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Original Article

Effect of dietary inclusion of *Albizia saman* pods on feed intake, digestibility, milk yield, and energy balance of crossbred Holstein Friesian transition cows

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Abstract

This experiment was aimed to determine the effect of dietary inclusion of *Albizia saman* pods (ASP) on feed intake, digestibility, milk yield and composition, and energy balance of crossbred Holstein Friesian transition cows. Ten transition cows were randomly assigned into two groups: control and ASP groups, whereas ASP was included as 20% of total diet for ASP group. This experiment was lasted for 10 weeks (week –3 to 7 relative to calving). The BW and BCS of treatments did not differ (P>0.05); however the nutrient intakes and digestibilities were higher (P<0.05) in ASP group. The higher energy intake (P<0.05) and lower extent of negative energy balance (NEB) (P<0.05) were found in ASP group. Milk yields, milk fat content, milk component yields and feed efficiency were higher (P<0.05) in ASP group, however milk protein, lactose and solid–non–fat were not different (P>0.05). Day returned to estrus after calving was also lesser (P<0.05) in ASP group. Thus, it could be concluded that inclusion of *Albizia saman* pods as 20% of total diet improved nutrient intake, digestibility, milk yield and feed efficiency, and reduced the extent of NEB and days returned to estrus after calving of crossbred Holstein Friesian transition dairy cows.

Keywords: *albizia saman* pods, energy balance, feed intake, milk yield, transition cows

1. Introduction

Transition period is an important and vulnerable life stage in dairy cows (Drackley, 1999; Grummer, 1995), whereas a shift from the gestation to lactation was observed. Due to the changes of physiologic and metabolic functions during this period, dry matter intake (DMI) was decreased about 30% (Grummer, 1995; Grummer, Mashek, & Hayirli, 2004), while nutrient requirement for milk production was immediately increased after calving. Thus the transition cows usually have to experience the negative energy balance (NEB) status (Ingvartsen, 2006) because the energy supply is lower than the requirement for milk production (Drackley, 1999). However, the extent and duration of NEB could be manipulated by the energy content of feed (Cowan, 1982).

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Carbohydrate and fat–based feedstuffs are usually considered as the major energy components of diets for dairy cows (Carmo *et al*., 2015). Dietary supplementation of fat increased energy supply (Overton & Waldron, 2004) and milk production (Hills, Wales, Dunshea, Garcia, & Roche, 2015; Roche *et al*., 2013), and reduced the extent and duration of NEB (Garnsworthy, Fouladi–Nashta, Mann, Sinclair, & Webb, 2009) of dairy cows during early lactation. Increasing energy density of diets by replacing cracked corn grain with steam–flaked corn improved milk yield of transition cows (Dann, Varga, & Putnam, 1999). Penner & Oba (2009) also reported that feeding high sucrose diet included cracked corn grain enhanced the feed intake and lactation performances of transition dairy cows. Moreover, dietary supplementation of starch and fat decreased body condition loss (Butler, 2003) and improved reproduction performance (Cavestany *et al*., 2009) of transition dairy cows.

As mentioned above, inclusion of dietary sugar and starch in the diet of early lactating cows showed the positive effects on feed intake, energy balance and productive performances. However, most of those researchers used the conventional sugar and starch sources, which are expensive and competitive with other animals and human being. Thus, use of locally available alternative sugar source in the diet of transition cows and its effect on DMI and energy balance become an attractive issue. As the alternative sugar source, *Albizia saman* pods (ASP) (Raintree or *Semanea saman* pods) are very attractive because of its higher nutrient contents, 32.30% total sugar, and 20.00 MJ/kg gross energy (Jetana, Vongpipatana, Thongruay, Usawong, & Sophon, 2010) and 18.92% crude protein (Aung, Kyawt, Htun, Mu, & Aung, 2016), and its lower tannin content (1.87%; Aung *et al*.,2016). The 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). Moreover, ASP supplementation to rice straw based diet improved the ruminal volatile fatty acid production and decreased methanogens and methane production (Anantasook & Wanapat, 2011). Anantasook *et al*. (2015) reported that ASP contains the high content of starch, which can increase the proportion of propionic acid and consequently decrease the availability of hydrogen for microorganisms (Archaea) that synthesize methane in the rumen. In our previous report (Aung *et al*., 2016), multi doses of ASP inclusion in diet (0, 5, 10 and 15%) were used to determine its effect on production performances of dairy cows, whereas 15% inclusion rate increased feed intake and milk yield in lactating dairy cows. In this manner, ASP has the potential to improve feed intake and to reduce the extent and duration of NEB of dairy cows during transition period. Thus, this experiment was conducted to determine the effect of dietary inclusion of ASP in diet on feed intake, nutrient digestibility, milk yield and composition, and energy balance of crossbred Holstein Friesian transition cows.

