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Effect of supplementing pounded *Prosopis juliflora* pods on hematological profiles of Afar goats fed on *Panicum antidotale* hay

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A study was conducted on thirty two 15.5±1.4 kg (mean ± SD) male Afar goats so as to evaluate effects of increasing dietary levels of pounded *Prosopis juliflora (P. juliflora)* pod on their performance. Hematological values, individual feed intake and body weight gain were determined during a 90-day experimental period. Four dietary treatments were applied using complete randomized design (CRD). The treatments were the experimental units (goats). The experimental feeds were 0 g *P. juliflora* (T1 as control animals), 150 g (T2), 300 g (T3), and 450 g (T4) and *Panicum antidotale* hay was offered as a roughage source, that is, *ad libitum*. Results of total dry matter and nutrient intakes, growth and feed conversion rates were appreciable as the amount of pounded *P. juliflora* is increased from 0 to 300 g. However, these values declined sharply as the amount of pounded *P. juliflora* supplementation increased to 450 g. Hematological analysis showed that there is significant difference (P<0.01) among all treatments in all of the parameters taken. However, all of the values were under the normal range mentioned for healthy goat breeds. Overall, feed intake, growth rate and feed conversion were maximized at 150 g pounded *P. juliflora*. This result also indicated that pounded *P. juliflora* pod could be fed to Afar goats up to 450 g without compromising their health.

Key words: Afar goats, growth, health, hematology, pod, *Prosopis juliflora*.

INTRODUCTION

In Ethiopia, feed scarcity is the major limiting factor, which contributes a lot to the reduction of productivity of the livestock sector (Birhanu et al., 2013). This reduction is highly aggravated especially during the dry season and

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hence supplementation of concentrates is always a mandatory (Nurfeta, 2010). However, according to Mahmoud and Seyoum (2015) availability of such valuable concentrates is very limited due to scarcity and high cost. Therefore, looking for other substitutes as natural fodder trees and shrubs can be used as supplements to livestock, especially during long dry season and fodder stress periods (Abusuwar and Ahmed, 2010). Of these*, Prosopis juliflora (P. juliflora)* is among those fodder trees that can be used as supplements to livestock feed. *P. juliflora* is native to Colombia, Ecuador, Mexico, Peru, and Venezuela and then spread to Central and North America (Pasiecznik, 2002). It had been introduced to many arid zones of different countries, with rainfall of less than 200 mm/year (Mahgoub et al., 2005).

In Ethiopia, the tree is introduced in late 1970s as a biological soil and water conservation means (Sertse and Pasiecznik, 2005). However, it is invading the traditional agro-and silvo-pastoral lands making the rangelands inaccessible to livestock. Consequently, currently the species causes various socio-economic and ecological impacts particularly in Afar rangelands (Kassahun et al., 2005). Consequently, the tree is now affecting even the food security of the afar regional state (Dubale, 2008). This is because, the areas which have already been invaded by the tree have lost natural pasture and the grazing potential of these rangelands have been reduced, native trees have already been replaced or disappeared forever and the productivity of croplands have been reduced (Zeraye, 2008).

P. juliflora is a woody stemmed, thorned, evergreen shrub or small tree usually up to about five meters tall. The tree has green-brown twisted stem, flexible branches and produce flattened, multi-seeded curved pods with hardened pericarp (Getu et al., 2013). The pods of *P. juliflora,* based on the soil type and the process of extraction, have a crude protein level of 7 to 22% and a carbohydrate level of 30 to 75% (Choge et al., 2007). This makes the pod a good low cost alternative feed resource almost for all ruminant species (Abdullah et al., 2011). Since complete removal of the plant by mechanical cutting as well as burning has proven to be difficult, many studies have urged to use this tree as a feed supplement to livestock.

However, since the grinding process requires hammer mill and electrical power and mixing the pod with commercial concentrates is also very expensive and unavailable, almost all of the research out puts done in Ethiopia and outside turned to be non-recommendable to the pastoralists of Afar. Hence, direct feeding of the pod after being pounded with local handmade materials without mill grinding might serve as alternative recommendation to pastoral communities. However, the productivity of *P. juliflora* pod fed animals, for various products such as milk (Abedelnoor et al., 2009), egg (Meseret et al., 2011) and meat as well as their growth performance (Mahgoub et al., 2005) were impeded by the higher inclusion level of the pod. Tabosa et al. (2000) also reported that feeding the pod directly for prolonged time may cause mandibular tremors mainly during chewing, constipation, diarrhea, loss of appetite and other health related problems. These physiological changes and symptoms could be assessed using hematological parameters. Thus, blood is an important and reliable medium for assessing the physiological and health status of individual animals (NseAbasi et al., 2013). Therefore, the objective of this study was to assess the effect of supplementing pounded *P. juliflora* pod on feed intake, growth performance and health situation of Afar goats fed on *Panicum antidotale (P. antidotale)* hay.

