The Utilization of *Indigofera sp* as the Sole Foliage in Goat Diets Supplemented with High Carbohydrate or High Protein Concentrates

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ABSTRAK

GINTING, S.P., R. KRISNAN, J. SIRAIT dan ANTONIUS. 2010. Pemanfaatan *Indigofera sp* sebagai hijauan tunggal pada kambing yang diberi konsentrat dengan kandungan karbohidrat atau protein tinggi. *JITV* 15(4): 261-268.

Indigofera sp merupakan tanaman leguminosa pohon yang dikenal toleran terhadap kekeringan, sehingga berpotensi sebagai sumber hijauan untuk ternak ruminansia. Penelitian ini bertujuan untuk mempelajari respon kambing terhadap penggunaan *Indigofera sp* sebagai sumber hijauan dalam ransum.Digunakan 20 ekor kambing jantan persilangan Boer x Kacang (umur 6 bulan; bobot badan 16 ±2.1 kg) dan secara acak diberi salah satu dari empat perlakuan yaitu: 1) *Indigofera sp* segar + Konsentrat karbohidrat tinggi (KKT), 2) *Indigofera sp* dilayukan + KKT, 3) *Indigofera sp* segar + Konsentrat protein tinggi (KPT) dan 4) *Indigofera sp* dilayukan + KPT. Penelitian dirancang dalam pola faktorial 2 x 2 dalam rancangan acak lengkap dengan lima ulangan. Jenis konsentrat dan pelayuan tidak berpengaruh (P > 0,05) terhadap pH rumen (6,14-6,85), sedangkan konsentrasi NH_3-N rumen nyata lebih tinggi (P < 0,05) pada kelompok yang diberi KPT (32.54-32.36 mg dL^{-1}) dibandingkan pada kelompok KKT (17,94-23,57 mg dL^{-1}). Konsentrasi total VFA tidak dipengaruhi (P > 0,05) oleh pelayuan maupun jenis konsentrat, namun secara numerik total VFA lebih tinggi pada kelompok yang diberi KKT (178,5-183,75 mmol L^{-1}) dibanding pada kelompok yang diberi KPT (142,21-174,64 mmol L^{-1}). Kecernaan BK, BO protein kasar dan energi tidak dipengaruhi oleh proses pelayuan (P > 0,05), sedangkan kecernaan BK dan BO nyata (P < 0,05) lebih tinggi pada kelompok yang diberi KPT. Konsumsi pakan dan kadar glukosa darah tidak berbeda antar perlakuan (P > 0,05), namun kadar urea N darah nyata lebih tinggi pada kambing yang diberi KPT. PBBH pada kelompok yang diberi KPT (80-87 g h^{-1}) nyata lebih tinggi (P < 0,05) dibandingkan pada kambing yang diberi KKT. Disimpulkan bahwa *Indigofera sp* dapat digunakan sebagai hijauan tunggal pada kambing dan proses pelayuan sebelum diberikan tidak diperlukan, karena tidak meningkatkan performans. Penggunaan konsentrat dengan kandungan protein tinggi dapat dipertimbangkan untuk memaksimalkan pertambahan bobot badan.

Kata Kunci: *Indigofera sp*, Suplement, Fermentasi Rumen, Kambing

ABSTRACT

GINTING, S.P., R. KRISNAN, J. SIRAIT and ANTONIUS. 2010. The Utilization of *Indigofera sp* as the sole foliage in goat diets supplemented with high carbohydrate or high protein concentrates. *JITV* 15(4): 261-268.

