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Research Article

Study on Chemical Composition, Digestibility and Ruminal Degradation Parameters of Siris Leaves, Flowers and Pods in One-Humped Camel

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Abstract

The aim of this experiment was to determine the chemical composition, digestibility, fermentation and ruminal degradation parameters of siris (*Albizia lebbeck*) leaves, flowers and pods by total microorganisms or fungi + protozoa mixture in one-humped camel. Chemical composition of samples was measured and gas production technique and *in situ* method were used for determination of fermentation and rumen degradation parameters, respectively. The result showed the CP values of siris flowers were the greatest whenever NDF, ADF and ether extract of pods were more than leaves and flowers ($p < 0.05$). The gas production potential of siris leaves, flowers and pods by the total microorganisms of camel rumen were 48.1, 22.2 and 51.2 ml, respectively ($p > 0.05$). The lowest gas production potential by fungi + protozoa mixture was recorded for leaves ($p < 0.05$). The difference in gas production rate of the leaves, flowers and pods by total microorganisms, and fungi + protozoa after 96 h incubation was not significant ($p > 0.05$). There was no significant difference among siris leaves, flowers and pods for the partitioning factor, microbial biomass and biomass efficiency by total microorganisms and fungi + protozoa mixture. The rapidly degradable fraction in flowers and pods were different from that in leaves, with siris flowers having the highest rapidly degradable fraction ($p < 0.05$). Potential and effective degradability of siris flowers were higher as compared to leaves and pods ($p < 0.05$). The slowly degradable fraction in pods was lower than in leaves and flowers ($p < 0.05$). Therefore, according to proper rumen degradation and fermentation; siris leaves, flowers and pods especially flower can be used in one-humped camel nutrition to improve rumen degradation processes, effectively.

Keywords: Camel; Gas Production; Chemical Composition; Rumen; Degradation; Siris

Introduction

The camels obtain all their nutritional demands from pasture forages such C4 plants [1,2] that can be found in all tropical grasslands and have lower digestibility than C3 plants [3]. Rumen cellulolytic enzymes activity in camelids is high that have a special ability to use low quality forages higher than the other ruminants [4,5]. It is reported, one of the most abundant organisms of camel rumen are Bacteroides that has been improved animal digestion [6,7]. There is insufficient information available on the microbial ecology of the camels [8].

Siris (*Albizia lebbeck*) is a tropical legume in the *Fabaceae* family. It is one of the most widespread and common species of *Albizia* genus in the world and is called "Woman's Tongue", Koko and Lebbeck tree. Siris is a native plant of tropical Africa, Asia and northern Australia. It grows up to 5 m in height, and can produce 100 - 120 kg edible dry matter in one year. The fragrant flowers are greenish-yellow to white (2.5 - 7.5 cm in diameter). The tree produces numerous light grey pods (10 - 30 cm long; 2 - 5 cm wide), and each pod contains 4 -1 2 pale brown seeds. Most livestock eat leaves and young twigs of this promising fodder tree readily [9]. Carbohydrates are the major components of siris, and potassium and copper are found to be in the highest and lowest among its mineral, respectively [10,11]. Flowers contain no harmful constituents and have relatively high amounts of N and Ca, but low amount of P in compared with other parts of this plant [9,12]. The amino acids profile indicated that arginine and lysine are present in large amounts in seeds while glutamic acid and aspartic acid are higher in pods [9,11]. The siris leaves are contain 23 % CP and pods contain 19 % CP and 45% NDF [13]. The seeds CP is more than pods [14]. Due to high DM and low moisture of the leaves, they can be used as protein supplements for formulation of livestock rations [14].

Economically, siris is an important industrial and medicinal plant [11]. Leaves and seeds are used for treatment of eye inflammations and the flowers are used for the treatment of spermatorrhea [11]. Siris leaves has a low tannins and phenolic compounds contents. Linoleic acid is the major fatty acid in leaves and pods [11,15]. Total tannin content of siris leaves is around 4 % DM that cannot be having negative effect on healthy of livestock [15]. It is concluded that the tannin by 2 to 4 % DM, protect protein from rumen degradation and increase essential amino acids uptake in the intestine, but tannin content more than 5 %, considerably decrease palatability, feed intake and digestibility [27]. This plant has been used in cow, buffalo, goat and sheep feeding in the different experiments (*in vitro* and *in vivo*).