MATERIALS AND METHODS

Description of the study area

The experiment was conducted at Dubti Pastoral and Agro Pastoral Research Center (DPARC) which lies between latitude 11° 27' North, longitude 41° 20' East and an altitude of 382 m above sea level. The mean annual rainfall and temperature of the area are 400 mm and 34.1°C, respectively. The area has sandy loam soil with acacia species, such as *Acacia nilotica* and *P. juliflora*, dominated vegetation cover.

Research methodology

Chemical analysis

The chemical analysis of the feed samples was done as per the following protocols at Holeta Agricultural Research Centre (HARC). All feed samples were collected and dried at 55°C in a forced draft oven to a constant weight and ground to pass through 1 mm mesh screen size. Following this, the samples were subjected for the analysis of dry matter, organic matter, ash, and crude protein according to the procedures of AOAC (1990). Neutral detergent fiber and acid detergent fiber were analyzed according to the procedure of (Van Soest et al., 1991).

Experimental animals, design and management

Twenty four male goats of less than one-year age having 15.5 ±1.4 kg (mean ± SD) of body weight were purchased from the surrounding market. The goats were quarantined for seven days and during this period they were de-wormed against internal and external parasites and penned individually.

The basal diet, that is, *P. antidotale* hay was cultivated at DPARC by cutting at 35 days interval. It was at early blossom, leafy, light green and soft stage which was chopped immediately using a locally made stand chopper at the length of 20 to 25 cm. Similarly,

Table 1. Mean analysis of the treatment feeds during the feeding trial.

P. antidotale	*Prosopis* pod	Chemical components
935.0	894.0	DM (g/kg)
102.0	147.1	CP (g/kg DM)
902.0	954.9	OM (g/kg DM)
737.0	430.4	NDF (g/kg DM)
425.0	270.0	ADF (g/kg DM)
98.0	42.1	Ash (g/kg DM)

the supplemental feed used for the study, that is, *P. juliflora* pods were collected from trees grown in the study area. Following this, pods were dried in the sun, pounded with traditional equipment (Mortar/*Mewqecha* (Amharic) and Pestle/*Zenezena (Amharic)*), mixed with salt and finally fed to animals.

Experimental design and treatments applied

The goats were arranged into four groups of eight animals each in a complete randomized design (CRD). Number of replication per treatment was determined using the general formula $8(CV)^2/d\%^2$; where CV is a coefficient of variation; d% is the expected difference among local control and treatment means. From previous studies, CV was estimated to be 9%, while d% was 10. Treatments were assigned to each group randomly. Four dietary treatments were applied using CRD. The experimental feeds were 0 g pounded *P. juliflora* (T1 as control animals), 150 g (T2), 300 g (T3), 450 g (T4) and *P. antidotal* hay was offered as a roughage source, that is, *ad libitum.*

Statistical analyses

Nutritional parameters were analyzed using generalized linear model (GLM) procedure of SAS (2003). The statistical significant difference among treatment means were checked by Tukey test. Weight gain and feed intake were analyzed using this model:

$$Yij = \mu + Ti + Ei$$

where Yi is the ith observation of the trait in question, μ is the the overall mean, Ti is the treatment effect, and Ei is the residual error. The effect of feed on hematological parameters was analyzed by the following model:

$$Y = a + bx + ei$$

where Y is the dependent variable, a is the intercept on y axis, b is the linear regression coefficient, X is the independent variable, E is the error term, $Y = a + b_1x + b_2x^2 + e$, and b_2 is the quadratic regression coefficient.

Feed intake and body weight gain

Pounded *P. juliflora* supplemented for each animal were offered twice a day at 8:00 and 16:00 h in two equal portions. *P. antidotale* hay and water was made available to the goats at *ad libitum*.

To determine daily feed intake, daily feed offered and refusals were weighed and recorded for each goat. Representative samples of feed offered per batch and refusals per goat were collected and pooled on treatment for determination of chemical composition. The feed conversion ratio (FCR) was calculated as a proportion of daily intake (DM) to daily gain (BW). Initial BW of each goat was determined by taking the mean of two consecutive weights after overnight fasting, and BW was subsequently measured every 7 days after overnight fasting.