Indigofera sp is a leguminous tree forage species known to be adaptable to the drought climate and saline soil and it has potential as alternative feed resource to support the ruminant animal production. This research was aimed to study effect of *Indigofera sp* as the sole foliage in diet on goat responses. Twenty male Boer x Kacang crossbred goats (6 months of age; 16 ± 2,1 kg BW) were randomly assigned to four dietary treatments containing fresh or wilted leaves of *Indigifera sp.* as the sole foliage and supplemented with high carbohydrate (HCC) or protein (HPC) concentrate. Edible part i.e. leaves and twigs of about 8 to 10 months of age of *Indigofera sp.* were harvested by hand plucking every day in the morning. The experiment design was a 2 x 2 factorial design arranged in a Completely Randomized Design. The rumen pH ranged from 6.14-6.85 and were not affected (P > 0.05) by wilting nor by the type of concentrates. Wilting did not affect (P > 0.05) the concentration of rumen NH_3-N, but it was significantly higher (P < 0.05) in HPC group (32.36-32.54 mg dL^{-1}) than those in HCC group (17.94-23.57 mg dL^{-1}). Total VFA concentration were not affected by wilting nor by the type of concentrates (P > 0.05). Goats in the HCC group, however, numerically have higher total VFA concentration (178.5-183.75 mmol L^{-1}) than those in the HPC group (142.21-174.64 mmol L^{-1}). The apparent digestibility coeficients of DM, OM, CP and energy of the diet were not different (P > 0.05) when contained wilted or fresh *Indigofera* foliage. Significant increase (P < 0.05) in the DM and OM, but not in the CP and energy apparent digestibility coeficients were observed in the HPC goats. Dry matter intakes were not different (P > 0.05) among dietary treatments, but the ADG of goats in the HCC group (60-63 g d^{-1}) were significantly lower (P < 0.05) than those of goats in the HPC treatment (80-87 g d^{-1}). Blood glucosa concentration was not affected by wilting nor by type of concentrates (P > 0.05). BUN was not affected by wilting process, but providing high protein concentrates significantly (P < 0.05) increased the BUN concentration. It is concluded that foliage of *Indigofera sp* could be used as the sole forage in intensive production of goats. Wilting the foliage prior to feeding seemed to be unnecessary, since this process does not improve the animal productivity in term of daily gain and efficiency of feed utilization.

Key Words: *Indigofera sp*, Supplements, Ruminal Fermentation, Goats

INTRODUCTION

Forages, in particular grasses are the most readily available feed for ruminant animals in the tropics on which the smallholders almost totally depend on. The productivity of ruminants in this regions, therefore, often tends to decrease during dry season due to scarcity and poor nutritional quality of available feed (SALEM *et al*., 2006; STÜRM *et al*., 2007). Due to their high nutritive values (high N and low fibre content) and high tolerancy to dry climate many species of leguminous fodders have been recommended as the most promising forages to alleviate the scarcity of feed in the tropics (KHAMSEEKHIEW *et al*., 2001; WINA *et al*., 2005). Studies have shown that fodder of tree legumes fed as supplements have been associated with increased feed intake, digestion rate, growth rate and milk production, although the effects varied among the fodder species used (NHERERA *et al*., 1998; PAMO *et al*., 2006). Some fodder trees were also used as the sole feed for goats and their effects on intake and digestion are different among the fodder species (DEGEN *et al*., 1995; VAN *et al.* 2000). *Indigofera* being Leguminosae with hundred of species are high in nutritive values as indicated by its high crude protein content (223-311 g/kg DM), high OM digestibility (507 – 722 g/kg DM) and sufficient mineral content (Ca, Mg, Zn and Mn) in several *Indigofera* accessions to meet the ruminant requirements as observed by HASSEN *et al*. (2007). These fodder trees also possess many advantageous agronomic characterics such as drought tolerance and adaptation to saline and acidic infertile soils (HASSEN *et al*., 2007). *Indigofera sp* exhibits good perennial growth and retains a high yield (leaf and stem) of up to 15 t/ha/year (TARIGAN *et al*., 2009). Our objectives were to evaluate the nutritive values of *Indigofera sp.* when fed as a sole foliage for growing goats supplemented with high carbohydrate or high protein concentrates.

MATERIAL AND METHOD

Location

The study was conducted at the Sungai Putih Goat Research Station, North Sumatra. The site is located approximately 50 m above sea level at latitude 4^0 N and longitude 99^0 E. Annual rainfall is approximately 1900 mm with mean minimum and maximum temperature of 22^0C and 31^0C, respectively, and relative humidity averaged 85%.

