PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

Pakistan Journal of Nutrition, 6 (1): 68-71, 2007
ISSN 1680-5194

Supplementation of Cassava Hay as a Protein Replacement for Soybean Meal in Concentrate Supplement for Dairy Cows

M. Wanapat*, C. Promkot and S. Khampa
Tropical Feed Resources Research and Development Center (TROFREC), Department of Animal Science, Faculty of Agriculture, Khon Kaen University, P.O.Box 40002, Khon Kaen, Thailand

Abstract: Three crossbred Holstein-Friesian dairy cows in mid-late lactation were randomly allocated to three ratio of cassava hay (CH) and soybean meal (SBM) (CH:SBM) in concentrate supplement treatments(0:100, 60:40, 100:0) according to a 3 x 3 Latin square design. Concentrate mixture containing 16 %CP was given to animals at two equal parts (2 % of body weight per day) while urea-treated rice straw (5 %urea) (UTRS) was given on *ad libitum*. The experiment revealed that increasing CH:SBM ratio in concentrate had no effect on dry matter intake and digestibility while reduced concentrations of ruminal ammonia nitrogen (NH_3-N) and blood urea nitrogen (BUN) were reduced. Milk yield across treatments were similar (8.0-8.5 kg/hd/d) while fat contents of milk tended to linearly increase as ratio of CH to SBM in concentrate increased. Moreover, increasing levels of CH to SBM ratio in concentrate linearly increased income over feed thus resulted in more milk income return. Conclusions can be made that CH should be recommended used as a protein source replacement a soybean meal in concentrate for a sustainable dairy production in the tropics.

Key words: Cassava hay, soybean meal, rumen fermentation, milk yield and composition, dairy cows

Introduction

The substitution of traditional feeds in the diets of dairy cows is common as economic condition changes. Soybean meal (SBM) has long been used as a prominent source of CP for dairy cows, however, with its increasing price, the use results in higher cost of production. Cassava (*Manihot esculenta*, Crantz) is an important cash crop, widely grown in sandy loam soil, low fertility and under hot long dry season. Its' leaves collected at harvesting time, contained high level of protein, and could be used as a protein supplement in ruminants (Wanapat *et al.,* 2000a, 2000c). In comparison with SBM, CH has a higher concentration of RUP (Wanapat *et al.,* 2000b) cand is beneficial because it can supply more total AA for absorption in the lower-gut. The AA profiles of CH were relatively comparable with SBM (Wanapat, 2003). Lysine, glutamine, asparagine and arginine were higher in SBM but in CH methionine were higher. Therefore, the objectives of the experiments were to study the effect of cassava hay and soybean meal ratio in concentrate on rumen fermentation, digestibility, milk yield and composition and economical return.

Materials and Methods

Animals and design: Three, crossbred Holstein-Friesian dairy cows in mid-late lactation were randomly allocated to three ratio of CH and SBM (CH:SBM) in concentrate treatments(0:100, 60:40, 100:0) according to a 3 x 3 Latin square design. Experimental periods were 21 d in length per each period.

Table 1: Ingredient mixtures (%) and chemical compositions of concentrate, urea-treated rice straw (UTRS) and cassava hay (CH) for dairy cow

Item	CH:SBM				
	0:100	60:40	100:0		
Cassava chip	67.5	62.9	64.4		
Soybean meal (SBM)	20	9.6	0		
Dried brewery's grain	7.3	6.1	6.1		
Cassava hay (CH)	0	14.8	20		
Urea	1.5	2	3.1		
Molasses	2	2	3		
Sulphur	0.5	0.5	0.5		
Salt	0.5	0.5	0.5		
Mineral mix	0.5	0.5	0.5		
Vegetable oil	0.2	1.2	2		
Chemical compositions, (%)				UTRS	CH
	------% dry matter ------				
DM	90.5	90.2	91	51.6	92.5
OM	94.8	95.1	94.9	86.5	92.8
CP	16.2	16	15.9	8.3	22.5
NDF	18.1	22.7	26.9	79.7	57.2
ADF	12.5	14.8	17.5	53.3	34.3
Ash	5.1	5	5.2	13.5	7.2

Experimental feeds and management: Ingredient compositions of concentrate feed, CH (CH making could be found in Wanapat *et al.,* 1997, 2000a) and roughage (urea-treated rice straw 5% urea; UTRS) (Wanapat, 1985) are shown in Table 1. Animals were individually penned and water was available at all times. Concentrate mixture containing 16 %CP with different ratio of CH and SBM and given to animals at two equal parts (2 % of body weight per day) during morning and