2. Materials and Methods

2.1 Animals, feeds and feeding

Twenty–one days before the expected calving day, ten multiparous crossbred Holstein Friesian cows were randomly allocated into two groups; control (n = 5) and ASP group (n = 5). The mean values (means±SE) of parity (after calving), body weight (BW; 21 d before the expected calving day), body condition score (BCS; 21 d before the expected calving day) and milk yield (305–day milk yield during the previous lactational period) for the control and ASP groups were 3.60±0.24 and 3.40±0.24, 505±10.58 and 509±9.01 kg, 3.35±0.10 and 3.40±0.06 and 4,540±171 and 4,617±187 kg, respectively.

The chemical compositions of feedstuffs used in this experiment are shown in Table 1. The ingredient composition and nutritive values of prepartum and postpartum diets fed to experimental cows are presented in Table 2, whereas ASP was included as 20% of total diets.

All experimental cows were kept in the individual pen with free access of mineral salt block and water. Cows were fed total mixed prepartum diets before calving, whereas total mixed postpartum diets were offered after calving. All experimental diets were offered *ad libitum* to allow for 5 to 10% refusal. Refused feeds were removed at 08:00 and the diets were delivered at 09:00 throughout experiment. This experiment lasted for 10 weeks; from week –3 to 7 relative to calving.

2.2 Sampling and measurements

Feed offered and refusals were recorded and sampled for four consecutive days in every week to determine weekly dry matter intake (DMI). To determine the nutrient digestibilities of experimental cows at prepartum and postpartum periods, the total feces output of each cow was recorded and sampled four consecutive days, at week –3 and 6 relatives to calving. Cows were milked at 06:00 and 16:30–h every day. Milk yields were automatically recorded at each milking and samples were taken for two consecutive days

Table 1. Chemical compositions of feedstuff used in experiment

Items	Chemical composition, %					
	DM	OM	CP	NDF	ADF	EE
Mombasa	37.97	86.93	8.73	60.62	37.72	2.41
Corn	90.72	98.57	7.86	13.20	7.20	3.20
Chickpea bran	92.88	96.06	7.46	49.00	20.00	2.11
Rice bran	89.85	89.12	13.32	34.40	19.60	8.50
Commercial concentrate	89.68	92.21	17.34	35.50	17.56	2.39
Albizia saman pods	93.34	95.87	17.15	24.28	11.20	1.85

DM, dry matter; OM, organic matter; CP, crude protein; NDF, neutral detergent fiber; ADF, acid detergent fiber; EE, ether extract.

Table 2. Ingredient compositions and nutritive values of experimental diets

Items	Diets			
	Prepartum		Postpartum	
	Control	ASP	Control	ASP
Ingredient composition, %				
Mombasa	50.00	50.00	35.00	35.00
Corn	19.00	19.00	21.00	21.00
Chickpea bran	20.00	5.00	20.00	5.00
Rice bran	10.00	5.00	14.00	9.00
Commercial concentrate	0.00	0.00	9.00	9.00
Albizia saman pods	0.00	20.00	0.00	20.00
Vitamin and mineral supplement	1.00	1.00	1.00	1.00
Nutritive values, %				
Dry matter (DM)	65.74	65.36	74.16	73.97
Organic matter (OM)	90.52	90.94	91.13	91.76
Crude protein (CP)	12.91	13.06	15.62	15.80
Neutral detergent fiber (NDF)	49.34	45.52	46.65	42.94
Acid detergent fiber (ADF)	36.57	31.51	34.74	29.77
Ether extract (EE)	2.17	2.09	2.20	2.13
NFC[1]	26.1	30.27	26.66	30.90
TDN[2]	62.24	65.78	63.28	66.95
NE_L[3] (Mcal/kg DM)	1.45	1.56	1.48	1.62