Feeding trial

Experimental animals and treatments

Twenty male Boer x Kacang crossbred goats (6 months of age; 16 ± 2,1 kg body weight) were randomly assigned to four dietary treatments containing fresh or wilted leaves of *Indigifera sp.* as the sole foliages and supplemented with high carbohydrate (HCC) or protein (HPC) concentrates. Foliages and the concentrates were offered separately. Consumable parts i.e. leaves and twigs of about 8 to 12 months of age of *Indigofera sp.* were harvested by hand plucking every day in the morning. The animals were housed in metabolic pens (1,0 x 1,5 m^2) in a naturally ventilated barn. The animals received *Indigofera sp.* foliage *ad libitum* (by ensuring orts of 0.1 of the amount fed daily) twice daily (08:30 and 14:00,), while the concentrates (Table 1) were offered at 1.5% body weight (BW) in the morning (08:00). Water was available all the times during the experiment. Feed refusals were weighed daily while body weight was recorded weekly before morning feeding. The feeding trial was conducted for 60 days with a 7-d adaptation period.

Table 1. Ingredient and chemical compositions of concentrates used in the experiment[a]

Item	HCC	HPC
Ingredient composition:		
Corn	700.0	0.0
Soybean meal	0.0	700.0
Rice bran	280.0	280.0
Micro-mineral mix[b]	10.0	10.0
Salt	10.0	10.0
Chemical composition:		
DM	868.5	866.2
Organic matter	912.3	891.5
Ash	97.2	101.2
Crude protein	94.4	316.5
Crude fibre	87.1	95.5
Ether extract	200.4	292.8
NFE	309.4	60.2

Values expressed as g/kg of DM, exept for DM, which is expressed as g/kg of the total; [b]Declared composition of micro-mineral mix (%): Ca carbonate (50), P (25), Mn (0.35), I (0.20), K (0.10), NaCl (23.05), Fe (0.8), Zn (0.20) and Mg (0.15); HCC: High carbohydrate concentrate; HPC: High protein concentrate.

Measurements and analyses

Feed offered and feed refused were recorded daily after the adaptation period. Samples of feed offered and refused of individual animals were taken daily for analysis of DM (at 100^0 C for 24 h) and one portion of each sample was also taken and pooled to an individual weekly sample for further analyses. The samples were analysed for DM, CP, neutral detergent fibre (NDF), acid detergent fibre (ADF), and ash according to the standard procedure of AOAC (1990). NDF was determined by the method of VAN SOEST *et al*. (1991) without use of alpha amylase but with use of sodium sulfite.

Ruminal fermentation

To evaluate ruminal fermentation, ruminal fluid samples were collected using stomach tube from all animals six hours after morning feeding at the end of the feeding trial. The pH of the filtrate was recorded immediately and centrifuged (10,000 x *g*) for 15 minutes. The supernatant was stored at -20^0C prior to NH_3-N and VFA analyses. Amonia N was measured by micro diffusion of Conway, while volatile fatty acids (VFA) was analysed by gas chromatography.

Blood metabolites

A blood sample (about 10 ml) was drawn from the jugular vein at the same time as rumen fluid sampling, separated by centrifugation at 1500 x *g* at 40^0C for 20 minutes. Plasma was transferred to labeled tubes and were stored at -20^0C until analysis. Plasma samples were analysed for blood urea nitrogen (BUN) and glucose concentration colorimetrically.