Therefore, the aim of this experiment was to study chemical composition, fermentation and rumen degradation parameters of siris leaves, flowers and pods by total microorganisms and or fungi+protozoa mixture in one-humped camel.

Materials and Methods

Different parts of 5 siris trees (leaves, flowers and pods) were collected from field of Khuzestan Agricultural Sciences and Natural Resources University, and then milled properly. The sampling was done in plots with dimensions of 100 * 100 meters. Chemical composition of siris leaves, pods and flowers were determined by standard methods of AOAC [16].

Gas production (GP) experiments were done in 3 runs and 4 replicates (syringes) per samples. The rumen fluid was collected and mixed before morning feeding from two fistulated one-humped camels, which was fed for 1 month with a forage based diet (60% straw and 40% alfalfa) and some siris branches for adaptation.

Rumen content was strained through four layers of cheese cloth. The strained and free feed residual of rumen fluid were used as total rumen microbiota. The isolation of ruminal fungi+protozoa were carried out from strained rumen fluid by using antibacterial agents (streptomycin sulfate, potassium penicillin G, and chloramphenicol), which were added at the rate of 0.1 ml per 1 ml to the gas production medium [17].

About 300 ± 10 mg sample (1.0 mm screen, milled) were incubated with 35 ml buffered rumen fluid under continuous CO_2 reflux in 100 ml calibrated glass syringes for 2, 4, 6, 8, 10, 12, 16, 24, 48, 72 and 96h, in a water bath at 39°C [18]. The samples were incubated together with three syringes containing only incubation medium (as blank). After 96 hours of incubation, the content of each syringe was used for determination of ammonia-N (NH_3-N) concentration (Kjeltec 2300 Autoanalyzer, Foss Tecator AB, Hoganas, Sweden). Cumulative gas production data were fitted to the exponential equation $Y=b\ (1-e^{-ct})$, where b is the gas production (ml) from the fermentable fraction, C is the rate constant of gas production (ml/h), t is the incubation time (h) and Y is the volume of gas produced at time [18].

For determination of the partitioning factor (PF) at the end of each incubation period, the content of syringes was transferred into an Erlenmeyer flask, mixed with 20 ml neutral detergent fiber solution, boiled for 1 hour, filtered, dried (in oven at 60°C for 48 h) and ashed (in furnace, at 550°C for 3h). The partitioning factor, microbial biomass and actual degradable organic matter were calculated by the method of Makkar and Becker.

Dry matter degradability was measured by *in situ* technique using 2 male one-humped camels fitted with rumen fistula (400 ± 12 Kg, BW). Five g (DM basis) of each milled sample (2.0 mm screen) was transferred into a polyester bag (10 × 20 cm, 52 µm pore size) and incubated in the rumen for 2, 4, 6, 8, 16, 24, 48, 72 and 96 hours (n = 4). At the end of each incubation period, the bags were immediately hand-rinsed under cold tap water until clear and dried in a forced-air oven at 60°C for 48 hours. The bags without incubation (0 h) were washed to estimate the wash-out at initial time. The disappearance of DM and CP were calculated using the equation $P = a + b\ (1- e^{-ct})$. Where, P is fraction degraded in the time t, a is soluble fraction, b is potentially degradable fraction, c is degradation rate and t is incubation time. The effective degradability (k = 0.03, 0.05 and 0.08/h) was calculated using the equation ED = a + (bc/(c+k) in which k is the estimated rate of outflow from the rumen [19].

The data were subjected to analysis of variance as a completely randomized design using the General Linear Model (GLM) procedure of the SAS. The Duncan's multiple range test was used to compare the mean difference at $p < 0.05$.

Results and Discussion

The result of chemical composition of different parts of siris was given in figure 1. The CP value of siris flower was the greatest in compared with pods and leaves whenever NDF, ADF and ether extract of pods were more than leaves and flowers ($p < 0.05$).

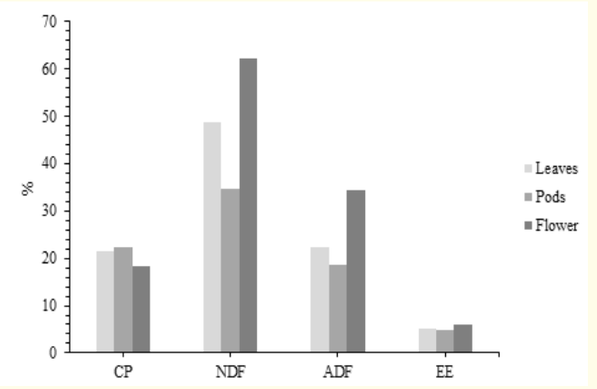

Figure 1: Chemical composition of siris leaves, pods and flowers (%).