Hematological examination

Blood samples from all experimental animals were collected in vials containing ethylenediamine tetra acetic acid (EDTA), as anticoagulant, weekly from the day 0 to the end of the experiment (day 90). Blood was drawn from the animals at rest, that is, with minimum animal physiological disturbance or excitement by allowing animals to rest at least 5 min of an adaptation time before sampling. Rectal temperature, pulse, and respiratory rates were also checked for apparent normality. To avoid the effect of diurnal variation, the sampling time was adjusted for all goats at around 7:30 a.m. From each animal, 4 ml of blood was drawn from the jugular vein using a heparinized vacutainer tube following standard procedures. To dissolve the anticoagulants, the collected samples were immediately tipped back and forth a dozen times gentle enough to avoid hemolysis of red blood cells.

Within 1 h from sampling, hematological parameters such as total white blood cell (WBC) count, hemoglobin (Hb) and red blood cell (RBC) count, mean corpuscular hemoglobin concentration (MCHC), mean corpuscular volume (MCV), and mean cell hemoglobin (MCHb) were measured using an automatic analyzer (Mindray BC, 2800).

RESULTS

Chemical composition

The chemical composition of feeds used in this experiment is shown in Table 1. The crude protein (CP) and organic matter (OM) content of *P. juliflora* pods were higher than *P. antidotale* grass hay. On the other hand, the neutral detergent fiber (NDF) and acid detergent fiber (ADF) content of *P. antidotale* hay were higher than *P.*