[1] Non-fiber carbohydrate = 100 – (% NDF + % CP + % fat + % ash); [2] Total digestible nutrient (%) = tdNFC + tdCP + (tdFA × 2.25) + tdNDF (NRC, 2001); [3] Net energy for lactation (Mcal/kg DM) = 0.0245 × TDN% – 0.12 (NRC, 2001).

every week for analysis of milk compositions. Fat–corrected milk and energy–corrected milk was calculated according to the following equations: 4% FCM = (0.4 × milk yield) + (15 × milk fat) (Gaines & Davidson, 1923) and ECM = (12.82 × milk fat) + (7.13 × milk protein) + (0.32 × milk yield) (Tyrrell & Reid, 1963), with all units as measured in kg yield. Feed efficiency was calculated as FCM/DMI and ECM/DMI.

For the estimation of energy balance (EBAL), the model; EBAL = Feed energy intake – (energy for pregnancy + energy for activity + energy for maintenance + energy for milk production), was used (National Research Council [NRC], 2001). To quantify the feed energy intake, the DMI was multiplied by the energy content of feed. The net energy for lactation (NE_L) of feeds were calculated by the equation; NE_L (Mcal/kg) = 0.0245 × TDN% – 0.12 (NRC, 2001). Energy requirements for pregnancy, activity (walking and grazing), maintenance and milk production were estimated with the models; NE_L (Mcal/d) = [(0.00318 × Day of gestation – 0.0352) × (Calf birth weight (kg)/45)]/0.218, NE_L (Mcal/km) = 0.00045, NE_L (Mcal/kg $BW^{0.75}$) = 0.080 and NE_L (Mcal/kg) = (0.0929 × Fat%) + (0.0547 × CP%) + (0.0395 × lactose%), respectively (NRC, 2001). The concentrations of total digestible nutrients (TDN) in feed samples were estimated by the model: TDN (%) = total digestible (td) non fibre carbohydrate (NFC) + td crude protein (CP) + (td fatty acid [FA] × 2.25) + td neutral detergent fibre (NDF; NRC, 2001). Non fiber carbohydrate (NFC) content of feed was estimated by the model: NFC% = 100 – (NDF% + CP% + fat% + ash%) (NRC, 2001). Body weights were measured by weighing balance with digital scale. The BCS was estimated with five point scales (Wildman *et al*., 1982), whereas BCS 1 and 5 indicated extremely thin and fat, respectively. For the estimation of days returned to estrus after calving, it was recorded as the day of estrus return when cow showed the standing heat.

2.3 Laboratory analysis

Samples of feed offered, refusals and feces were dried at 60 ºC in a forced air oven for 48 hrs to get constant weight and ground for analysis. Chemical composition of feed offered, refusals and feces were analyzed for dry matter (DM), organic matter (OM) and ether extract (EE) by the method described by Association of Official Analytical Chemists (AOAC, 1990) and analyzed for NDF and acid detergent fiber (ADF) by Goering & Van Soest (1970). Nitrogen was analyzed by using Kjeldahl method (Fross 2020 digester and Foss 2100 Kjeltec distillation unit) and CP was calculated as 6.25 × N (AOAC, 1990). Milk samples were individually analyzed by lactoscan (Lactoscan MCCW–V1, Milkotronic Co. Ltd., Bulgaria) for milk fat, protein, lactose and solid–non–fat (SNF).