Balance trial

A digestion study of 15 days duration, involving quantitative collection of feeds, refusals, urine and faeces was conducted to determine the apparent digestibility and nitrogen balances of the diets. Animals were acclimatized to the metabolism cages for 5 days prior to the 10 day-collecting period. Feed was sampled daily at feeding and composited and dried at 60^0C in a forced-air oven for 3 d and stored in refrigerator for further analysis. To estimate total tract nutrient digestibility, on d 11 – 15 total, orts, feces and total urine were collected before the morning feeding. After weighing, subsamples (200 g/kg) of total orts and feces were taken and composited by animal and retained for chemical analysis. Of the subsamples, 100 g/kg was taken for analysis of DM (at 100^0C for 24 h). Subsamples were dried at 60^0C in a forced-air oven for 3 d and stored in refrigerator for further analysis. Dried feed, orts and feces were ground in a Wiley mill to pass through a 2 mm screen and analysed for DM, OM, N and gross energy content. Urine was collected using buckets under the metabolic pens. After the volume was recorded, subsamples of urine were acidified with 50 ml of 25% sulfuric acid and stored in refrigerator for further analysis.

Statistical analysis

The experiment was done based on a 2 x 2 factorial design arranged in a completely randomized design (GOMEZ dan GOMEZ, 1984). Data were analysed by the general linear model of the SAS (2002) with kids as the experimental units. Significant mean differences in effects were tested using the least significant differences test and a probability of $P < 0.05$ was considered to be statistically significant.

RESULTS AND DISCUSSION

Rumen fermentation

The effects of wilting and the type of concentrate on the rumen fermentation characteristics are shown in Table 2. It is shown that the ruminal pH ranged from 6.14-6.85 and were not different among treatments ($P > 0.05$). The ruminal pH was numerically lower in goats supplemented with high carbohydrate concentrate (6.14-6.29) than those supplemented with high protein concentrates (6.44-6.85). This more acidic of rumen liquor was corresponding to the increase in total VFA concentration as the result of high intake of feed starches in the high carbohydrate concentrate groups. The lower ruminal pH in the HCC group compared to those in HCP group is characteristic of high carbohydrate concentrate. The ruminal pH of goats fed fresh or wilted *Indigofera* foliage and supplemented with high carhohydrate concentrate were close to the lowest limit of the normal range of 6.2-7.2 reported as optimal pH for microbial digestion (VAN HOUTERT, 1993; VAN SOEST, 1994). WARE and ZINN (2005) observed a similar decreased ruminal pH in cattle fed diet high in flaked corn. A similar range of ruminal pH (6.13-6.66) was also reported by PEREIRA *et al.* (2008) in cattle fed concentrate at levels ranged from 200 to 650 g/kg dry matter. The ruminal pH in all treatments in this study, however, were numerically above 5.0-5.5 proposed to be as inhibitory to the development of cellulolytic microorganisms (HOOVER, 1986).

As expected, the concentration of ruminal NH_3-N was significantly higher ($P < 0.05$) in goat supplemented with high protein concentrates (32.36-32.54 mg dL^{-1}) than those in goat supplemented with

high carbohydrate concentrates (17.94-23.57 mg dL^{-1}). Wilting process, however, did not affect ($P > 0.05$) the concentration of ruminal NH_3-N.The ruminal NH_3-N concentrations in all groups were well above the recommended level of 10 mg dL^{-1} as non-limiting for microbial growth in tropical conditions (LENG, 1990). However, the ruminal NH_3-N concentration in goats fed wilted *Indigofera sp* and supplemented with high carbohydrate concentrate (17.94 mg dL^{-1}) was numerically lower than 20 mg/dL which is suggested to be as maximization point for DM intake in tropical condition (LENG, 1990). Wilting process may have increased the proportion of undegradable protein of *Indigofera sp*.

Total VFA concentration were neither affected by wilting process nor by the type of concentrates ($P > 0.05$). Goats supplemented with high carbohydrate concentrates, however, numerically have higher total VFA concentration than those supplemented with high protein concentrates. Total VFA concentration in all treatments ranging from 142 – 183 mmol L^{-1} is considerably high. A relatively lower total VFA concentration (100 mML^{-1}) in goat fed alfalfa with balance concentrate was reported by GALINA *et al*. (2004). This indicates that the diets have been extensively fermented in the rumen which is related to the relatively high ruminal NH_3-N concentration and normal range of ruminal pH.

