as the acidity of urine in Garut breed rams. The dietary treatments were as follows: R0= basal ration (DCAD +14) without fish oil, R1= basal ration (DCAD +14) with 3% fish oil, R2= base ration (DCAD +40) without fish oil, R3= base ration (DCAD +40) with 3% fish oil, R4= acid ration (DCAD -40) without fish oil, and R5= acid ration (DCAD -40) with 3% fish oil. All rations contained 150 ppm of zinc and were offered to 18 of Garut breed rams. The result indicated that DCAD +40 and -40 decreased DMI significantly. The ration with DCAD +40 had the lowest DMI. Fish oil supplementation decreased DMI. No differences were observed for DMD and OMD. DCAD +40 and -40 decreased body weight of rams except RA0 ration. However, the body weight of rams was very low. Variation of urine pH followed the DCAD pattern. It could be concluded that DCAD +40 and -40, as well as fish oil supplementations decreased DMI, body weight and urine's pH followed DCAD pattern.

Key words: Cation, anion, body weight, digestibility, Garut breed rams

INTRODUCTION

High concentrate diet and fat supplementation are often carried out to increase feed energy contain in order to support high livestock growth. High concentrate diet might cause metabolic disorders such as acidosis. Fat supplementation is often used to increase feed energy, fatty acid contains and mineral absorption such as Zn (Hartati, 1998; Leray et al., 1985; Hafez, 1980). $NaCO_3$ is often used as *buffer* to avoid acidosis. However, mineral supplementation is often used without determining of the effect of cation-anion dietary excess.

Dietary cation-anion difference (DCAD) effects Ca metabolism, so it is thought to affect other nutrients metabolism include fatty acids (Yingst *et al*., 2001), DCAD with high anion is often used to deal with *milk fever* (Hu and Murphy, 2004). Fathul *et al*., (2008) reported that DCAD 28, -18, 0, +14 and +32 on female Garut sheep affect pH diet, blood, urine, and fetus number per ewe. The other researchers said that the balance of cation-anion difference in the diet of Garut sheep did not give any negative effect on feedintake, growth, digestibility, mineral absorbtion, and the characteristic of microscopics spermatozoa (Anggreini, 2007). The balance of body liquid acid can be affected by consuming Na, K, Cl and S dietary (Stewart, 1983; Tucker *et al*. 1992). The negative Dietary cation-anion difference (DCAD) causes the decreases of blood and urine pHs (Moore *et al*,. 2000; Roche *et al*., 2003a; Roche *et al*., 2003 b; Boruchi *et al*., 2004). On the contrary, if DCAD is increased, it will raise blood pH, Ca plasma and urine PH but decreasing K and Cl of blood (Vagnoni and Oetzel, 1998). Anion salt is not palatable and too much addition in the

diet will decrease its consumption (Horst *et al*., 1994). Chan *et al*. (2005) said that there will be a decrease of dietary consumption by increasing the value of DCAD. Decreasing of dietary consumption by increasing DCAD value causes the livestock insufficiency of energy. Insufficiency of energy can be solved by increasing fish oil in the diet because fish oil can be a source of energy. Cation-anion are absorbed by intestine channel resulting in the increase of strong ion in plasma so it produces alkalosis metabolic (Horst, 1997 ; Riond, 2001).

The research aim is to study the effect of DCAD and oil supplementations in ruminant diet on: (1) dry matter intake (2) organic and dry matter digestibility (3) weight gain and (4) urine pH value. This research used Garut breed rams as models. It is thought that DCAD will affect dietary consumption that can affect weight gain and urine pH due to the addition of DCAD.in the ration.

MATERIAL AND METHOD

Basal ration was a complete ration containing materials in all mash with the same nutrient contents (Table 1).

Table 1. Composition and nutrients content of basal ration

Feed composition	(% of DM ration)
Corn roughage	35.0
Rice hull/bran	7.0
Cassava waste	10.5
Corn seed	17.5
Copra meal, mech extr.	8.0
Soybean meal	22.0
Total	100.0
Nutrient content of basal ration	(% of DM)
Dry matter	89.41
Ash	8.19
Crude Protein	14.94
Fat	2.98
Crude Fiber	14.71
Nitrogen free extract	56.17