2.4 Statistical analysis

The weekly data (from week –3 to 7 relative to calving) on feed intake, energy status and milk yield were analyzed using repeated measures ANOVA. The model included the group and the time as fixed effects and its interactions, and the random effect of the cow. When an interaction between groups and time was detected, these data were analyzed using Student's *t*–test for each sampling period to determine the simple effect of treatment and time on dependent variables. The data from week –3 to –1 and from week 1 to 7 relative to calving were averaged and assumed as the data of prepartum and postpartum periods, respectively. The average data on body weight, BCS, feed intake, energy status and nutrient digestibility, milk yield, milk composition, milk component yield, feed efficiency and days returned to heat after calving were analyzed using Student's *t*–test. The Statistical Package for the Social Sciences (SPSS) for

Windows version 16.0, 2007 (Chicago, SPSS Inc.) is used for all statistical procedures. The significant differences were considered at P<0.05.

3. Results

The BW and BCS of both groups were not significantly different (P>0.05) at prepartum and postpartum periods (Table 3). The DM intake was not significantly different (P>0.05) at week –3 and –2, however, it was significantly higher (P<0.05) in ASP group than in control group from week –1 to 7 relative to calving (Figure 1a). The NFC intake of ASP group was significantly higher (P<0.05) than that of control group throughout the experimental period, from week –3 to 7 (Figure 1b). The NDF intakes of control group were significantly higher (P<0.05) than that of ASP group at week –3, however there were not significantly different (P>0.05) at week –2 and –1. From week 1 to 7, NDF intake of ASP group was significantly higher (P<0.05) than that of control group (Figure 1c). The average DM and NDF intakes of both groups did not differ (P>0.05) at the prepartum period, however the higher (P<0.05) DM and NDF intakes were observed in ASP group than in control group at postpartum period. The NFC intake of ASP group was significantly higher (P<0.05) than that of control group at prepartum and postpartum periods (Table 4).

The higher (P<0.05) energy intake was observed in ASP group compared with control group from week –3 to 7 relative to calving (Figure 1d). No differences (P>0.05) of energy requirements were observed from week –3 to 1, however there were significantly higher (P<0.05) in ASP group than in control group from week 2 to 7 (Figure 1e). As the energy balance, the positive and negative energy balances were observed from week –3 to –1 and from week 1 to 7, respectively. The higher positive energy balance (P<0.05) and the lower negative energy balance (P<0.05) were observed in ASP group compared with control group throughout the experimental period (Figure 1f). The average energy intakes of ASP group were significantly higher (P<0.05) than that of control group at both prepartum and postpartum periods. At the prepartum period, the energy requirement did not differ (P>0.05), however it was significantly higher (P<0.05) in ASP group than in control group. The higher (P<0.05) positive energy balance and lower (P<0.05) negative energy balance were observed in ASP group compared with control group (Table 5).

Table 3. Effect of dietary inclusion of *Albizia saman* pods on average body weight and body condition score of experimental cows during prepartum and postpartum periods

Items	Mean ± SEM		*p* values
	Control	ASP	
Body weight, kg			
Prepartum	505 ± 10.58	509 ± 9.01	0.971
Postpartum	451 ± 11.66	461 ± 8.77	0.504
Body condition score (BCS)			
Prepartum	3.35 ± 0.10	3.40 ± 0.06	0.681
Postpartum	2.75 ± 0.11	2.90 ± 0.06	0.273