Molar proportion of VFA in the rumen was affected by the type of concentrates, but not by the wilting process ($P > 0.05$). The molar proportions of acetate and valerate were similar among the treatment groups, but molar proportions of propionate, isobutyrate and isovalerate were greater ($P < 0.05$) in goats fed high protein concentrates than those fed high carbohydrate concentrates. Significant differences ($P < 0.05$) in the butyrate molar proportion was observed only between the high carbohydrate concentrate group (15.93%) and the high protein concentrate group (10.16%) fed fresh *Indigofera* foliages. The molar proportion of butyrate was lowest ($P < 0.05$) in goats supplemented with high protein concentrate and offered fresh *Indigofera sp*, while the molar proportion of valerate was not different among the treatments.

Feed digestibility

Effects of wilting and type of supplementation on total tract digestion are shown in Table 3. The apparent digestibility coeficients of DM, OM, CP and energy of the diet were not different ($P > 0.05$) when contained wilted or fresh *Indigofera* foliages. In contrast to this results, RYMER (2008) observed a significant increase in *in vitro* organic matter digestibility (IVOMD) of wilted forages fed to goats. Significant increases ($P < 0.05$) in apparent digestibility coeficients DM and OM, but not those in CP and energy were observed in goats supplemented with high protein concentrates. In goats supplemented with HPC there was an increase by 21% in both DM and OM digestibility when offered fresh compared to wilted *Indigofera* foliage. In contrast, increases by 12% in DM digestibility and by 28% in

Table 2. Rumen fermentation characteristics of goat fed fresh or wilted *Indigofera sp.* and supplemented with high carbohydrate (HCC) or high protein concentrates (HCP)

Parameter	Fresh + HCC	Fresh + HCP	Wilted + HCC	Wilted + HCP
pH	6.14 [a]	6.85 [b]	6.29 [a]	6.44 [a]
NH_3 , mg dL^{-1}	23.57 [ab]	32.36 [b]	17.94 [a]	32.54 [b]
Total VFA, mmol L^{-1}	178.50[a]	142.21 [a]	183.75 [a]	174.64 [a]
Molar Proportion VFA, %				
Acetate	63.34 [a]	64.29 [a]	64.52 [a]	60.24 [a]
Propionate	16.56[a]	18.27[b]	16.03[a]	19.49[b]
Isobutyrate	1.71 [a]	3.08[b]	2.46 [ab]	2.86[b]
Butyrate	15.93 [b]	10.16 [a]	14.72 [ab]	13.07 [ab]
Isovalerate	1.77 [a]	3.06 [b]	1.80 [a]	3.15 [b]
Valerate	0.68 [a]	1.13 [a]	0.47 [a]	1.19 [a]

Means in a row with different superscripts differ significantly ($P < 0.05$)

OM digestibility were observed when goats supplemememented with HCC were fed wilted *Indigofera* foliages.

The considerably high digestibility of the CP in all treatments of this study (84-91%) can be related to its high CP content. The apparent protein digestibility was shown to increase as the levels in diets increase (SANON *et al*., 2008). This high CP digestibility could also explain the high concentration of ruminal NH_3-N observed in this study, since protein degradability is the main factor influencing NH_3-N. The fact that soybean meal, which is mostly degradable, was used as the source of protein in the high-protein concentrate treatment supports this.

Intake and ADG

Dry matter intakes of *Indigofera sp*. and concentrates were not significantly different (P>0.05) among dietary treatments (Table 4). But, numerically higher intake of wilted *Indigofera sp* and total DM occured in goat receiving wilted than the fresh *Indigofera sp*. The intake of fresh or wilted *Indigofera sp* accounted for 68-69% of total DM intake. The high DM intake of *Indigofera sp* can be explained by the high CP content (23-28%) and low content of NDF (34 – 36%) (TARIGAN, 2009). In general there is a positive correlation of CP content and negative correlation of fibre with the voluntary feed intake (FISHER, 2002).

