A RESPONSE OF NUTRIENT INTAKE, NITROGEN RETENTION AND LIVE WEIGHT CHANGE OF BACH THAO GOAT FED DIETARY CABBAGE (*BRASSICA OLERACEA*) RESIDUES

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ABSTRACT

A study was implemented to evaluate the effects of replacing Para grass (*Brachiaria mutica*) by cabbage residue *(Brassica oleracea*) in the diets on feed utilization, rumen characteristics and daily weight gain in growing Bach Thao goat. It was a 4 x 4 Latin square using 4 male Bach Thao goats (24.3 ±0.92 kg). The treatments were replacing Para grass with 4 levels of cabbage residue (DM basis); 0, 25, 50 and 75% (CR0, CR25, CR50 and CR75). Concentrate and urea were supplied to balance level of protein in all treatments at 6.0 gCP/kg live weight. The experimental period was 14 days consisting of 7 days adaption and 7 days of sampling period. The results showed that DM intake was not different among the treatments which ranged from 705 to 760 g/day ($p>0.05$). Similarly CP intake tended to increase (149 -159 g/day) with increasing content of cabbage residue but not significantly different. As expected because of the lower NDF and ADF content in the cabbage residue, the NDF and ADF intakes reduced with increasing cabbage residue in the diets. Rumen pH, N-NH_3 and VFA concentrations were not significantly different ($p>0.05$) among the treatments It cab be concluded that replacing para grass with cabbage residue up to 75% of the diet did not result in any adverse effects on feed digestibility and rumen parameters. However, Bach Thao goats fed with 50% replacement (CR50 treatment) resulted in better in growth gain.

Key words*: cabbage residue, Bach Thao goat, rumen environment, digestion*

INTRODUCTION

The use of agro-industrial residue as animal feed has been a common practice in many industrialized countries where many volumes of them are produced each year. Some vetgetable residue products have been successfully fed in developed countries, but others are not consistently used because of the uncertainty of its availability, storage properties, variation in chemical composition, variable digestibility, poor palatability and toxicity of residues. A market scrutiny showed that residue of leaves from cabbage species can reach 30 - 50% of total production (Nguyen and Ledin 2005). Cabbage residue products can also reduce the dependence of livestock on grains. Wadhwa et al. (2005) showed that cabbage leaves are good source of crude protein and have low levels of neutral detergent fiber (NDF) and lignin which indicate their potential for higher voluntary intake. Cabbage residue includes leftover cabbage leaves and cores, is one way farmers can feed quality ingredients at bargain prices is to use food residue in the ration. Discarded cabbages are high-moisture by-products, but their dry matter is rich in protein and sugars and is rapidly fermented in the rumen. Crude protein of all tested cabbages was rapidly and extensively degraded in the rumen, indicating a negligible by-pass fraction, whose in vitro intestinal digestibility ranged from 61.4 to 90.2%. In vitro results indicated that dried Brussels sprouts could replace 24% of conventional feeds (barley, corn, and soybean meal) in the concentrate of a dairy sheep diet without producing negative effects on rumen fermentation (Evan et al., 2019). The cabbage residue is daily produced with the large amount in the markets in the Mekong delta of Vietnam. In many cases it also causes the pollution due to the leachate and spoiled residues. While goats could consume the cabbage residue based on its nutrients. Therefore an understanding of feeding cabbage residue in goat

diets should be known for an application to contribute to feed resources and to reduce the feed cost of goat production. The objective of this experiment is to indentify the optimum level of cabbage residue in growing goat diets.

MATERIALS AND METHODS

Study location and time

The experiment was conducted in the farm of Cho Moi District of An Giang Province, while the feed samples were sent and chemically analyzed by the Laboratory E205, College of Agriculture of Can Tho city. It was implemented from Feb 2020 to June 2020

Experimental design

A 4 treatments x 4 periods Latin square design was used in this study to evaluate the effects of replacing increasing levels of Para grass with cabbage residue on feed utilization, nutrient digestibility and rumen environment of male Bach Thao goats. Four male Bach Thao goats of 14 months old (24.3 ± 0.92 kg) were used for this study. The four dietary treatments consisted of different amounts of cabbage residue to replace 0, 25, 50 and 75% (DM basis) of paragrass in the diets corresponding to CR0, CR25, CR50 and CR75 treatmentm respectively. Dietary and and chemical compositions of the diets are presented in Table 1. The experimental period was 14 days which consisted of 7 days of adaption and 7 days of sampling period.