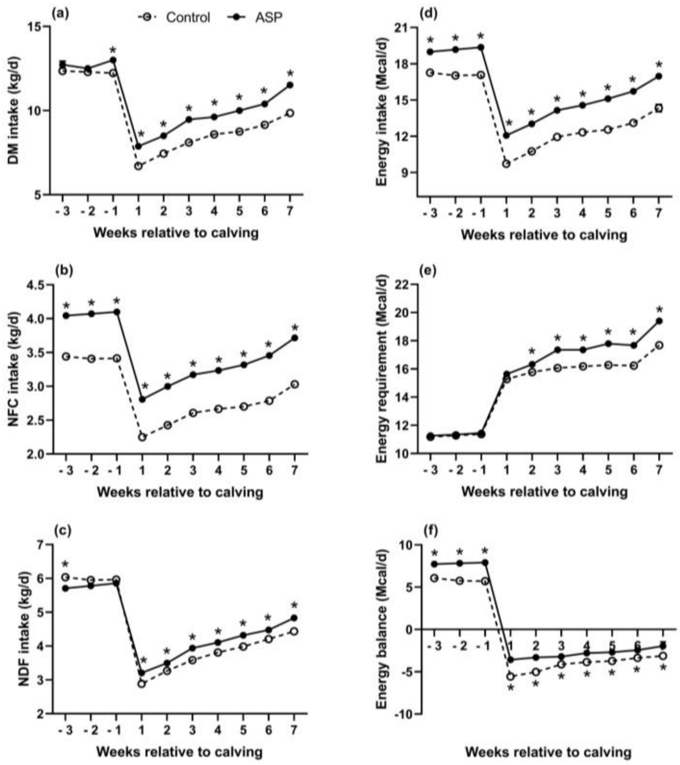

Figure 1. Effect of dietary inclusion of *Albizia saman* pods on weekly DM intake (1a), NFC intake (1b) and NDF intake (1c), energy intake (1d), energy requirement (1e) and energy balance (1f) of experimental cows. Control group (dotted line with white circles) vs. ASP group (black lines with black circles). Data are shown as the mean ± SEM. Asterisks (*) indicate significant differences (P<0.05) between groups at the same time.

Table 4. Effect of dietary inclusion of *Albizia saman* pods on average intakes of DM, NFC and NDF of experimental cows during prepartum and postpartum periods

Items	Mean ± SEM		*p* values
	Control	ASP	
DM intake (kg/d)			
Prepartum	12.29 ± 0.59	12.74 ± 0.67	0.101
Postpartum	8.37 ± 0.33	9.63 ± 0.42	0.000
NFC intake (kg/d)			
Prepartum	3.42 ± 0.12	4.07 ± 0.11	0.001
Postpartum	2.64 ± 0.13	3.24 ± 0.11	0.000
NDF intake (kg/d)			
Prepartum	5.98 ± 0.34	5.78 ± 0.21	0.103
Postpartum	3.80 ± 0.28	4.06 ± 0.32	0.018

DM, dry matter; NFC, non-fiber carbohydrate; NDF, neutral detergent fiber

Table 5. Effect of dietary inclusion of *Albizia saman* pods on average energy intake, requirement and balance of experimental cows during prepartum and postpartum periods

Items	Mean ± SEM		*p* values
	Control	ASP	
Energy intake[1] (Mcal/d)			
Prepartum	17.12 ± 0.58	19.17 ± 0.63	0.000
Postpartum	12.10 ± 0.21	14.51 ± 0.36	0.000
Energy requirement[2] (Mcal/d)			
Prepartum	11.28 ±0.45	11.35 ± 0.42	0.718
Postpartum	16.22 ± 0.48	17.37 ± 0.32	0.001
Energy balance[3] (Mcal/d)			
Prepartum	5.84 ± 0.26	7.82 ± 0.31	0.000
Postpartum	– 4.11 ± 0.13	– 2.85 ± 0.18	0.000

[1] Energy intake = DMI × energy content of feed. Energy content of feed, NE_L (Mcal/kg) = 0.0245 × TDN% – 0.12 (NRC, 2001); [2] Energy requirement = requirements for pregnancy + requirements for activity + requirements for maintenance + requirements for milk production. Requirements for pregnancy, NE_L (Mcal/d) = [(0.00318 × Day of gestation – 0.0352) × (Calf birth weight (kg)/45)]/0.218; requirements for activity, NE_L (Mcal/km) = 0.00045; requirements for maintenance, NE_L (Mcal/kg $BW^{0.75}$) = 0.080; requirements for milk production, NE_L (Mcal/kg) = (0.0929 × Fat %) + (0.0547 × CP %) + (0.0395 × lactose %), respectively (NRC, 2001); [3] Energy balance (EBAL) = Energy intake – (energy requirement for pregnancy + energy requirement for activity + energy requirement for maintenance + energy requirement for milk production) (NRC, 2001).