The CP intakes in goats receiving fresh or wilted *Indigofera sp* and supplemented with high carbohydrate concentrates were 146 and 155 g, respectively. As expected, the CP intake was greater in goats supplemented with high protein concentrate, being 206 and 212 g, respectively. These levels of CP intakes would have been enough to cover the CP requirement for growth of goats weighing 25 kg at 100 d^{-1} according to MANDAL *et al.* (2005). The average daily gain (ADG) of goats supplemented with high carbohydrate concentrates (60-63 g d^{-1}) were significantly lower ($P < 0.05$) than those in goats receiving high protein concentrates (80-87 g d^{-1}), probably resulted from more amino acids available to the animal, particularly lysine, methionine, arginine

Table 3. Apparent digestibility of diets consisting of fresh or wilted *Indigofera sp* and supplemented with high carbohydrate (HCC) or high protein (HPC) concentrates

Feed	Digestibility			
	DM (g/kg)	OM (g/kg)	CP (g/kg)	Energy (%)
Fresh + HCC	605.0[a]	621.0[a]	836.8[a]	68.68[a]
Fresh + HCP	733.2[b]	755.3[b]	911.9[a]	73.47[a]
Wilted + HCC	617.4[a]	649.9[a]	855.0[a]	69.28[a]
Wilted + HCP	711.6[b]	734.1[b]	914.5[a]	70.65[a]

Means in a column with different superscripts differ significantly ($P < 0.05$)

Table 4. DM intake, daily gain and feed conversion in goat offered fresh or wilted *Indigofera* foliage and supplemented with high carbohydrate (HCC) or high protein concentrates (HPC)

Parameter	Fresh + HCC	Fresh + HCP	Wilted + HCC	Wilted + HCP
DM intake (g $h^{-1}d^{-1}$):				
Indigofera sp	517.35[a]	540.55[a]	558.08[a]	565.34[a]
Concentrates	242.73[a]	243.05[a]	245.58[a]	246.92[a]
Total	760.08[a]	783.60[a]	803.66[a]	812.26[a]
ADG (g)	60.48[a]	80.95[b]	63.81[a]	87.14[b]
FCR	14.81[a]	10.16[b]	16.07[a]	14.59[a]

Means in a row with different superscripts differ significantly ($P < 0.05$)

and threonine in the latter due to using soybean meal as the main source of protein in the concentrate. These amino acids are recongized as the most limiting amino acids for ruminants (MERCHEN and TITGEMEYER, 1992; WATERMAN *et al*., 2007).

Blood metabolites

Wilting process did not influence the BUN level, but as expected, providing high protein concentrates significantly (P<0.05) increased the BUN concentration (Table 5). The BUN concentration in all groups in this study are considerably high, particularly those in goats supplemented with high protein concentrates. The normal ranges for BUN concentration was reported to be 8 to 20 mg dl^{-1}. In sheep supplemented with leguminous herbage CHIKAGWA-MALUNGA *et al*. (2009) found that BUN concentration ranged from 16,1 to 17,2 mg dl^{-1}. In this study, BUN concentration showed a similar trend as the NH_3-N concentration in rumen. The ruminal pH values which was >6.0 in all treatments might contribute to the relatively high BUN concentration, since the rate of NH_3-N absorption tend to increase as the ruminal pH level increased. This result agrees with CHUMPAWADEE *et al*. (2006) and CHEN *et al*. (2002) who found that an increase in rumen NH_3-N level results in increased level of BUN.

Blood glucose concentration was neither affected by wilting process nor by type of concentrates (P>0.05), but numerically it was higher in goats supplemented with high carbohydrate concentrates compared to those supplemented with high protein concentrates. The values in all treatments, however, were relatively lower than the normal ranges of 50-80 mg dl^{-1} reported by KANAKO (1989).