Table 1. Dietary feed ingredients of the experiment (%DM)

Feed, %DM	**Treatments**			
	CR0	***CR25***	***CR50***	***CR75***
Para grass	63.0	48.7	31.5	16.3
cabbage residue	0.00	16.2	31.5	48.9
Concentrate	35.4	33.6	35.8	33.7
Urea	1.60	1.50	1.20	1.10
Chemical composition of diets, %DM				
DM	25.1	18.7	15.5	12.6
OM	89.3	89.1	89.2	89.0
CP	19.2	19.3	19.2	19.3
EE	4.42	4.69	5.04	5.33
NDF	49.5	44.2	38.2	32.6
ADF	25.6	23.5	21.2	18.9
ME, MJ/kgDM	10.2	10.2	10.4	10.4

CR0, CR25, CR50 and CR75 were the treatments contained different levels of cabbage residue replacement Para grass (DM basis) from 0, 25, 50 and 75%. DM: dry matter, OM: organic matter, CP: crude protein, EE: crude fat, NDF: neutral detergent fiber, ADF: acid detergent fiber, ME: metabolizable energy

Animal and housing

The goats were kept in individual cages of 1.20 m (width), 1.80 m (length) and 0.65 m (height). Prior to the start of the experiment, the goats were given treated for parasites (Ivermectin 0.250%) and vaccinated to prevent foot and mouth disease and Pasteurellosis. The cages were disinfected once per 2 weeks by spraying *DISINA* solution (Vemedim Corporation, Can Tho city, Vietnam).

Feeds and Feeding

Para grass, cabbage residue and self formulated concentrate were the main ingredients used for this experiment. Para grass was cut daily from areas surrounding the experimental farm while cabbage residue was collected at the Can Tho market in the morning and late afternoon. Concentrate was mixed from broken rice (19.6%), rice bran (20.3%), soybean extraction meal (27.5%), copra meal (29.2%), premixed vitamin (0.6%), salt (1.05%) and dicalcium phosphate (1.75%) (%DM). The diets were offered twice daily at 6:30h and 14:30h. Firstly, concentrate was fed, and then cabbage residue and the last being Para grass. Urea was added to the diet daily and supplied to balance level of protein in all treatments at 6.0 gCP/kg live weight (Thu and Van 2009). Feeds offered and refusals were recorded daily, while fresh water was freely available at all time.

Measurements

Feed intake was determined daily by weighing the amount offered and the refusals.

Chemical composition of feeds including dry matter (DM), organic matter (OM), crude protein (CP), crude fat (EE) and ash were analyzed following the methods described by AOAC (1990). Neutral detergent fiber (NDF) and acid detergent fiber ADF analysis was done according to the Van Soest et al. (1991). The metabolizable energy (ME) values of feeds were calculated according to Bruinenberg et al. (2002).

Apparent nutrient digestibility and nitrogen retention were determined by collecting and analyzing offered and refusal feeds, feces, and urine daily. Digestibility study was conducted over 7 consecutive days following the method described by McDonald et al. (2002). Feces were collected twice dairy, at 0600 and 1700h. Nitrogen retention, urine was collected in each morning and immediately brought to the laboratory to determine total nitrogen by Kjeldhal methods. Feed offered and refusaland feces samples were dried at 55°C for 24 hours and finely ground through 1mm sieve before analyzing.

Rumen parameters, samples of rumen contents were collected at 0600h before feeding and again 3 h after feeding and their. pH was measured by a pH meter (HI 122 pH/mVMeter Hanna-Italy). N-NH_3 was analyzed by the Micro-Kjeldahl method and volatile fatty acids (VFAs) were analyzed following the methods described by Barnet and Reid (1957)

Live weight change, the live weight of goat was weighed 2 consecutive days at the end of each each experimental period.

Data analysis

The data were analyzed by analysis of variance using the One-way model in Minitab 16.1.0.0 software (Minitab, 2010). To compare difference between mean values of treatments, Tukey's test was used (Minitab, 2010).

RESULTS AND DISCUSSION

Chemical composition of feeds

Chemical compositions of the feed ingredients are presented in Table 2.