The digestibility of DM, OM, CP, NFC, NDF, ADF and EE of both groups were not significantly different (P>0.05) at prepartum period, however there were significantly higher (P<0.05) in ASP group than in control group at postpartum period (Table 6).

The actual milk yields of both groups did not differ (P>0.05) at week 1 and 2, however from week 3 to 7, the higher (P<005) milk yield was observed in ASP (Figure 2a). The 4% FCM (Figure 2b) and ECM (Figure 2c) of both groups were not different (P>0.05) at week 1, subsequently, there were higher (P<0.05) in ASP group. The average milk yields (kg/d, 4% FCM, ECM), milk fat content and feed efficiency (FCM/DMI, ECM/DMI) were higher (P<0.05) in ASP group. No significant difference (P>0.05) of milk protein, lactose and SNF contents were observed between groups. The milk fat, protein, lactose and SNF yields were higher (P<0.05) in ASP group (Table 7). The earlier (P<0.05) day returned to estrus after calving was observed in ASP group compared with control group (Figure 2d).

Table 6. Effect of dietary inclusion of *Albizia saman* pods on nutrient digestibilities of experimental cows at prepartum and postpartum periods

Items	Mean ± SEM		*p* values
	Control	ASP	
DM digestibility, %			
Prepartum	72.76 ± 1.39	73.63 ± 2.97	0.112
Postpartum	63.99 ± 2.52	71.42 ± 1.80	0.001
OM digestibility, %			
Prepartum	74.42 ± 0.51	76.11 ± 0.92	0.145
Postpartum	65.63 ± 0.30	73.50 ± 0.05	0.001
CP digestibility, %			
Prepartum	76.03 ± 0.36	77.49 ± 0.56	0.059
Postpartum	69.50 ± 0.64	77.03 ± 0.32	0.001
NFC digestibility, %			
Prepartum	75.19 ± 2.21	77.56 ± 3.39	0.235
Postpartum	68.16 ± 1.89	75.01 ± 1.15	0.004
NDF digestibility, %			
Prepartum	74.37 ± 2.67	75.85 ± 3.83	0.581
Postpartum	65.90 ±1.58	73.09 ± 1.56	0.005
ADF digestibility, %			
Prepartum	71.48 ± 0.44	72.92 ± 0.88	0.184
Postpartum	60.81 ± 0.43	69.92 ± 0.01	0.001
EE digestibility, %			
Prepartum	74.67 ± 0.23	76.19 ± 0.68	0.067
Postpartum	63.85 ± 0.37	70.97 ± 0.25	0.001

DM, dry matter; OM, organic matter; CP, crude protein; NFC, non-fiber carbohydrate; NDF, neutral detergent fiber; ADF, acid detergent fiber, EE, ether extract

4. Discussion

The higher intakes of DM, NFC and NDF observed in ASP group are consistent with Aung *et al*. (2016), who reported that ASP inclusion in diet (15%) increased the intakes of DM, NFC and NDF of lactating dairy cows. The ASPs are filled with a sticky, brownish pulp that is sweet, edible and palatable (Durr, 2001) and rich in sugar (Jetana *et al*., 2010). Anantasook & Wanapat (2011) stated that ASP could be used as a potential supplement for improving rumen fermentation, thereby improving nutrient intakes. Moreover, Nombekekla, Murphy, Gonyou & Marden (1994) and Penner & Oba (2009) also reported that sucrose supplementation may improve the dry matter intake of dairy cows because of its sweet taste. The DM intakes of control and ASP groups declined from 12.23 to 6.71 kg/d (45.14%) and from 13.00 to 7.88 kg/d (39.40%) after calving. Those values are higher than the value (30%) reported by Grummer (1995) and Grummer *et al*. (2004). This is likely due to the higher circulating estrogen level during parturition, which is believed to be one important factor that contributes to decrease dry matter intake around calving (Grummer, 1993).