DM= dry matter

The dietary treatment is basal ration supplemented with mineral salt resulting in DCAD +14, +40 and -40 meq, each of them was added by 0 and 3% fish oil (Table 2). Base ration was gained by adding Na_2CO and K_2CO into basal ration in which each of them acted as cation resource of Na and K in order to meet the value of difference cation-anion dietary (DCAD) became +40. The group of acid rations were gained by adding $MgCl_2$ and $MgSO_4$ into each of the basal ration as the anion resources of C1 and S in order to meet the value of CAD became -40. The ration was then analized on the contents of Na, K, Cl and total S, continued by calculating the cation-anion difference based on the equation of Tucker et al., (1992). All rations contained Zn 150 days mg/kg DM rations by adding $ZnSO_4$ (table 3), zinc letal dosage is 750 ppm in ration (Salt Institute, 2001). Ration was applied to 18 Garut breed rams aged two years for 50 days. Two weeks before the application, the rams were given basal ration without supplementation $ZnSO_4$ (Table 1). Randomized Group Design (RGD) was used as the research method where rams were classified based on their waights, i.e (I) wight 34,58 ±2,38 kg, (II) 30,75 ±0,42 kg and (III) 29,67 ±0,68 kg.

Tabel 2. Dietary cation-anion difference and fish oil supplementation of rations

Rations	DCAD	Fish oil (%DM)
R0	+14	0
R1	+14	3
R2	+ 40	0
R3	+ 40	3
R4	- 40	0
R5	- 40	3

R0=DCAD +14 without fish oil;R1=DCAD +14 + 3% fish oil;R2=DCAC+40 without fish oil; R3= DCAD +40 + 3% fish oil;R4= DCAD-40 without fish oil; R5= DCAD -40 + 3% fish oil

The observed parameters include (1) dry matter intake (g/day). The amount of daily ration consumption was calculated as follow: The amount of consumption (gram) = the amount of given ration (gram) – the amount of remaining ration in the next morning. Measuring ration consumption was carried out every day during the research (50 days).

Table 3. Supplementation of minerals and fish oil of the ration

	Rations					
	R0	R1	R2	R3	R4	R5
Supplementation of mineral and fish oil (g/100 g DM)						
$ZnSO_4$	0.030	0.030	0.030	0.030	0.030	0.030
Na_2CO_3	-	-	4.356	4.356	-	-
K_2CO_3	-	-	1.663	1.663	-	-
$MgSO_4$	-	-	-	-	12.36	12.36
$MgCl_2$	-	-	-	-	2.26	2.26
Fish oil	0,0	3.0	0.0	3.0	0.0	3.0
Minerals content (g/100g DM of ration)						
Sodium	0.041	0.041	1.957	1.957	0.041	0.041
Potassium	0.1076	0.1076	1.048	1.048	0.1076	0.1076
Chlorine	0.193	0.193	0.193	0.193	1.882	1.882
Sulfur	0.151	0.151	0.151	0.151	3.447	3.447
Calcium	0.020	0.020	0.020	0.020	0.020	0.020
Phosfor	0.019	0.019	0.019	0.019	0.019	0.019
Magnesium	0.42	0.42	0.42	0.42	3043	3.043
Zinc	0.150	0.150	0.150	0.150	0.150	0.150

R0=DCAD +14 without fish oil;R1=DCAD +14 + 3% fish oil;R2=DCAC+40 without fish oil; R3= DCAD +40 + 3% fish oil;R4= DCAD-40 without fish oil; R5= DCAD -40 + 3% fish oil

Feed consumption was calculated based on the dry matter (DM) of the ration. Daily asfeed ration consumption was converted into DM in order to determine ration DM consumption. (2) Dry matter digestibility (DMD) and organic matter digestibility (OMD) (%). Feces sample collections to measure DMD and OMD were taken out from the 14^{th} day to the 20^{th} day of the research. During the collection time, all the feces tratment were collected and weighed in fresh condition every day. Feces were then dried up under the sun shine then they were weighed on dry condition. In about 10 % of dried feces at the same treatment was collected for further analysis of DMD and OMD. (3) Body weight gain (BWG) (g/day), was obtained by calculating the final body weight minus the initial body weight (4). Value of urine pH, measuring of urine pH was carried out once a week, (day -7, 0, 7, 14, 21, 28, 35, 42 and 49). Urine collection was carried out from 06.00 a.m. using urine bag. After it was collected, soon the urine was measured by using digital pH meter.

Data of the research were analized by using analysis of variance (ANOVA) in SAS programme (SAS, 2005), if there was a significant difference ($p<0,05$) it was followed by Duncan Multiple Range Test and contrast orthogonal (Mattjik and Sumertajaya, 2002).

RESULTS AND DISCUSSIONS

Dry Matter Intake

Average dry matter (DM) intake of Garut breed rams fed by ration containing different DCAD and fish oil supplmentation were shown at table 4. DM intake at the first week of experiment were at the lowest level. It is caused by the effect of ration treatment hasn't been visible. Even though, Garut breed rams fed with basal DCAD (+14), had the higest DM intake then followed by rams which are given +40 and -40 DCAD ration.

