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Effect of Inclusion of *Albizia saman* Pods in the Diet on the Performances of Dairy Cows

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Abstract: Ruminants can achieve high productivity when the diet includes concentrates; however these are often expensive due to competition with humans and mono-gastric animals. This experiment was conducted to determine the effect of partial inclusion of *Albizia saman* pods (ASP) in a Commercial Concentrate (CC) on the performances of dairy cows. Twelve cross-bred Holstein Friesian cows (472±13 kg) in the 12th week of lactation were randomly allocated into four treatment groups with three replicates acconding to the completely randomized design. The four treatments were control diet-CD [35% urea-treated-rice-straw (URS; 79g crude protein (CP)/ kg dry matter (DM)) and 65% CC (contained 40% cottonseed cake, 35% broken chickpea and 25% chickpea husk on an as fed basis and provided 200g CP/kg DM)], D1[35% URS + 60% CC + 5% ASP (189g CP/kg DM)], D2 (35% URS +55% CC + 10% ASP) and D3 (35% URS + 50% CC + 15% ASP). Cows were fed treatments for 60 days. Dry matter intake was significantly higher ($p<0.05$) for cows in the D3 treatment compared with the other three treatments, however there were no significant differences in the DM digestibility of treatments. Nitrogen intake and faecal-nitrogen of cows offered the D3 treatment were significantly higher ($p<0.05$) than those of cows offered the other three treatments. In contrast urine-nitrogen and nitrogen utilization were not significantly different among the treatments. The average milk yield (4% fat-corrected-milk) increased as the percentage of ASP was increased in the diets, however the composition of milk did not differ significantly between treatments. The costs of TDN/kg and per kg of milk was highest for the CD treatment and the lowest was found in D3 treatment ($p<0.05$). These results suggest that *Albizia saman* pods could be replace up to 15% of the commercial concentrate fed to lactating Holstein Friesian cross-bred cows without detrimental effects.

Keywords: *Albizia saman* Pods, Digestibility, Nitrogen Utilization, Milk Yield

Introduction

The ruminants can achieve high productivity with the supplementation of concentrates in the diets. However these are often expensive due to competition with humans and mono-gastric animals. Therefore, many researchers have been considering the alternative ways to replace for the concentrates. In the region of Asia, Africa and Pacific, the tree leaves and pods have been traditionally used as sources of forage for ruminants (Le Houérou, 1980). Among them, *Albizia saman* pods (ASP) are highly palatable and suitable as a feed supplement in dry season (Durr, 2001). ASP are black brown, oblong, lumpy and filled with a sticky, brownish pulp that is sweet and edible (Staples and Elevitch, 2006). Moreover, ASP has the advantage for the enhancing microbial growth in the rumen of cattle because of its higher values of digestibility, total sugar and protein contents (Jetana *et al*., 2010).

However, ASP contained the low level of toxic substances such as tannin. The low level of dietary condensed tannin (2-3%) has the beneficial effects to the ruminants and reduces the wasteful protein degradation in the rumen (Barry, 1987). Consumption of higher amount of tannin (>5%) significantly reduces voluntary feed intake, while medium or low consumption (<5%) did not affect on the feed intake (Barry and Duncan, 1984; Barry and Manley, 1984; Waghorn *et al*., 1994).

ASP were used as a valuable feed supplement in the pasture system for cattle, goats and sheep (Flores, 2002). Using ASP, the feed cost for the ruminants can be significantly reduced (Hosamani *et al*., 2005). Babayemi and Igbekoyi (2008) stated that ASP could be replaced guinea grass up to 40% for silage as dry season feed without detrimental effects on performances of WAD ram. Adeniji *et al*. (2010) also reported that ensiling with cassava wastes and ASP would give a good feed resource, however sole diet as a dry season feed for sheep might be unsuitable, but their Conversely, there was still little information on the use of ASP for ruminant feed, especially for the feed of dairy cattle. Therefore, this experiment was conducted to determine the effect of partial inclusion of ASP in the commercial concentrate (CC) on the performances of dairy cows.