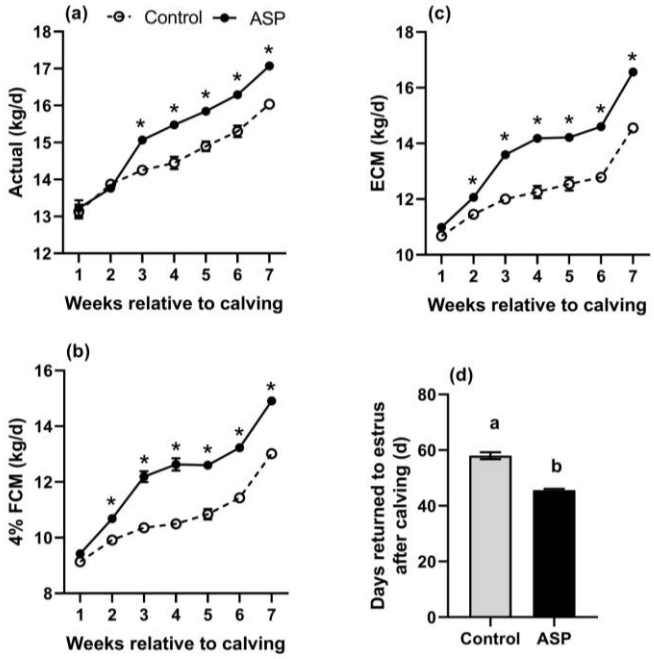

Figure 2. Effect of dietary inclusion of *Albizia saman* pods on weekly actual milk yield (2a), 4% FCM (2b), ECM (2c) and days returned to estrus after calving (2d) of experimental cows. Control group (dotted line with white circles) vs. ASP group (black lines with black circles). Data are shown as the mean ± SEM. Asterisks (*) and different superscripts ([a,b]) indicate significant differences (P<0.05) between groups at the same time.

Table 7. Effect of dietary inclusion of *Albizia saman* pods on average milk yield, milk compositions, milk component yield and feed efficiency of experimental cows

Items	Mean ± SEM		*p* values
	Control	ASP	
Milk yield (kg/d)			
Actual	14.50 ± 0.33	15.39 ± 0.53	0.001
4% FCM[1]	10.74 ± 0.45	12.24 ± 0.29	0.001
ECM[2]	12.33 ± 0.49	13.75 ± 0.37	0.001
Milk composition, %			
Fat	2.24 ± 0.211	2.67 ± 0.13	0.001
Protein	3.29 ± 0.33	3.35 ± 0.42	0.205
Lactose	4.67 ± 0.73	4.68 ± 0.85	0.901
Solid non fat	8.29 ± 1.06	8.47 ± 1.12	0.232
Milk component yield, kg/d			
Fat	0.33 ± 0.01	0.41 ± 0.01	0.001
Protein	0.48 ± 0.01	0.50 ± 0.01	0.009
Lactose	0.69 ± 0.01	0.73 ± 0.01	0.001
Solid non fat	1.21 ± 0.01	1.29 ± 0.02	0.005
Feed efficiency			
FCM/DMI	1.11 ± 0.02	1.29 ± 0.01	0.001
ECM/DMI	1.34 ± 0.01	1.46 ± 0.01	0.001

[1] Fat corrected milk = [(0.4 × milk yield) + (15 × milk fat)] (Gaines & Davidson (1923); [2] Energy corrected milk = [(12.82 × milk fat) + (7.13 × milk protein) + (0.32 × milk yield)] (Tyrrell & Reid, 1963)

Increasing the energy intake in ASP group is due to the greater nutrient intake of that group. During postpartum period, energy requirement of ASP group increased due to its higher milk yield and milk fat content. As the energy balance, both groups showed the positive balance during prepartum, however there was NEB during postpartum period because the energy intakes did not meet the requirement of cows. After calving, cows shifted from the gestational non–lactating state to the onset of lactation, resulted the sudden increase of nutrient requirements for milk production while dry matter intake and nutrient supply lags behind (Drackley, 1999). Thus the cows have to experience a physiologically unavoidable NEB status (Ingvartsen, 2006). Although both groups experienced the NEB, the extent of NEB was reduced by the dietary inclusion of ASP in this experiment. This is likely due to higher sugar content of ASP, which provided the greater energy density in ASP included diet. It was explained by Cowan (1982), the extent and duration of NEB could be influenced by energy density or quantity of the feed offered. Moreover, Garnsworthy *et al*. (2009) also stated that the inclusions of dietary starch into diets could reduce the extent and duration of NEB during early lactation.