A linear increase in dry matter intake was recorded according to research time, The rams fed by DCAD +14 without fish oil supplementation (R0) had the highest DM intake followed by R1, R4, R5, R2 and R3 repectively. However, rams were fed by +40 and -40 of DCAD had low DM intake. The lowest DM intake is got by rams that are given -40 DCAD.

Fish oil supplementations decreased DM intake of all the rations. It was indicated that the flavour of fish oil are not interested of Garut breed rams.

The pesent study indicated that ration containing different DCAD and fish oil supplmentation had significant affect ($p<0.01$) on dry matter intake (g/day) of Garut breed rams. Ration without fish oil supplementation had higer dry matter intake than ration that supplemented with 3% fish

oil (R0, R2 & R3 vs R1,R3& R5). It is also happened to DM intake between ration with DCAD +14 and -40 (R0 & R1 vs R4& R5), and DCAD 14 and +40 (R0 & R1 vs R2& R3). Futhermore, DCAD +40 had lower DM intake than -40 (R4 & R5 vs R2 & R3). Giving ration with DCAD outside of normal such as +40 or -40 decreased dry matter intake significantly, but DCAD +40, its effect is worse than DCAD -40.

Increasing some minerals either cation or anion causes ration less of palatable so it is decreasing DM intake of Garut breed rams. Decreasing of DM intake is very drastic so the rams which get ration treatment with DCAD -40 or +40 tend less of nutrient. It shows that the changing of DCAD value is very sensetive to the DM intake of Garut breed rams. Morton and Roach (2002) and Chan et al. (2005) said that more increase DCAD value in ration causes more decrease the amount of DM intake. It is different with Delaquis and Block (1955) and Riond (2001) reported that increasing DCAD ration value equal with increasing of DM intake. Other opinion said that DCAD ration value doesn't effect DM intke. (Romo et al., 1991). The fact above shows that the difference respond of livestock to DCAD ration value. Some factors that effect the respond i.e. fisiological status and the kind of livestock used.

Sarwar et al., (2007) reported that giving ration with DCAD -110, +110, +220 and +330 to Thali sheeps causes increasing of ration DM intake linierly with increasing of DCAD. Less of DM intake on DCAD -110 is caused by increasing anion ($CaCl_2$) because calcium chloride isn't palatable and it can reduce DM intake.

Garut breed rams have good consumption regulation system. If the amount of cation or anion in ration is more, Garut breed rams will reduce to consume anion or cation of ration. So the negative effect of cation or anion exceed in ration can be minimalized.

Dry Matter and Organic Matter Digestibility and Average Daily Gain

Average of DM intake, DM and OM digestibility, and average daily gain (ADG) between 67.33 – 74.67%, OM digestibility is between 69.67 – 78.33%. The value of DM and OM digestibility on this experiment include to high value. It is effected by feedstuff matterial of experimental ration arranger. Feedstuf such as Copra meal, mech extr., Rice hull/bran, Cassava waste, Corn seed and Soybean meal are some matterial which have high degestibility for ruminansia livestock. The higher digestibility of ration shows that the feedstuff has good quality tobe consumed by livestock and used for metabolism process. It is generally caused by ration vitamin that can be highly digested, so the nutrient value will also high.

There are some factors that effect digestibility i.e. temperature, rate of passage, feed physical shape, ration composition and nutrient content. DM or OM digestibility of ration isn't effected by DCAD. It shows that DCAD +40 or -40 doesn't disturb digestion process of Garut breed rams. Ruminants produce saliva as *buffer*. The saliva is able to netralize normal pH rumen from excess or lack of ration cation – anion so it is normal (6,5-7,5). Normal pH of rumen keeps rumen microbe works optimally so DM and OM digestibility ration isn't disturbed. It's different from what had reported by Sarwar (2007*) he said that dry matter digestibility on sheeps which are fed by DCAD -110 is higher if it is compared with sheeps which are fed by DCAD +10, +220 and +330.

Reducing consumption of DM on DCAD +40 or -40 caused the rams lack of nutrient and it will cause reducing of body weight Garut breed rams which got DCAD +40 and -40(R2 and R5) get the biggest decreasing of body wight regularly -40 gram /day and -36,66 gram/day, while the rams which are fed DCAD -40 with supplementation of fish oil 3% (R5) get decreasing of body weight -36 g/day. The decreasing of body weight is caused of acidosis metabolism which is caused by low of DCAD in ration (Sarwar, 2007*). Garut breed rams fed by DCAD +140 without supplemntation of fish oil (R0) have the highest daily gain 133,34 g/day with consumption rate 871±90 g DM/day. Desreasing of body weight is caused more by low of ration palability so it decreases ration consumption on DCAD +40 and -40 either fish oli supplementation .