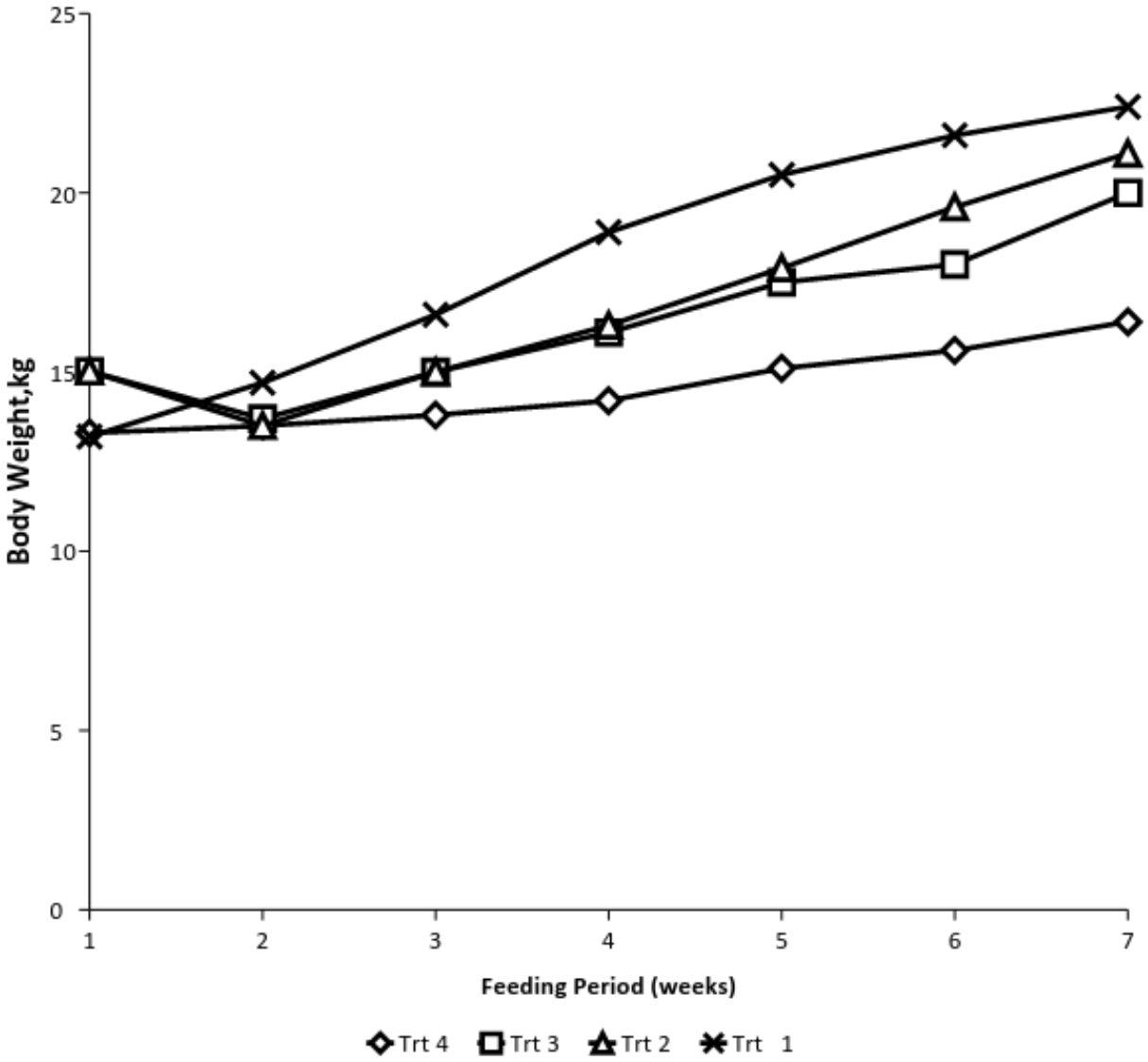

Figure 1. Growth curves of Afar goats fed various levels of pounded *P. juliflora* pod and *P. antidotale* grass hay.

juliflora pod.

Feed intake and body weight parameters

Goats which did not get *P. juliflora* and those fed 150 g of pounded *P. juliflora* pod had higher feed intake (P<0.05). In general, feed intake was found to decrease as the supplementation of pounded *P. juliflora* pod increased across the feeding regime (Figure 1). A similar pattern occurred when feed intake was expressed as a proportion of BW. Goats fed 450 g pounded *P. juliflora* pod had the lowest (P<0.05) final BW gain, body weight change and average daily gain than the other groups. The feed conversion ratio (FCR) was increased significantly (P<0.001) as the amount of pounded *P. juliflora* pod increased from 0 to 450 g (Table 2).

Hematological results

The least square means of erythrocyte series are presented in Table 3. The overall estimates for WBC, RBC, Hb, PCV, MCV, MCH and MCHC were within the

Table 2. Mean feed intake and body weight change of Afar goats fed pounded *Prosopis juliflora* pod and *P. antidotale* grass hay.

Linear	Quadratic	Treatment[-1]				SEM Probability>F
		450	300	150	0	Variable
						Intake (g/day)
0.003	0.001	468.7±46.4	474.9	508.8	516.8	DM
0.002	0.001	3.1±0.68	3.2	3.4	3.5	DM (%BW)
						Growth performance
0.075	0.077	14.2±0.34	14.9	14.9	13.5	Initial weight (kg)
0.02	0.01	16.4±1.37	20.2	20.2	22.4	Final weight (kg)
0.0004	0.007	2.3±1.5	5.3	5.5	8.8	BW change (kg)
0.04	0.03	26.4±35.1	58.9	62.1	97.8	ADG (g/day)[2]
0.03	0.01	0.06±0.08	0.12	0.12	0.19	FCR[3] (kg gain/feed)

Table 3. Erythrocyte serious of Afar goats fed pounded *P. juliflora* pod during the feeding trial.

Linear	Quadratic		Mean values of all treatments	Treatment[-1]				SEM Probability>F
				450	300	150	0	
0.15	0.15	2.39	8.0±0.11	7.2±0.1	8.0±0.1	8.2±0.1	8.6±0.1	WBC (10^9 g/L)
0.74	0.91	0.27	11.1±0.2	9.9±0.2	10.9±0.2	11.6±0.2	11.9±0.2	RBC (10^6)
0.18	0.26	0.30	8.0±0.1	7.2±0.1	8.0±0.1	8.2±0.1	8.6±0.1	Hob (g/dl)
0.66	0.84	0.71	24.3±0.2	23.8±0.2	23.8±0.2	24.2±0.2	25.2±0.2	PCV (%)
0.96	0.83	0.92	22.2±0.2	24.0±0.1	21.8±0.2	20.9±0.1	22.1±0.2	MCV (fl)
0.63	0.61	61.6	7.3±0.5	7.4±0.5	7.4±0.4	7.2±0.4	7.2±0.5	MCH (pg)
0.90	0.76	12.3	32.5±0.3	31.0±0.2	33.9±0.3	34.4±0.2	30.7±0.3	MCHC (g/dl)

normal range mentioned for healthy goats.

DISCUSSION

Chemical composition

In the current study, the chemical composition of *P. juliflora* pod was found lower than the results of Ahmed et al. (2012), although samples were collected from the same area. However, Mahmoud and Seyoum (2015) reported almost similar results for all the chemical compositions of *P. juliflora* pod collected from the same area. This similarity and/or difference might be attributed to genotype, stage of maturity at sampling, season of harvesting, pre and post-harvest management, soil type, climate, time and intensity of grazing and plant fraction as well as method of analysis used in the laboratories (Adesogan et al., 2012). *P. juliflora* pod, though its chemical composition differs among the studies, can serve as an alternative livestock feed when compared with other available feed resources especially to the commonly used *P. antidotale* hay (El Hag et al., 2000).