Materials and Methods

Experimental Animals and Diets

Prior to the experiment, the animals were fed on the experimental diets for 2 weeks to become adaptation to these diets. Twelve cross-bred Holstein Friesian cows (472±13 kg) in the 12th week of lactation were randomly allocated into four treatment groups with three replicates accoding to the completely randomized design. The four treatments were control diet-CD [35% urea-treated-rice-straw (URS; 79g crude protein (CP)/kg dry matter (DM)) and 65% CC (contained 40% cottonseed cake, 35% broken chickpea and 25% chickpea husk on an as fed basis and provided 200g CP/kg DM)], D1[35% URS + 60% CC + 5% ASP (189g CP/kg DM)], D2 (35% URS +55% CC + 10% ASP) and D3 (35% URS + 50% CC + 15% ASP). Cows were fed treatments for 60 days.

Measurements

During the feeding trial, all of the feedstuffs were weighed and sampled before feeding. Moreover, milk yield was also recorded three consecutive days in one week. Milk was analyzed once in every two weeks with Lactoscan. During collection period, milk samples, feedstuffs offered samples and refused (orts) samples were collected for chemical analysis. The orts were weighed and sampled before morning feeding and then removed. Faeces voided and urine outputs were recorded daily during the collection period.

Chemical Analysis

Ground samples of feed offered, residues (orts) and faeces were analyzed for DM, organic matter (OM) and ether extract (EE) by the method described by AOAC (1990) and analyzed for neutral detergent fibre (NDF) and acid detergent fibre (ADF) by Goering and Van Soest (1970). Faeces and urine were analyzed for nitrogen by using Kjeldahl method (Fross 2020 digester and Foss 2100 Kjeltec distillation unit) and CP was calculated as 6.25 × N (AOAC, 1990).

Statistical Analysis

The data were subjected to the analysis of variance (ANOVA) and the significance of differences between treatments means were compared by Duncan's Multiple Range Test (DMRT) using SPSS (version 16.0) software.

Results and Discussion

The chemical compositions of ASP shown in Table 1 were consistent to the report of Hosamani *et al*. (2005; Babayemi *et al*., 2010). Nutrient intakes dry matter intake (DMI), organic matter intake (OMI) and crude protein intake (CPI)] of cows fed on D3 were significantly higher ($p<0.05$) than those of cows fed on other diets (Table 2). This finding was consistent with the reports of Babayemi and Igbekoyi (2008) and Adeniji *et al*. (2010) who reported that the feed intake of sheep could be improved with the increased inclusion level of ASP ensiling and cassava waste. ASP are palatable (Durr, 2001) and filled with a sticky, brownish pulp that is sweet and edible (Staples and Elevitch, 2006) and rich in soluble carbohydrate. The supplementation of starch in diets linearly increased the amount of OM digested and outflow rates of solid and liquid which resulted the increased microbial yield. The increased passage of microbial protein to the small intestine occurred as a result of the increased passage of both fluids and solids with increased intake (Gomes *et al*., 1994; Djouvinov and Todorov, 1994).

Although all of digestibilities were not significantly different ($p>0.05$) among them, it was noted that dry matter digestibility (DMD), organic matter digestibility (OMD) and crude protein digestibility (CPD) slightly decreased when inclusion level of ASP was increased in the diets (Table 3). This finding supports the report of Babayemi and Igbekoyi (2008). They observed that DMD, OMD and CPD slightly decreased when the inclusion level of ASP was increased in the ensiling guinea grass diet for sheep. The greater amount of sugar contained in ASP might decrease pH and cellulolytic microbial activity in the rumen which depressed the fibre digestion (Hoover, 1986). Increasing the inclusion level of ASP in the diets increased the feed intake which leads to decrease digestibility. This assumption agreed with the finding of Tyrrel and Moe (1975) who reported that the digestibility of dairy cow diets was reduced with increasing intake. Moreover, the changes in digestibility observed with increased intake have been associated with reduced digesta retention time in the rumen.