Value of Urine pH

Average of urine's pH of Garut Breed Rams fed by ration containing different DCAD and fish oil supplmentation contain shows at Table 5. All of rams in seven days and a day before treatment is given it has same value of urine pH about 8,65 – 9,46. It shows that all rams when they are fed preparation ration had same fisiological condition. The urine pH rams change when the experimental ration is given. The changing of urine pH of rams on the seventh day untill the 21st day has the same pattern i.e. experimental livestock fed with DCAD +14 and +40 (R0, R1, R2, and R 3) have the same value between 7,81 – 9,44. While urine pH of rams fed with DCAD (R4 and R5) have lower pH value about 4,994 – 5,78. The pH value above shows that exceeding consumption of negative ion which is consumed by experimental livestock soon excreted through urine which is manifested through decreasing of urine pH value. It proofs that negative ion has a great effect to urine pH.

On the 28th and 42nd days, ration with basa CAD +40 clearly effects the urine pH value. Garut rams fed with experimental ration with DCAD +14 produces higher pH value compared with Garut rams fed with DCAD -40 or +14. It is also happened on the 35th and 49th of experimental days, although DCAD +14t with fish oli supplementation has relatively same pH value with given +40. DCAD -40 has a stronger effect to urine pH if it is compared with DCAD +40. The ration with DCAD -40 consistently decreasing urine pH during the experiment. Fat supplementation in DCAD -40 or +40n tends increase urine pH. DCAD -40 has more consistent effect and decreasing urine pH directly. Urine's pH follows the DCAD pattern DCAD during experiment ($p<0,01$). Increasing $MgCl_2$ and $MgSO_4$ on DCAD -40 (R4 and R5) cause rams are exceed to consume acid anion Cl' and S'. The rams maintains homeostasis by excreted through urine which is manifested with decreasing urine pH. Chan et al., (2006) eksplained that decreasing of urine pH is an anion effect that is contained in ration. It is also with sheep which are fed with DCAD +40e (R2 and R3), increasing meneral salt Na_2CO_3 and k_2CO_3 cause rams excess to consume of anion-cation Na' and K'. Sarwar et al. (2007) reported that sodium bicarbonat in ruminant ration cause of increasing urine pH. It's a reflection from increasing kidney and blood pH which has important role in minimalized pH changing in the body. Through the homeostasis process, excess of cation-anion is excreted through urine which is indicated with high of urine pH.

CONCLUSIONS

The result indicated that: DCAD +40 and -40 and fish oil supplementation decreased dry matter intake significantly. The ration with DCAD +40 had the lowest dry matter intake. No differences were observed for dry matter and organic matter digestibility. DCAD +40 and -40 decreased body weight of rams except R0 ration, however, the body weight of rams was very low. Variation of urine pH followed the DCAD pattern.

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REFERENCES

[1] Anggreini, D. 2007. Konsumsi dan Kecernaan Nutrien serta Kualitas Semen Domba Garut dengan Ransum yang Bernilai Neraca Kation-anion Berbeda. Thesis. Sekolah Pascasarjana. IPB Bogor.

[2] Boruchi, SI., L.E. Phillip, V. Girard and A. Tremblay. 2004. Altering dietary cation-anion difference in lactating dairy cows to reduce phosphorus excretion to the environment. J. Dairy Sci. 87:1751-1757.

[3] Chan, P.S., J.W. West and J.K. Bernard. 2005. Effects of dietary cation-anion difference on intake, milk yield, and blood components of the early lactation cow. J. Dairy Sci. 88:4384−4392.

[4] Chan, P.S., J.W. West and J. K. Bernard. 2006. Effect of prepartum dietary calcium on intake and serum and urinary mineral concentrations of cows. J. Dairy Sci. 89:704−713.

[5] Delaquis, A.M. and E. Block. 1995. Dietary cation-anion difference, acid-base status, mineral metabolism, renal function, and milk production of lactating cows. J. Dairy Sci. 78:2259−2284.