Although the nutrient intakes were higher in ASP group, the BW and BCS of both groups were not different at the prepartum and postpartum period. This finding is consistent with Ordway, Ishler & Varga (2002), who reported that sucrose supplementation into the diets of transition dairy cows could not change the prepartum and postpartum BW and BCS of cows. This is likely due to the nutrient utilization pattern of cows in early lactation. After calving, the nutrients from ingested feeds were utilized for milk production rather than BCS because of rapid increase of milk yield (Garnsworthy, 1988; Nebel & McGilliard, 1993).

No differences of nutrient digestibilities at prepartum period are consistent with the statement of Aung *et al*. (2016), who reported that ASP inclusion in diet (15%) could not change the nutrient digestibilities of lactating dairy cows. Penner & Oba (2009) also stated that the digestibilities of DM, OM, NDF and starch were not affected by sugar supplementation in lactating dairy cows. However, the nutrient digestibilities of ASP group were higher than that of control group at postpartum period. This is likely due to the different BCS losses of experimental cows after calving. The BCS of both groups were not different during prepartum and postpartum periods, however the BCS losses of control and ASP groups during postpartum period were 17.91% and 14.71%, whereas the BCS loss in control group was higher than that of ASP group. Bernabucci, Ronchi, Lacetera & Nardone (2005) stated that cows with greater BCS losses are more sensitive to oxidative stress, which impact on animal performances such as intake, digestibility and milk production.

The higher milk yield observed in ASP group is consistent with Aung *et al*. (2016), who stated that milk yield was increased with ASP inclusion in diet (15%) of lactating cow diets. It might be due to higher energy intake of ASP group. After calving, cows utilized the nutrients especially energy for milk production (Garnsworthy, 1988; Nebel & McGilliard, 1993). Thus, it could be assumed that the higher energy intake in early lactation favored to increase milk production. Hills *et al*. (2015) documented that increasing energy intake with the supplementation of starch and fat in diet improved milk yield of lactating cows. Moreover, Anantasook *et al*. (2015) stated that the supplementation of ASP into the basal diets of dairy cows improved the rumen environment and carbohydrate availability in the rumen, which have beneficial in terms of milk production and lipid metabolism (Dann *et al*., 1999). Ordway *et al*. (2002) also reported that milk fat content was tended to be higher with the supplementation of sucrose in dairy cows. Consistently, the milk fat content was higher in ASP group in this experiment. Increasing the yields of milk fat, protein, lactose and SNF observed in ASP group is likely due to the greater milk yield of ASP group. The greater FE in ASP group is also due to the greater milk and milk component yields of ASP group. The FE (ECM/DMI) was 1.34 and 1.46 for control and ASP groups, which were slightly lower than the level (1.6 to 1.8) for multiparous cows with day in milk (DMI) <90 reported by Hutjens (2008).

Days returned to estrus after calving was less in ASP group, which might be due to the lesser extent of NEB found in ASP. Butler (2000) reported that prolong ovulation at postpartum is associated with the extent and duration of NEB in lactating cows. Cavestany *et al*. (2009) also stated that dietary supplementation of starch and fat improved reproduction performance of transition dairy cows.

5. Conclusions

The inclusion of *Albizia saman* pods as the 20% of total diet improved nutrient intake, digestibility, milk yield, milk component yields and feed efficiency, and reduced the extent of energy balance and days returned to estrus after calving of crossbred Holstein Friesian transition dairy cows.

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