The potential of gas production by total rumen microorganisms were 48.07, 22.71 and 51.16 ml/300 mg for leaves, flowers and pods, respectively ($p > 0.05$). However, the corresponding values by fungi+protozoa mixture were 11.54, 29.65 and 18.91 ml, respectively (Table 1). No significant difference was observed in potential and gas production rate during 96 h incubation period for leaves, pods and flowers of siris in mixed fungi + protozoa ($p > 0.05$) (Table 2). There was no significant difference in PF amount and microbial biomass in the presence of two microbial groups ($p > 0.05$) (Table 1 and 2).

	Partitioning factor (mg mL^{-1})	Microbial biomass (mg)	Microbial biomass efficiency (%)	Actual organic matter disappearance (mg)	Cell wall degradation (%)	b (mL)	c(mL/h)
Leaf	3.50	24.30	36.83	46.20	0.76	48.07	0.03
Pod	3.33	115.35	33.58	39.45	0.20	22.71	0.05
Flower	2.54	88.95	17.39	11.95	0.53	51.16	0.04
SEM	0.23	47.42	11.32	18.41	0.71	15.70	0.01
P-value	0.10	0.10	0.10	0.10	0.10	0.10	0.50

Table 1: Gas production parameters of siris leaves, pods and flowers by total rumen microorganisms b: gas production from the fermentable fraction, c: rate constant of gas production. SEM: Standard error of the mean.

	Partitioning factor (mg mL^{-1})	Microbial biomass (mg)	Microbial biomass efficiency (%)	Actual organic matter disappearance (mg)	Cell wall degradation (%)	b(mL)	c (mL/h)
Leaf	2.90	25.95	24.37	106.25	0.33	11.54	0.07
Pod	2.77	18.10	20.42	87.40	0.36	29.65	0.02
Flower	2.43	11.95	12.88	90.55	0.40	18.91	0.06
SEM	0.51	8.41	7.31	11.86	0.65	9.66	0.05
P-value	0.10	0.10	0.10	0.10	0.10	0.10	0.90

Table 2: Gas production parameters of siris leaves, pods and flowers by fungi+protozoa mixture in one - humped camel.

SEM: Standard error of the mean.

The effects of siris leaves, pods and flowers on ammonia nitrogen in gas environment (Table 3) were significant. Siris flowers in presence of the two microbial groups had maximum concentrations of ammonia nitrogen ($p < 0.05$).

The difference between rapidly degradable fraction of DM in pods and flowers was significant (Table 4). The potential and effective degradability of siris flowers increased significantly as compared to leaves and pods ($p < 0.05$). The slowly degradable fraction of pods decreased more significantly than leaves and flowers. The rapid degradable fraction of flowers and pods as compared to siris leaves was considerably different. Furthermore, potential and effective degradability of siris flower in comparison to leaf and pod were increased significantly (Table 4).

	Total microorganisms		Fungi + protozoa	
	Ammonia Nitrogen (mg/ 100 mL)	pH	Ammonia Nitrogen (mg/ 100 mL)	pH
Leaf	19.77^{b}	7.18	14.60^{a}	7.25
Pod	14.85^{c}	7.22	10.38^{b}	7.27
Flower	22.72^{a}	6.75	15.65^{a}	6.65
SEM	0.60	0.14	0.30	0.26
P-value	0.006	0.10	0.002	0.30

Table 3: Fermentation parameters of siris leaves, pods and flowers by rumen microorganism in one-humped camel

SEM: Standard error of the mean, $^{a, b}$: Means with common letter (s) within each column do not differ significantly ($p > 0.05$).

	Rapidly degradable	Slowly degradable	Constant rate of degradation	Potential degradability	Effective degradability
Leaf	0.31^{b}	0.39^{a}	0.08^{a}	0.70^{b}	0.60^{b}
Pod	0.35^{ab}	0.20^{b}	0.06^{a}	0.56^{c}	0.49^{c}
Flower	0.43^{a}	0.42^{a}	0.03^{b}	0.87^{a}	0.67^{a}
SEM	0.02	0.01	0.007	0.008	0.003
P-value	0.03	0.0002	0.01	0.0001	0.0001

Table 4: Parameters of in situ dry matter rumen degradation of siris leaves, pods and flowers in one-humped camel.