[6] [Ditjennak] Direktorat Jenderal Peternakan. Departemen Pertanian Republik Indonesia 2005. Statistik Peternakan *2005*. Ditjennak. Jakarta.
[7] Fathul, F., T. Toharmat, I.G. Permana dan A. Boediono. 2008. Keasaaman cairan tubuh dan rasio kelamin anak domba Garut (Ovis aries) yang diberi Kation-anion ransum yang berbeda. Media Peternakan. Jurnal Ilmu Pengetahuan dan Teknologi Peternakan. 31 (2):87-98.
[8] Hafez, E.S.E. 1980. Reproduction In farm Animal. Philadelphia. Lea & Febiger.
[9] Hartati, E. 1998. Suplementasi Minyak Lemuru dan Seng ke Dalam Ransum yang Mengandung Silase Pod Kakao dan Urea untuk Memacu Pertumbuhan Sapi Holstein Jantan. Disertasi. Program Pascasarjana IPB Bgor.
[10] Horst, R.L. *et al*. 1997. Strategies for preventing milk fever in dairy cattle. J. Dairy Sci. 80:1269 −1280.
[11] Hu, W. and M.R. Murphy. 2004. Dietary cation-anion difference effects on performance and acid-base status of lactatung dairy cows: a meta-analysis. J. Dairy Sci. 87:2222-2229
[12] Leray, C., G. Nonote, P.Rouband and C. Leger. 1985. Inciden of (n-3) esential fatty acid deficiency develop. Eur. J. Clin Nutr. 25 (3):567-581.
[13] Mattjik A.A. & M. Sumertajaya. 2002. Perancangan Percobaan dengan Aplikasi SAS dan MINITAB. Jilid I. Edisi ke-2. Institut Pertanian Bogor (IPB)- Press, Bogor.
[14] Moore, S.J., M. J. Vanderhaar, B. K. Sharma, T. E. Pilbeam, D. K. Beede, H. F. Bucholtz, J. S. Liesman, R. L. Horst and J. P. Gofft. 2000. Effects of altering dietary cation-anion difference on calcium and energy metabolism in peripartum cow. J. Dairy Sci. 83 : 2095-2104.
[15] Morton, J. and C. Roach. 2002. Potash- How does it affect production and cow health. In Taranaki, editor. Proceedings of the Westpac Trust Dairy Conference. New Zealand. Page:19−23.
[16] Riond , J.L. 2001. Animal nutrition and acid-base balance. Eur. J. Nutr. 40:245− 254.
[17] Roche, J.R., D. Dalley, P. Moate, C. Grainger, M. Rath and F. O'Mara. 2003a. Dietary cation-anion difference and the health and production of pasture-fed dairy cows. 1. Dairy cows in early lactation. J. Dairy Sci. 86:970-978.
[18] Roche, J.R., D. Dalley, P. Moate, C. Grainger, M. Rath and F. O'Mara. 2003b. Dietary cation-anion difference and the health and production of pasture-fed dairy cows. 2. Dairy cows in early lactation. J. Dairy Sci. 86:979-987.
[19] Romo, G.A. *et al*. 1991. Some blood minerals and hormones in cow fed variable mineral levels and ionic balance. J. Dairy Sci. 74:3068−3077.
[20] Salt Institute. 2001. Salt and trace minerals for lifestock, poultry and other animals: *Zinc for Animals*. http//www.salt institute.com.html [16 Juni 2006].
[21] Sarwar, M., M.A. Shahzad and M. Nisa. 2007[a]. Nutrient intake, acid base status and growth performance of thalli lambs fed varying level of dietary cation-anion difference. Asian-Aust.J. Anim. Sci. 20(11):1713-1720.
[22] Sarwar, M., M.A. Shahzad and M. Nisa. 2007[b]. Influence of varying level of sodium bicarbonat on milk yield and its composition in early lactating nili ravi buffaloes. Asian-Aust.J. Anim. Sci. 20(12):1858-1864.
[23] [SAS] Statistical Analysis Software. 2005. SAS 6.12. Help and Documentation. SAS Institute Inc. USA.
[24] Stewart, P.A. 1983. Modern quntitative acid-base chemistry. Can. Physiol. Pharmacol 61:1444-1461.
[25] Tucker, W.B., G. A. Harrison and R. W. Hemken. 1992. Sulfur should be included when calculating the dietary cation-anion balance of diets for lactating dairy cows. Anim. Sc.i Res. Rep.: 141-150.
[26] Vagnoni, D.B. and G. R. Oetzel. 1998. Effects of dietary cation-anion difference on the acid-base status of dry cows. J. Dairy Sci. 81:1643−1652.
[27] Yingst, D.R., J. Davis and R. Schiebinger. 2001. Effects of extracellular calcium and potassium on the sodium pump of rat adrenal glomerulosa cells. *Am. J. Physiol. Cell Physiol.* 280:C119−C125.