Table 2. Chemical composition of feeds used for the experiment (%DM)

Feeds	DM	OM	CP	EE	NDF	ADF	Ash
Para grass	17.7	90.3	11.1	3.70	61.7	29.3	9.70
Cabbage residue	7.40	88.8	14.5	5.60	25.5	14.9	11.2
Concentrate	87.9	91.5	21.5	5.90	29.9	20.2	8.50
Urea	100	-	288	-	-	-	-

DM: dry matter, OM: organic matter, CP: crude protein, EE: crude fat, NDF: neutral detergent fiber, ADF: acid detergent fiber

Cabbage residue is a wet product (92.6% moisture) and with a relatively high CP content of 14.5% but lower in the NDF content (25.5%) than that of the Para grass. Thus, cabbage residue is a good substitute to replace Para grass in the ration. The DM content of cabbage residue used in this experiment (7.60%) was similar to that reported Nguyen Van Thu and Danh Mo (2008) which was lower than those of Para grass (17.7%) and the concentrate (87.9%). In other studies, Huynh Hoang Thi (2011) and Nguyen Van Lam (2013) reported DM content of Para grass to be 19.6 and 20.7%, respectively.

Feed and nutrient intake

Table 3. The feed, nutrient and metabolizable energy (ME) intakes of goats

	Treatments				SEM	P
	CR0	***CR25***	***CR50***	***CR75***		
Feed intake, gDM/goat/day						
Para grass	447^{a}	361^{b}	222^{c}	123^{d}	10.7	0.001
Cabbage residue	-	133^{c}	221^{b}	326^{a}	13.9	0.001
Concentrate	259	255	250	256	4.40	0.197
Urea	11.6	11.5	11.3	11.5	0.21	0.126
Nutrient intake, g/goat/day						
DM	717	760	705	717	30.9	0.627
DM, % BW	2.65	2.80	2.64	2.65	0.109	0.069
OM	642	678	627	637	27.7	0.069
CP	149	157	153	159	3.62	0.289
CP, g/Kg BW	5.49	5.72	5.78	5.90	0.128	0.124
EE	33.5	37.1	26.9	39.7	1.26	0.068
NDF	349^{a}	330^{ab}	265^{bc}	232^{c}	16.4	0.007
ADF	174^{a}	171^{a}	140^{ab}	127^{b}	8.43	0.02
Ash	70.3	77.4	13.9	77.5	3.20	0.409
ME, MJ/goat/day	6.81	7.47	7.11	7.06	0.299	0.576
ME, MJ/$W^{0,75}$	0.333	0.363	0.351	0.346	0.123	0.514

The numbers with different superscript letters in the same row were significantly different ($P < 0.05$), CR0, CR25, CR50 and CR75 were the treatments contained different levels of cabbage residue replacement Para grass (DM basis) from 0, 25, 50 and 75%, BW: Body weight.

Dry matter, OM and CP intakes were not significantly different ($p>0.05$) among treatments with 705-760, 627-678 and 149-159 g/day respectively (Table 3). DM intake per unit body weight of goats in this study was similar to the findings of Nguyen Van Hon (1998) which ranged from 2.38 to 3.15% BW. Nguyen Trong Ngu and Inger Ledin (2005) reported DM intake/kg BW of Bach Thao goats (average weight 9.2 kg) fed cabbage residue, Para grass and soybean residue to be 2.3% but for heavier goats (average weight 13.1 kg) fed cabbage residue supplemented with 100-200 g concentrate to be around 2.9%. In this experiment, the values of g CP intake/kg live weight were from 5.49 to 5.90 g/kg BW.

Crude protein (CP) intake of goats from this study is similar to those (5.63-6.10 g/kg BW) reported by Le Thuy Trieu (2009). As expected NDF and ADF intakes decreased ($p<0.05$) with increasing cabbage residue in the diets because cabbage residue contained low ADF and NDF then Para grass. ME intake did not differ ($p>0.05$) among treatments, ranging from 6.81 to 7.47 MJ/day. The ME intakes of goats in this study were higher than those (3.74-5.19 MJ/goat/day) reported by Nguyen Duy Khanh (2014)

Rumen Parameters

The $N\text{-}NH_3$ and VFAs values of rumen fluid after feeding 3 hours were higher than those values before feeding while pH values tended to remain constant (Table 4). According to Prins (1990) the rumen pH was relatively stable (6.0 - 7.0) due to the buffering capacity of the bicarbonate from saliva and the uptake of the final fermentation products through rumen. The $N\text{-}NH_3$ values of treatments in experiment were higher than the results of Le Thuy Trieu (2009) being from 28.5-29.8 mg/100ml rumen fluid of goats was fed fresh water hyacinth and Para grass.