N Balances

As expected, goats receiving high protein concentrate had higher N intakes (P < 0.05) compared to those receiving high carbohyderate concentrates (Table 6). Wilting *Indigofera sp* did not affect the N balances. Fecal N was numerically lower, while urinary N was statistically greater (P<0.05) in the protein supplemented group compared to those goats supplemented with high carbohydrate concentarte. As a consequence, total N excretion was greater in the high protein supplemented goats, but the N absorbed and retained of remained greater (P < 0.05) in this group. Many published studies have also reported increases in both N retention and N excretion as dietary protein concentration in diet was increased (LUDDEN *et al*., 2002; MARINI *et al*., 2004; KIRAN and MUTSVANGWA, 2009; SAUVÉ *et al*., 2009).

The increase in urinary N in response to protein supplementation indicates that supplementation may have provided protein in excess of requirement, or more likely that the fermentable energy levels were too low for ruminal microorganism to fully capture the extra N supply as microbial supply. The water soluble carbohydrate (WSC) concentration of tropical leguminous trees has been reported to be relatively low (SPEIJERS *et al*., 2005). This is supported by the fact that N retention as a percentage of N apparently absorbed was increased in goats supplemented with high carbohydarate concentrate compared to those supplemented with high protein concentrate. Meanwhile, the lower urinary N and higher fecal N observed in goat supplemented with high carbohydrate concentrate might be associated with fermentable energy which is more available for the hindgut fermentation, so that more N is trapped into microbial N and excreted in the feces and less N is excreted via urine. ØRSKOV (1992) has pointed out that fecal N excretion could increase and urinary N decrease when more carbohydrate was fermented in the large intestine.The average increase in N retention when high protein concentrate was fed was 57 and 33% of additional N intake in goat given fresh or wilted *Indigofera sp*, respectively. This indicated that wilting could have resulted in less protein degraded in the rumen so that more is available for the intestinal digestion. Nevertheless, feeding *Indigofera sp* as the sole foliage to goats wether freshly or wilted resulted in sufficient N intake in goats.

Table 5. Blood glucose and blood urea nitrogen levels of goats offered fresh or wilted *Indigofera* foliage and supplemented with high carbohydrate (HCC) or high protein concentrates (HPC)

Parameter	Fresh + HCC	Fresh+ HCP	Wilted + HCC	Wilted + HCP
Blood glucosa, mg/dl	39.98[a]	30.90[a]	49.18[a]	37.11[a]
Blood urea nitrogen, mg/dl	27.01[a]	41.87[b]	24.26[a]	46.92[b]

Means in a row with different superscripts differ significantly (P < 0.05)

Table 6. N balances in goat offered fresh or wilted *Indigofera* foliage and supplemented with high carbohydrate (HCC) or high protein concentrates (HPC)

Parameter	Fresh + HCC	Fresh + HPC	Wilted + HCC	Wilted + HPC
N consumed,g/d	21.79[a]	31.90[b]	23.13[a]	34.55[b]
Fecal N,g/d	3.62	2.79	3.39	2.99
Urine N,g/d	8.12[a]	13.30[b]	7.22[a]	15.25[b]
Absorbed N,g/d	18.17[a]	29.11[b]	19.74[a]	31.56[b]
Retained N,g/d	10.05[a]	15.81[bc]	12.51[ab]	16.31[c]
g/kg of N intake				
Fecal N	16.32[a]	8.81[b]	14.5[a]	8.55[b]
Urine N	37.84[ab]	41.90[a]	30.95[b]	44.08[a]
Absorbed N	83.68[a]	91.19[b]	85.50[a]	91.45[b]
Retained N	45.84[a]	49.30[a]	54.55[b]	47.38[a]
g/kg of N Absorbed				
N retained	55.00[a]	53.82[a]	63.58[b]	51.68[a]

Means in a row with different superscripts differ significantly ($P < 0.05$)

CONCLUSION

Foliages of *Indigofera sp* could be used as the sole forages in intensive production of goats. Wilting the foliage prior to feeding seemed to be unnecessary, since this process does not improve the animal productivity in term of daily gain and efficiency of feed utilization. Although the CP content of *Indigofera sp* foliage is high, providing feed supplement high in protein still give benefit in term of better daily gain and efficiency of feed utilization.

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