Table 2: Effect of cassava hay (CH) and soybean meal (SBM) ratio in concentrate on dry matter (DM) intake, ruminal fermentation, blood urea nitrogen (BUN), in mid-late lactating dairy cows

	CH:SBM				Contrast[1]	
Item	0:100	60:40	100:0	SEM	L	Q
DM Intake						
Concentrate						
kg/hd/d	8.2	7.5	6.9	0.3	NS	NS
%BW	1.5	1.4	1.4	0.2	NS	NS
Urea-treated rice straw						
kg/hd/d	6.7	6.2	6.9	0	NS	NS
%BW	1.3	1.2	1.4	0	NS	*
Rumen ecology,						
pH	6.8	6.7	6.7	0.1	NS	NS
NH3-N (mg/dl)	15.4[a]	14.5[ab]	14.4[b]	0.1	*	NS
BUN (mg/dl)	14.8[a]	13.8[b]	13.6[b]	0.1	*	NS
Total VFA (mmol/L)	72.8	73.9	73.8	0.4	NS	NS
VFA (mol/100 mol)						
Acetate (C2)	70.8	72.7	73	0.4	NS	NS
Propionate (C3)	19.9	18.1	17.6	0.5	NS	NS
Butyrate (C4)	9.3	9.2	9.5	0.3	NS	NS
C2:C3 ratio	3.5	4	4.2	0.3	NS	NS

[a, b]Values on the same row with different superscripts differed ($p<0.05$).
[1]L = Linear, Q = quadratic, NS = non-significant, *$P<0.05$, ** $P<0.01$

afternoon milking times. UTRS (5%) was given on *ad libitum*.

Sampling procedure, data collection and analysis: UTRS and concentrate were sampled for chemical composition analyses. Rumen fluid was taken by stomach tube with vacuum pump at 0 and 4 h-post feeding and analyzed for pH immediately, and for later analysis of NH_3-N (Bremner and Keeney, 1965), ruminal volatile fatty acids (VFAs) (Samuel *et al.,* 1997). Bood samples were collected from jugular vein of each cow at 0 and 4 h-post feeding and serum was removed and analyzed for BUN composition according to the method of Croker (1967) using automated clinical chemistry analyzers. Milk yield was recorded daily and composited samples from mornings and afternoon were analyzed for milk compositions using Milko Scan.

Statistical analysis: All data were subjected to analysis of variance using Proc. GLM and treatment means were statistically compared by Duncan's New Multiple Range Test (SAS 1998). Trend analysis for increasing CH and SBM ratio was compared using orthogonal polynomial analysis.

Results and Discussion

Table 1 illustrates details of chemical compositions of experimental feeds. UTRS contained 51.6% DM and 8.3% CP on dry matter basis. CH had 22.5% CP but was slightly lower than the value earlier reported by Wanapat *et al*. (1997). The reasons have been stated by Wanapat *et al*. (2000a) that the lower value may have been attributed by having higher portion of stem to leaf containing in the CH itself. The CP contents of concentrate were similar among dietary treatments, (16.2%) (0:100, CH:SBM), 16.0% (60:40, CH:SBM) and 15.9 % (100:0, CH:SBM), respectively. Data on intakes, ruminal fermentation parameters are presented in Table 2. For both concentrate and UTSR intakes, there were no significant differences among treatments while CH intakes were 1.11 and 1.38 kg DM/hd/d for CH to SBM ratio at 60:40 and 100:0, respectively. This roughage level was sufficient for dairy cattle as reported by many researches (Kumer and Singh, 1984; Barry, 1989; Wanapat *et al*., 2000a). Increasing CH to SBM ratio in concentrate particularly at 100:0 ratio remarkably enhanced UTRS intake. This result has also been found in previous study by Wanapat *et al*. (2000c).