Feed intake and body weight parameters

Feed intake results indicated that *P. juliflora* pods may be included in goat diets up to 450 g. In the present study, reduced feed intakes were (Linear = 0.003, Quadratic = 0.001) observed due to the increased pounded *P. juliflora pod* supplementation which is similar to previous reports of Mahgoub et al. (2005). Such reduction in feed intake could be attributed to the presence of tannins and other phenolic compounds in the *P. juliflora* pods that suppress appetite (Koech et al., 2010). It seems that, due to this effect, goats fed on 450 g pounded *P. juliflora* pod had the least body weight gain.

As feed conversion ratio is an important economic factor, the objectives of many studies have been focused on increasing weight gain per unit of feed used and then a lower FCR (Sebsibe, 2006). The minimum FCR in the

current study was observed in goats under treatment one (linear P= 0.03; Quadratic P = 0.01). This shows that as supplementation with pounded *P. juliflora pod* increased to 450 g, feed conversion efficiency decreased and thus the amount of feed used per unit of weight gained is increased. All the feed conversion values of this study, except for treatment four, were higher than (0.07) what was reported by Sebsibe (2006) for stalled Afar goats. Thus, in goat feed, as the inclusion levels of *P. juliflora pod* increases, the FCR increases and feed intake decreases.

Hematological result

As per our knowledge, hematological profiling of Afar goats on *P. juliflora* feed is a first report in its kind and hence related information on Afar goats was missing. The effect of feeding different levels of pounded *P. juliflora* pods on hematological parameters was not significant (linear and quadratic). In general, the hematological profiles of the goats in question were within the range for caprine species (8 - 18 × 10^6 μL^{-1}) mentioned by Latimer et al. (2003). However, the mean values for all hematological parameters of Afar goats were lower than the mean values reported for three Ethiopian goats Arsi-Bale, Central high land and long eared Somali (Tibbo et al., 2004).

This difference in hematological parameters could be due to the difference in altitude. It is already reported that, the shortage of oxygen in high altitudes, leads to an increased production and release of erythropoietin, thereby, stimulating erythropoiesis as a coping or adaptive mechanism to low oxygen level (Tibbo et al., 2004). Therefore, the lower RBC and Hb values exhibited in Afar goats in the present study (360 to 365 m above sea level) could provide evidence of adaptation of these breeds to high atmospheric oxygen.

The mean total WBC values observed in this study (8.0±0.11 × 10^9 g/L) were in close agreement with the result of tropical goats (8.0±0.6 × 10^3 μL^{-1}), for Sokoto Red, Kano Brown, Salla and Borono white goats in Nigeria (Tibbo et al., 2004) and were lower than the mean WBC values of Arsi-Bale goats (11.88 × 10^3 μL^{-1}), Central high land (11.05 × 10^3 μL^{-1}) and long eared Somali (11.09 × 10^3 μL^{-1}) (Tibbo et al., 2004). The observed difference in the mean total WBC might be attributed to the tanniniferous content level of *P. juliflora* which tends to suppress haemopoietic tissues with consequent production of low WBC count (Mahgoub et al., 2008; Olafadehan, 2011). Depressed leukocyte and lymphocyte counts were previously reported in sheep and goats fed tanniniferous diets (Mahgoub et al., 2008; Olafadehan, 2011).

In general, the present study reported that feeding pounded *P. juliflora* to Afar goats did not appear to affect their health condition. However, according to Tabosa et al. (2000) feeding *Prosopis* pod in high proportions and for longer periods can cause health problems in small ruminants. The author also reported that goats fed 600 and 900 g *P. juliflora* pods had mandibular tremors, mainly during chewing. Therefore, lack of manifestation of health problems in the current experimental goats may be due to either the short period of feeding or to the smaller proportions of pods in the diet (maximum 450 g as compared to 600 and 900 g/kg). Thus, further research on the health effects of afar goats fed on *P. juliflora* pods has to be conducted to rule out the benefits and risks associated with *P. juliflora.*

CONCLUSION AND RECOMMENDATIONS

In the current study, feed intake results indicated that *P. juliflora* pod may be included in goat diets up to 450 g without any negative side effect. The effect of feeding different levels of pounded *P. juliflora* was also found to be under normal range for tropical goats.

From these results, it can be concluded that, direct supplementation of pounded *P. juliflora* pod up to 450 g in Afar goats could serve as a means of maximizing feed intake, body weight gain and feed conversion efficiency without compromising any health abnormalities. However, further studies are needed to investigate the impact of direct supplementation of pounded *P. juliflora* pod on physiological behavior of goats and other feed intake and health related parameters.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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