Table 1. Chemical composition (%) of experimental feedstuffs and diets

Description	DM	OM	CP	NDF	ADF	EE	Tannin
Experimental feedstuffs							
URS	44.42	80.56	7.94	65.22	47.44	1.61	-
CC	89.01	94.64	19.95	52.05	45.70	2.60	-
ASP	81.73	95.94	18.92	22.30	35.86	1.85	1.87
Experimental diets							
CD	91.77	91.49	16.09	53.65	43.92	2.30	-
D1	91.18	91.35	16.06	52.77	44.30	2.41	0.06
D2	90.55	91.57	16.02	52.28	42.53	2.28	0.13
D3	89.40	91.74	15.99	51.23	42.18	2.44	0.19

CD: 4% URS + CC
D1: 4% URS + CC + ASP at the 5% level of CC
D2: 4% URS + CC + ASP at the 10% level of CC
D3: 4% URS + CC + ASP at the 15% level of CC

Table 2. Nutrient Intake (g/kg $BW^{0.75}$) of dairy cattle offered experimental diets

	Experimental diets					
Description	CD	D1	D2	D3	SEM	P value
DMI	125.48^{b}	137.59^{b}	138.34^{ab}	151.33^{a}	3.24	0.02
OMI	114.34^{b}	125.10^{b}	125.68^{b}	138.12^{a}	2.93	0.03
CPI	20.88^{c}	22.6^{b}	23.15^{b}	25.54^{a}	0.55	0.04
NDFI	70.42	75.71	74.36	79.3	1.39	0.13
ADFI	58.32^{b}	63.34^{ab}	63.00^{ab}	68.48^{a}	1.34	0.04
EEI	2.98	3.21	3.20	3.49	0.06	0.09

DMI: Dry Matter Intake, OMI: Organic Matter Intake, CPI: Crude Protein Intake, NDFI: Neutral Detergent Fibre Intake, ADFI: Acid Detergent Fibre Intake and EEI: Ether Extract Intake
[a,b,c.], Mean value with different superscripts with the same row are significantly different ($p<0.05$)

Table 3. Digestibility (%) of nutrients offered to dairy cattle

	Experimental diets					
Description	CD	D1	D2	D3	SEM	P value
DMD	71.92	70.73	73.88	69.51	1.17	0.66
OMD	74.99	74.32	76.63	72.85	1.04	0.70
CPD	60.99	60.10	61.52	58.23	1.37	0.88
NDFD	69.70	68.90	70.30	64.74	1.33	0.50
ADFD	69.28	68.57	70.31	64.61	1.43	0.58
EED	88.43	86.10	86.96	84.28	0.72	0.24

DMD: Dry Matter Digestibility, OMD: Organic Matter Digestibility, CPD: Crude Protein Digestibility, NDFD: Neutral Detergent Fibre Digestibility, ADFD: Acid Detergent Fibre Digestibility and EED: Ether Extract Digestibility

Table 4. Nitrogen utilization (g/kg $BW^{0.75}$) of dairy cattle offered experimental diets

	Experimental diets					
Description	CD	D1	D2	D3	SEM	P value
Nitrogen intake	3.66^{c}	3.99^{b}	4.08^{b}	4.52^{a}	0.10	0.04
Faecal nitrogen	1.49^{b}	1.67^{ab}	1.62^{ab}	1.96^{a}	0.08	0.05
Urine nitrogen	1.05	0.97	1.02	1.16	0.09	0.87
Nitrogen utilization	1.12	1.36	1.44	1.40	0.13	0.89

[a,b,c]; Mean value with different superscripts with the same row are significantly different ($p<0.05$)

Table 5. Milk yield (4% FCM) of dairy cattle offered experimental diets

	Experimental diets					
Description	CD	D1	D2	D3	SEM	P value
Milk yield (kg/d)	11.99	12.05	12.77	13.02	0.26	0.48

Table 6. Milk composition (%) of dairy cattle offered experimental diets

	Experimental diets					
Description	CD	D1	D2	D3	SEM	P value
Fat	4.21	3.92	3.76	3.47	0.14	0.34
Protein	3.40	3.46	3.64	3.39	0.05	0.20
Conductivity	7.14	7.56	7.64	8.37	0.29	0.10
Density	31.47	32.47	33.70	31.94	0.55	0.21
Solid Not Fat	9.11	9.36	9.77	9.10	0.12	0.20
Lactose	4.82	4.97	5.14	4.83	0.06	0.25
Salt	0.87	0.89	0.93	0.86	0.02	0.16

Table 7. Cost effectiveness (Kyat/kg) of dairy cattle offered experimental diets

	Experimental diets					
Description	CD	D1	D2	D3	SEM	P value
Per cow per day	3543^{a}	3425^{b}	3334^{c}	3161^{d}	42.22	0.01
Per kg of TDN	391^{a}	362^{ab}	329^{ab}	302^{b}	13.36	0.05
Per kg of milk	305^{a}	282^{a,b}	252^{b,c}	224^{c}	10.57	0.01