Table 4. pH values, N-NH3 concentration and VFAs of rumen fluid of goats

Items	Treatments				SEM	p
	CR0	***CR25***	***CR50***	***CR75***		
pH						
Before feeding	6.60	6.51	6.69	6.60	0.055	0.64
3 hours after feeding	6.14	6.40	6.38	6.34	0.106	0.587
$N\text{-}NH_3$, mg/100ml						
Before feeding	23.1	23.5	21.4	17.5	1.33	0.063
3 hours after feeding	34.3	34.1	29.7	31.9	3.13	0.406
VFAs, µmol/ml						
Before feeding	79.0	74.1	66.6	64.1	4.3	1.55
3 hours after feeding	88.9	96.3	98.4	94.1	3.34	0.26

VFAs: volatile fatty acids, CR0, CR25, CR50, CR75: cabbage residue replacing Para grass at levels of 0, 25, 50, 75 (%DM), respectively

Apparent digestibility, nitrogen balance and daily weight gain

The apparent DM and OM digestibility for CR50 diet were higher than the others treatments ($p<0.05$). Although CP digestibilty increased with inclusion rate of cabbage residue (CR0 to CR75) no significance ($p>0.05$) was found among treatments. Nitrogen intakes were similar among diets but N excretion in urine increased from CR0 to CR75 treatments ($p<0.05$) but N

retention was not significant among treatments (p>0.05). Results of this study showed positive weight gain in all treatments with those in CR25 and CR50 being the best. The weight gain obtained in this study is in agreement with the study of Pham Minh Duyen (2016) who reported that weight gain of male Bach Thao goats were 110 g/day when fed Elephant grass, soybean extraction meal and copra meal in diets containing 6.0 gCP/kg BW. Similarly, Le Van Phong et al. (2016) concluded from their study that replacing Para grass with cabbage residue at 50% and supplemented with concentrate did not affect growth of growing lambs. Le Minh Luan (2015) reported that Para grass with cabbage residue up to 30% level (DM basis) will not significantly affecting normal rumen characteristics (N-NH3, VFAs, pH) and weight gain in young cattle.

Table 5. Nutrient digestibility, nitrogen intakes, nitrogen retention and daily weight gain of goats fed cabbage residue replacing Para grass

	Treatments				**SEM**	**p**
	CR0	***CR25***	***CR50***	***CR75***		
Apparent digestibility, %						
DM	64.9^{c}	67.2^{ab}	68.7^{a}	66.6^{b}	0.034	0.001
OM	66.6^{c}	69.5^{ab}	71.1^{a}	69.0^{b}	0.400	0.001
CP	83.0	84.0	86.7	86.9	1.26	0.200
NDF	57.1	58.9	60.2	59.6	0.888	0.171
Nitrogen balanc, g/day						
Intake	23.8	25.1	24.4	25.5	0.579	0.289
Feces	4.05	3.82	3.03	3.25	0.284	0.205
Urine	3.28^{c}	4.04^{bc}	4.41^{b}	5.56^{a}	0.205	0.021
Nitrogen retention	16.5	16.8	17.0	16.7	0.545	0.354
Initial weight,kg	27.0	26.8	26.3	26.6	0.188	0.133
Daily weight gain, g	71.4^{c}	107^{ab}	116^{a}	80.4^{bc}	7.52	0.034

Note: DM: dry matter. OM: organic matter. CP: crude protein. NDF: neutral detergent fiber. CR0. CR25. CR50. CR75: cabbage residue replacing Para grass at levels of 0. 25. 50. 75%. Respectively. The numbers with different superscript letters in the same row were significantly different (P < 0.05).

CONCLUSION

It is concluded that cabbage residue is a viable replacement for Para grass in diet of Bach Thao goats to emhance nutrients intake leading to better growth performance. The optimum level of cabbage residue replacement to Para grass is up to 50%.

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REFERENCES

AOAC. 1990. Official Methods of Analysis. 13th edition. Association of Official Analytical Chemists. Washington, DC.

Barnett, A. J. G. and Reid, R. L. 1957. Studies on the production of volatile fatty acids from grass by rumen liquor in an artificial rumen. The volatile fatty acid production from grass. Journal of Agricultural Science 48, pp. 315–321

Bruinenberg, M. H. 2002. Factors affecting digestibility of temperate forages from seminatural grasslands. Grass and forage science 57, pp. 292-301

Evan, de T., Vintimilla, A., Marcos, C. N., Ranilla, M. J. and Carro, M. D. 2019. Evaluation of Brassica Vegetables as Potential Feed for Ruminants. Animals 2019, 9, 588; doi:10.3390/ani9090588

Huynh Hoang Thi. 2011. Effect of levels of brewery residue in diets on feed utilization, nitrogen retention and rumen environment of sheep. Animal science graduate thesis, College of Agriculture and Applied Biology, Can Tho University

Le Minh Luan. 2015. Effects of different levels of cabbage residue (Brassica oleracea) replacement to Para grass (Brachiaria mutica) in diets on feed ulitization, nutrient digestibility and rumen environment of growing cattle. Animal science graduation thesis (Vietnamese), College of Agriculture and Applied Biology, Can Tho University.