SEM: Standard error of the mean, $^{a, b}$: Means with common letter (s) within each column do not differ significantly ($p > 0.05$).

Siris flowers have higher protein and ether extract, and lower NDF and ADF in compared to leaves and pods. Flowers are used as a valuable protein supplement due to the high digestible nitrogen. The value of pods NDF and ADF were 56.1% and 42.1%, respectively [20]. The researchers [21] reported NDF, ADF, and ether extract content of leaves were 46.9, 33.7 and 5.4 %, respectively. But the others [22] evaluated the content of NDF, ADF, and ether extract of leaves were 48.44, 36.87 and 3.62 %, respectively.

Researches indicated the crude protein content of the siris leaves of the region of Townsville in Australia was 17.5% [23]. Also, it is reported that siris leaves can be used as a protein supplement instead of cotton seed meal to feed the goats [24]. In another experiment, the protein content of *Albizia julibrissin* and *Albizia procera leaves* were reported as 18.61% and 17-24%, respectively [25,26]. The reason for the difference in chemical composition depends on the differences in the sampling season, plant growth stage, species type, climatic differences and conditions in the areas [22].

Based on the result, gas production potential and rate of different parts of siris by total rumen microorganisms were not significant. But in contrast with this results, researchers reported that presence of tannin in siris leaves reduced gas production, because of tannins affinity to make a complex with nutrients, therefore, it keeps nutrients away from microorganisms and prevents their fermentation [27].

Tannin content in the siris leaves and seed was reported about 4 and 5.3%, respectively [15]. Tannins can also reduce microorganism adhesion to nutrients, inhibit microorganism growth and microbial enzymes activity which have negative effects on fermentation, nutrients digestibility and methane production [28].

The flowers are free of antinutrient and toxic compounds [11]. It is concluded, lack of anti-nutritional complex and higher quantities of proteins and carbohydrates in flowers of siris, makes it as suitable substrate for rumen microbial growth [9]. Also, they have higher gas production than leaves and pods because of lower NDF

and ADF [13]. It is reported, decreasing the content of lignin in the plant cell wall enhanced the fermentation and gas production [30]. Similar to the current findings, it was reported that when the siris flower was fed by 15 - 16%, the dry matter digestibility of the forage with the flower increased [29].

The mount of PF and microbial biomass in the two microbial groups were not different. It was reported that the tannin and saponin of leaves and pods of siris increases the PF [11].

The amount of saponin in siris branches (pods) was 669.4 mg/kg, that was higher than other anti-nutritional agents. It is suggested that the pods be separated from the seeds in order to increase the nutritional value. Also, tannin content in the siris leaves and pods mixture was about 4 % [11].

Generally, the feedstuff that contains tannin, have higher PF which might be related to tannins being dissolved during fermentation and decrement of dry matter. However, the latter had no effect on gas production or microbial protein synthesis. Tannins become complexed with proteins, the presence of which in the undigested residues results in under-estimation of the actual digested organic matter. Therefore, an error in PF quantity will occur [28]. The researchers reported that presence of resources which contains tannin, increased PF [31]. They found that tannin has a positive effect on protein nutrition in animal feeding. Digested nutrients are more effective in microbial protein synthesis as compared to short chain fatty acid synthesis. Siris belongs to *Fabaceae*, so improving those parameters can be related to legume ability to provide nitrogen requirement, energy and vitamins for microbial growth [32].

Saponin can increase microbial protein synthesis in vitro due to its negative effect on protozoa which prevents bacterial engulfing by protozoa and increases microbial nitrogen flow to the duodenum [18]. Moreover, it was reported that PF in some legume plants like Leucaena leucocephala and acacia (Fabaceae family) were 4.12 and 3.78, respectively [30].

Siris flowers in presence of two microbial groups had maximum concentrations of ammonia nitrogen which might be related to their higher protein value (i.e. 22.75%). Reduction of ammonia nitrogen concentration in siris pods might be related to the presence of saponin, and its negative effect on protozoa population. Therefore, by reduction of protozoa, bacteria lysis decreases and less ammonia will be produced, and ammonia concentration reduces indirectly [33]. Although, ammonia will be produced in the rumen through bacterial degradation by protozoa [33]. Protozoa has proteolytic and deamination effect which cause ammonia production in rumen [34]. By reducing protozoa in rumen, nitrogen flow between bacteria and protozoa reduces and nitrogen flow from the rumen increases [33]. Protozoa population reduction in rumen and decrement of ammonia nitrogen concentration might be due to negative effect of saponin on protozoa population [35].