^{a,b,c,d} Mean value with different superscripts with the same row are significantly different

Nitrogen intake and faecal-nitrogen of cows offered the D3 were significantly higher (p<0.05) than those of cows offered the other three treatments (Table 4). In contrast urine-nitrogen and nitrogen utilization were not significantly different (p>0.05) among the animals offered the experimental diets. It might be due to the higher output of the faecal-nitrogen. This assumption agreed whit the report of Yan *et al.* (2010), who stated that the main factor influencing the excretion of nitrogen from dairy cows was protein intake and there was a very strong and positive relationship between manure nitrogen output and dietary protein intake. Moreover, when the level of ASP was increased in the diets, the amount of the hard seeds contained in the ASP was also increased. All of these seeds could not be digested by the ruminants and contained in the faeces after passing through the digestive tract.

Although, the average milk yield (4% fat-corrected-milk) were not statistically different (p>0.05), increasing the percentage of ASP in the diets lead to slightly higher in milk yield (11.99, 12.05, 12.77, 13.02 kg/day for CD, D1, D2 and D3, respectively) (Table 5). This findings was consistent with the report of Anantasook *et al.* (2015), who observed that the supplementation of ASP into the basal diets of dairy cows improved the rumen environment and increased milk yield contents (protein and milk fat). It could be due to the higher amount of readily fermentable carbohydrate (sugar) contained in ASP. The end product of fermentation of starch and sugar is propionate. Increased propionic acid concentration in the rumen lead to increase lactic acid and glucose production, which improved the milk yield of host animals. Moreover, most of energy needed for live weight gain and for the mammary system to produce lactose, is also obtained from propionate. Another reason for this finding is the low level tannin included in ASP which increased the milk yield of animal with the reduceing of the wasteful protein degradation and increaseing microbial protein synthesis in the rumen. Schwab and Boucher (2005) presented that deficiency of rumen degradable protein (RDP) lead to poor microbial growth which reduce microbial protein synthesis, carbohydrate digestion, feed intake and consequently milk production.

The composition of milk did not differ significantly between treatments; however, milk fat percentage of cows fed on D3 was slightly decreased than those of others (Table 6). While the inclusion level of ASP was increased in the diets, the fibre content (NDF and ADF) was slightly decreased and increased the amount of sugar content of diets which decreased the milk fat content. An alteration in rumen fermentation and availability of endogenous fatty acid sources were probably involved in the causes of decreasing milk fat content (Christie, 1979). Feeding of readily fermentable carbohydrates depressed fiber digestion and pH of rumen. Therefore, it decreased acetic and butyric acid production and increased propionic acid production. Increased propionic acid concentration in the rumen lead to increase lactic acid and glucose production which stimulated insulin production, reducing free fatty acid release from adipose tissue. Therefore, the production of acetic and butyric acids, the main precursors of milk fat, could be affected by diet through changes in rumen fermentation or addition of fats in diets. Moreover, in 1980 and 1989, Sutton reported again that milk fat concentration was affected by the amount of fibre, the forage-to-concentrate ratio, the carbohydrate content of concentrate mix, lipids, intake and meal frequency.

The costs of TDN/kg and per kg of milk produced was highest for the CD treatment and lowest for D3 treatment (p<0.05) (Table 7). According to this result, it was found that cost for each group decreased when the inclusion level of ASP was increased. The cost for ASP and CC were 61 and 316 kyats per kg, respectively. It might be the main reason for the feed cost effectiveness of all treatment groups.

Conclusion

According to the results, *Albizia saman* pods could be replace up to 15% of the commercial concentrate fed to lactating Holstein Friesian cross-bred cows without detrimental effects.

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Author's Contributions

Min Aung: Participated in all experiments, coordinated the data-analysis and contributed to the writing of the manuscript.

Yin Yin Kyawt: Coordinated the data-analysis and contributed to the writing of the manuscript.

Moe Thida Htun, Khin San Mu and Aung Aung: Designed the research plan and organized the study.

Ethics

It is declared that there are no ethical issues that may arise after the publication of this manuscript.

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