Ruminal NH_3-N and BUN were similar in concentrate with CH to SBM ratio at 60:40 and 100:0 and were higher than in CH to SBM ratio at 0:100 while ruminal pH were similar among treatments. Wanapat *et al*. (1997) reported that CH contained tannin-protein complex that could provide ruminal by-pass protein and thus lowered ruminal NH_3-N and BUN. In addition, supplementation of cassoy-urea pellet as a protein source in concentrates for cattle resulted in improvement of digestibility, ruminal fermentation and rumen ecology (Wanapat *et al*., 2006). Milk yields were similar among treatments while fat contents of milk tended ($P = 0.061$) to linearly increase as ratio of CH to SBM in concentrate increased (Table 3). Wanapat *et al*. (2000c) stated that CH could have provided additional VFA necessary for milk fat synthesis. This is supported by the recent study, where acetate tended ($P = 0.073$) to linearly increase as ratio of CH to SBM in concentrate increased which would act as substrates for milk fat synthesis.

As clearly demonstrated, as levels of CH to SBM ratio in

Table 3: Effect of cassava hay and soybean meal ratio in concentrate on digestibility of nutrients, milk yield and compositions in mid-late lactating dairy cows

	CH:SBM				Contrast[1]	
Item	0:100	60:40	100:0	SEM	L	Q
Apparent total-tract digestibility (%)						
DM	78.3	77.5	77.6	0.7	NS	NS
OM	80.4	79.8	80.2	0.7	NS	NS
CP	77.1	73.6	73.5	0.9	NS	NS
NDF	64.4	64.6	67.2	1.3	NS	NS
ADF	62.4	61.6	62.0	1.6	NS	NS
Milk yield (kg/hd/d)	8.5	8.0	8.1	0.3	NS	NS
3.5% FCM (kg) [2]	10.1	9.3	9.3	0.4	NS	NS
Milk composition (%)						
Fat	3.7	3.9	4.2	0.5	NS	NS
Protein	3.3	3.5	3.1	0.1	NS	NS
Lactose	4.9	4.8	4.7	0.2	NS	NS
Solids-not-fat	9.3	9	8.6	0.2	NS	NS
TS[3]	14.5	14.4	14.3	0.7	NS	NS
Income over feed (US$[4]/hd/d)	0.3[a]	0.5[ab]	0.6[b]	0.9	*	NS
US$/hd/d	2.1[a]	3.5[ab]	4.2[b]	0.9	*	NS

[a, b]Values on the same row with different superscripts differed (p<0.05).
[1]L = linear, Q = quadratic, NS = non-significant, *P<0.05, ** P<0.01
[2]3.5% FCM = 0.4*(kg of milk)+15*(kg of fat),[3] TS = total solids, [4] 1 US$ = 39 Baht

concentrate linearly increased income over feed (P<0.05). This provides important data that CH can be an alternative source of protein. As reported by Wanapat and Khampa (2006) reported that cassava hay could not only provide as a protein source but also serve as an anthelmintic in ruminants. In addition, condensed tannin (CT) containing forages have the potential to help control anthelmintic resistant gastro-intestinal parasites (GIP). The CT may have direct or indirect biological effects on the control of GIP. Butter *et al.* (2000) reported that direct effects might be mediated through CT nematode interaction, thereby affecting physiological functioning of GIP. Condensed tannins also may react directly by interfering with parasite egg hatching and development to infective stage larvae (Athanasiadou *et al.,* 2000, 2001). The findings of Seng Sokerya and Rodriguez (2001) and Sokerya and Preston (2003) showed that eggs per gram (EPG) counted in goats fed the cassava and cassava + grass treatments steadily declined during the experiment from about 4000 – 5000 eggs/g of fresh feces in the first 30 days to about 1500 eggs/g after 70 days. The CT can improve protein nutrition by binding to plant protein in the rumen so preventing microbial degradation and increasing amino acid flow to the duodenum.

Increasing ratio of CH to SBM in concentrate for dairy cows resulted in similar nutrient digestion coefficients among treatments (Table 3). Level of CH intake in recent study was in good level and was in agreement of other studies (Kumer and Singh 1984; Barry, 1989; Wanapat *et al.,* 2000c).

Based on this experiment, the results suggest that CH as a protein replacement for soybean meal in concentrate for dairy cows which resulted in similar milk yield while milk fat was improved. Increasing levels of CH to SBM in concentrate significantly increased income over feed. CH can be used as a protein source replacement a soybean meal in concentrate for a sustainable dairy production as well as could result in more economical return and more sustainable dairy production in the tropics.

Acknowledgements

The authors are grateful for the financial support of the Tropical Feed Resources Research and Development Center (TROFREC), Khon Kaen University for their financial support of research and the use of research facilities.