The researchers reported that resources which contain tannins have reducing effect on ammonia nitrogen concentration in the rumen [28]. The effects of tannins on protein metabolism in the rumen might be related to tannins ability to attach to protein in order to reduce microbial enzyme activity, proteolytic bacteria growth and consequently protein degradation and ammonia nitrogen production in the rumen decreased. Another reason for reducing pH in diet which contains leaves, might be protozoa population reduction. Rapid digestion and storage of starch by protozoa cause stable rumen and constant pH [15].

Higher value of rapidly degradable fraction of siris flowers as compared to pods and leaves might be due to their higher protein content, soluble carbohydrate and lower ADF and NDF contents [36]. It seems that increasing crude protein content of siris had positive effect on DM degradation. By increasing protein content in plant, DM potential of degradability will be increased. Generally, degradability is affected by cell wall [37]. Significant reduction of slowly degradable fraction of pods as compared to leaves and flowers of siris might be related to higher values of NDF and lignin in pod [28].

On the base of studies [38] digestibility of dry matter, organic matter and crude fiber and nitrogen retention of siris leaves were 89.87%, 93.9%, 61.44% and 91.16% respectively. Also, it is concluded that siris silage could be used as source of protein for sheep fed with low-quality rations [38].

Presence of anti-nutritional factors such as saponins and oxalate in siris pod might be another reason for lower slowly degradable fraction, as these compounds reduce fiber digestibility in rumen. Saponins suppress fiber digestion in rumen, which might be related to reducing effect of fibrolytic enzyme activity [39]. Potential and effective degradability of siris flower in comparison to leaf and pods were significantly increased. It might be due to the presence of anti-nutritional factors like saponin and oxalate in siris leaves and pods.

The researchers reported the rapidly degradable fraction, slowly degradable fraction, degradation rate constant and potential of degradability of siris leaves were 42.2, 37.3, 0.1 and 79.5%, respectively [40]. It is seen that the rapidly degradable fraction and potential of degradability of the present research is lower, but slowly degradable fraction are same [11].

Conclusion

It can be concluded that siris leaves, flowers and pods have good rumen degradability in one-humped camel. Feeding camel with branches of this plant especially flower increase fiber digestion through improvement of rumen fermentation processes.

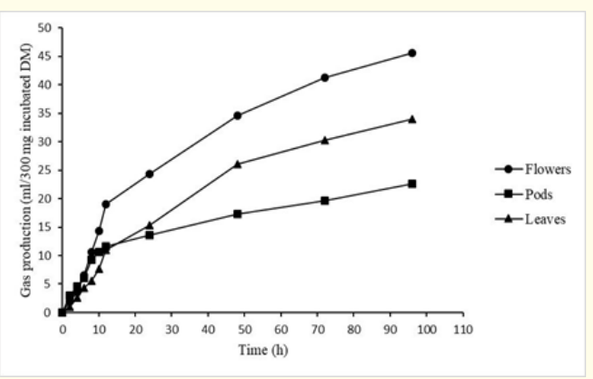

Figure 2: Gas production kinetics of siris leaves, pods and flowers by total rumen microorganisms in one-humped camel.

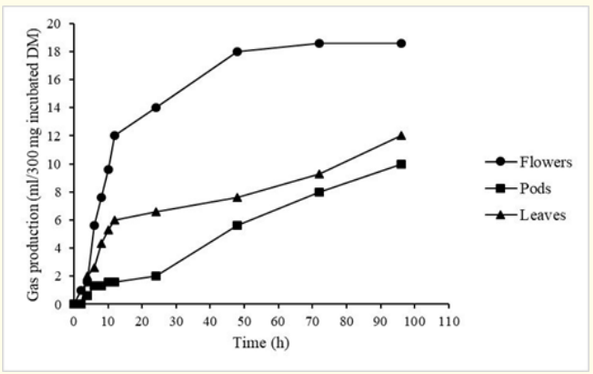

Figure 3: Gas production kinetics of siris leaves, pods and flowers by fungi + protozoa mixture in one-humped camel.

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Conflict of Interest

There is no conflict on any issues relating to the research between the authors.

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