Le Thuy Trieu. 2009. Effects of different replacement levels of fresh water hyacinth in Para grass basal diets on feed utilization and nutrient digestibility of Bach Thao goat and Phan Rang sheep. Animal science MSc thesis (Vietnamese). College of Agriculture and Applied Biology, Can Tho University

Le Van Phong, Nguyen Van Thu and Nguyen Thi Kim Dong. 2016. Effects of different levels of cabbage residue (*Brassica oleracea*) replacement to Para grass (*Brachiaria mutica*) in diets on feed utilization, nutrient digestibility and rumen environment of growing lambs. Journal of Animal Science and Technology 68, pp. 01-11

McDonald, P. R. A., Edwards J. F. D., Greenhagh and Morgan, C. A. 2002. Digestibility evaluation of foods. In Animal Nutrition, 6th edition. Longman Scientific and Technical, New York. pp. 245-255

Minitab. 2010. Minitab reference manual release 16.2.0. Minitab Inc

Nguyen Duy Khanh. 2014. Effects of crude protein levels on feed intake, digestibility and growth of Bach Thao goats at 3-5 months of age. Animal science graduation thesis (Vietnamese). College of Agriculture and Applied Biology Can Tho University.

Nguyen Trong Ngu and Inger Ledin. 2005. Effects of Feeding Residues from Brassica Species on Growth of Goats and Pesticide/Insecticide Residues in Goat Meat. Asian-Aust Journal Animal Science 18 (2): 197–202

Nguyen Van Hon, 1998. Using young corn cobs supplemented with Leucaena leucocephala and Sesbania grandiflora for goats. Animal science MSc thesis (Vietnamese). College of Agriculture and Applied Biology, Can Tho University

Nguyen Van Lam. 2013. The effect of supplementation of multi-nutrient and fish oil in diets, on feed intake, rumen digestibility and rumen Parameters of growing cattle. Animal science graduation thesis (Vietnamese), College of Agriculture and Applied Biology, Can Tho University

Nguyen Van Thu and Danh Mo. 2008. A study of nutritive values of forages as rabbit feed resources by using in vitro digestibility and gas production techniques. In proceedings of International MEKARN workshop 2008 of Organic Rabbit farming Based on Forages. 25-27 November 2008. Can Tho University, Can Tho City, Vietnam

Nguyen Van Thu and Nguyen Thanh Van. 2009. Effect of different levels of fresh water hyacinth (Eichhornia crassipes) in the diets on feed utilization and digestibilty, rumen Parameters and microbial protein synthesis in goat. In MEKARN proceedings of Live stock production, climate change and resource depletion. 9-11 November 2010 in Pakse, Laos. http://mekarn.org/workshops/pakse/html/thu.ctu3.htm

Nguyen, T.N. and Ledin, I. 2005. Effects of feeding residues from Brassica species on growth of goats and pesticides / Insecticides residues in goat meat. J. Anim. Sci. 18 (2), pp. 197-202

Pham Minh Duyen. 2016. Effects of gender and level of crude protein in diets to consume the nutrients, digestibility and rumen fluid indicators, nitrogen accumulation and growth Bach Thao goat. Animal science graduation MSc (Vietnamese), College of Agriculture and Applied Biology, Can Tho University

Prins, R. A. 1990. Aspect of rumen microbiology and metabolism, Proc proceeding of a one-day symposium held on May 26, 1989 at the Kungsangen research station. Uppsala Swedish University of Agricultural Sciences Department of Animal Nutrition and Management

Van Soest. P. J., Robertson, J. B. and Lewis, B. A. 1991. Method for dietary fiber, neutral detergent fiber and non-starch polysaccharide in relation to animal nutrition. Journal of Dairy Science 74, pp. 3583-3597. http://jds.fass.org/cgi/reprint/74/10/3583.pdf

Wadhwa, M., Kaushal, S. and Bakshi, M.P.S. 2005. Nutritive evaluation of vegetable residues as complete feed for goat bucks. Small Rumin. Res. 64, pp. 279-284

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