References

Athanasiadou, S., I. Kyriazakis, F. Jackson and R.L. Coop, 2000. Effects of short-term exposure to condensed tannins on an adult *Trichostrongylus colubriformis*. Vet. Rec., 146 : 728-732.

Athanasiadou, S., I. Kyriazakis, F. Jackson and R.L. Coop, 2001. Direct anthelmintic effects of condensed tannins towards different gastrointestinal nematodes of sheep: *in vitro* and *in vivo* studies. Vet. Parasitol., 99: 205-219.

Barry, T.N., 1989. Condensed tannins: their role in ruminant protein and carbohydrate digestion and possible effects upon the rumen ecosystem. In: The Role of Protozoa and Fungi in Ruminant Digestion (Eds., R.A. Nolan, L.A. Leng and Demeyer). Renambul Books, Armidale, NSW 2351, pp: 153-169.

Bremner, J.M. and D.R. Keeney, 1965. Steam distillation methods of determination of ammonium, nitrate and nitrite. Anal. Chem. Acta., 32: 363-367.

Butter, N.L., J.M. Dawson, D. Wakelin and P.J. Buttery, 2000. Effect of dietary tannin and protein concentration on nematode infection (*T. colubriformis*) in lambs. J. Agri. Sci., 134: 89-99.

Croker, C.L., 1967. Rapid determination of urea nitrogen in serum or plasma without deprotenization. Am. J. Med. Tec., 33: 361-365.

Kumar, R. and M. Singh, 1984. Tannins: their adverse role in ruminant nutrition. J. Agri. Food Chem., 32: 447-453.

Samuel, M., S. Sagathewan, J. Thomas and G. Mathen, 1997. An HPLC method for estimation of volatile fatty acids of ruminal fluid. Ind. J. Anim. Sci., 67: 805-807.

SAS, 1998. SAS/STAT User's Guide. Version 6.12. SAS INSt. Inc., Cary, NC, USA.

Sokerya, S. and T.R. Preston, 2003. Effect of grass or cassava foliage on growth and nematode parasite infestation in goats fed low or high protein diets in confinement. MEKARN M. Sc., 2001-2003.

Sokerya, S. and L. Rodriguez, 2001. Foliage from cassava, *Flemingia macrophylla* and bananas compared with grasses as forage sources for goats: effects on growth rate and intestinal nematodes. Livestock Res. Rural Dev.,13: LRRD Home Page.

Wanapat, M., 1985. Improving Rice Straw Quality as Ruminant Feed by Urea Treatment in Thailand. In: Relevance of Crop Residues as Animal Feeds in Developing Countries (Eds., M. Wanapat and C. Devendra). Funny press, Bangkok, Thailand.

Wanapat, M., 2003. Manipulation of cassava cultivation and utilization to improve protein to energy biomass for livestock feeding in the tropics. Asian-Aust. J. Anim. Sci., 16: 463-472.

Wanapat, M. and S. Khampa, 2006. Effect of cassava hay in high-quality feed bock as anthelmintics in steers grazing on ruzi grass. Asian-Aust. J. Anim. Sci., 19: 695-699.

Wanapat, M., A. Petlum and O. Pimpa, 2000a. Supplementation of cassava hay to replace concentrate use in lactating Holstein Friesian crossbreds. Asian-Aust. J. Anim. Sci., 13: 600-604.

Wanapat, M., C. Promkot and S. Wanapat, 2006. Effect of cassoy-urea pellet as a protein source in concentrate on ruminal fermenttaion and digestibility in cattle. Asian-Aust. J. Anim. Sci., 19: 10004-1009.

Wanapat, M., O. Pimpa, A. Petlum and U. Boontao, 1997. Cassava hay: A new strategic feed for ruminants during the dry season. Livestock Res. Rural Dev., 9: LRRD Home Page.

Wanapat, M., O. Pimpa, W. Sripuek, T. Puramongkol, A. Petlum, U. Boontao, C. Wachirapakorn and K. Sommart, 2000b. Cassava Hay: an important on-farm feed for ruminants In: Proceedings of International workshop on Tannins in Livestock and Human Nutrition (Ed., J.D. Brooker). ACIAR. No. 92: pp: 71-74.

Wanapat, M., T. Puramongkon and W. Siphuak, 2000c. Feeding of cassava hay for lactating dairy cows. Asian-Aust. J. Anim. Sci., 13: 478-482.