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ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Crude Nutrient and Mineral Composition of *Asystasia gangetica* (L.) as a Predominant Forage Species for Feeding of Goats

Khalil
Department of Animal Nutrition and Feed Technology, Faculty of Animal Science,
University of Andalas, Campus II Payakumbuh, West Sumatra, Indonesia

Abstract: The present study was aimed to define the suitability of *Asystasia gangetica* (L.) as a predominant forage for goats based on crude nutrient and mineral composition. Samples of forages collected by farmers were taken from 8 goat farms at three different sampling times. Fresh samples were taken from five different spots in each sample bunch from each farm, weighed and then sorted to determine the predominant species based on botanical composition and apparent frequency. Samples of six predominant species were chopped and mixed in with others from the same sampling time. Representative samples (about 150 g) from each of the predominant species were dried and ground for chemical analysis. Botanical composition, apparent frequency, dry matter, nutrient content (crude protein, fiber and ash) and minerals (Ca, P, Fe, Cu, Mn and Zn) were measured. Results showed that of the 47 total kinds of vegetation fed to goats in the Payakumbuh region of Indonesia, the six predominant forage species included *Axonopus compressus* (23.4%), *Centrocema pubescens* (6.8%), *A. gangetica* (5.5%), *Panicum maximum* (5.3%) and *Gliricidia sepium* (5.2%) and *Manihot utilissima* (5.0%) foliage. The crude nutrient and mineral content of *A. gangetica* showed it to be a good source of protein and minerals, particularly Ca, P, Cu, Mn and Zn. It was concluded that *A. gangetica* could be used as a good complementary source of protein and minerals for goats.

Key words: *Asystasia gangetica* (L.), nutrient and mineral composition, predominant forages

INTRODUCTION

The Payakumbuh region of Indonesia which includes Payakumbuh city and 50 Kota districts in West Sumatra is a potential area for development of goat farming. This area is dominated by annual, small-scale crop estates as potential sources of fodder feed. Goat farms in this area are predominantly small-scale enterprises with an average flock size of 35.9 and 14.3 goats per farm for dairy and meat farms, respectively (Kurnia *et al.*, 2015). Kurnia *et al.* (2015) reported that raising Peranakan-Etawah dairy goats has increased in popularity due to the potential market for goat milk and the high prices of bucks in Payakumbuh.

Goats are mostly raised intensively with cut and carry feeding systems. Feed primarily consists of fresh wild vegetation, tree leaves and agricultural by-products. The wild vegetation forages are derived from diverse sources, like plantation areas, river banks, rice fields, idle lands, forest edges and roadsides and are comprised of various types of plants, such as native grass, legumes, broadleaf species and ferns. Even though these feeds often vary in nutrient and mineral and dry matter (DM) content (Khalil *et al.*, 2015), mixtures of different plant species could be a good fodder feed for goats.

One the wild plant species found to be very palatable and often fed to goats in Payakumbuh is *Asystasia gengetica,* often called "akar jalar" or "aka jala" by locals. *A. gangetica* (Linn) T. Anderson belongs to the family of Acanthaceae and is commonly known as the Chinese violet. This rapidly growing herb spreads very quickly as a weed that infests crops, such as rubber, coffee and palm oil plantations in particular (Abdullah, 1985; Ong *et al.*, 2008). It adapts well to low fertility soils and shaded areas (Ong *et al.*, 2008; Samedani *et al.*, 2013). Although this plant is considered a serious environmental and agricultural weed in Indonesia and Malaysia (Asbur *et al.*, 2015), *A. gangetica* has some benefits. It contains various biologically active substances with various medicinal properties such as antiasthmatic, antidiabetic, anticancer and antioxidant, analgesic and anti-inflammatory, antimicrobial and antifungal effects (Akah *et al.*, 2003; Ezike *et al.*, 2008; Tilloo *et al.*, 2012; Kanchanapoom and Ruchirwat, 2007; Hamid *et al.*, 2011; Tilloo *et al.*, 2012). *A. gangetica* is also known to have high nutritional value as an animal feed because it is rich in protein, fiber and favorable amounts of minerals (Yeoh and Wong, 1993; Odhav *et al.*, 2007; Sobayo *et al.*, 2012; Acipa *et al.*, 2013; Adigun *et al.*, 2014).

The dietary mineral intake of goats in Payakumbuh is almost entirely dependent on wild vegetation forages since mineral supplementation is an uncommon practice in this area. Minerals are an essential component of goat nutrition, with deficiencies being the primary cause of productivity loss. Despite comprising 4-5% of the body weight of animals, minerals levels are often a critical problem of goat nutrition. Minerals are of vital importance in various tissues for metabolic processes, maintenance of osmotic pressure, acid-base equilibrium and cellular permeability. They are also key components in the formation of hormones, enzymes and tissues such as bones (Underwood and Suttle, 1999). Ca, P, Mn, Cu, Fe and Zn are all minerals involved in governing the reproductive success of goats (Wilde, 2006). Cu and Zn directly affect reproductive events in sheep and goats, such as expression of estrus, embryo implantation and reduced spermatogenesis; indirectly, they affect overall animal health (Vazquez-Armijo *et al.*, 2011). Thus, mineral deficiencies might lead to poor growth rates, reduced reproductive efficiency and decreased milk production.

The present study aimed to define the suitability of *A. gangetica* as a predominant forage for goats in the Payakumbuh region of West Sumatra, Indonesia, based on its crude nutrient and mineral content. Determining crude nutrient and mineral contents of predominant plant forage species may be useful for improvement of feeding strategies for better growth, milk production and reproduction of goats. This data might also reflect the ability of farmers in the Payakumbuh area to explore the potential of various forage sources for their goats.

MATERIALS AND METHODS

Forages sample collection: The current study was initiated by field survey to define diversity and predominant forages for goats. Samples of forages collected by goat farmers were taken from 8 goat farms at three different times during the day. The average flock size was about 24 goats per farm. The farms were distributed throughout six different sub-districts of North Payakumbuh, West Payakumbuh, Lareh Sago Halaban, Luhak, Arau and Tanjung Aro. Fresh forage samples were taken from five separate spots within each forage bunch or sack directly after arriving at each farm in the afternoon. Plants were also identified with their local names.

Individual samples were placed in individual plastic bags, weighed and then sorted by species for calculation of botanical composition and apparent frequency. Latin and common names of samples were identified at the University of Andalas Biology Department, Padang, West Sumatra, Indonesia. The percent botanical composition was calculated by dividing the fresh weight of each plant species in each individual sample with the total weight of each individual sample. The percent apparent frequency of each species was calculated by dividing the apparent number of species in each individual sample with the total number of individual samples from each farm. The six most predominant species were then selected by ranking the forages based on botanical composition and apparent frequency.

Sample preparation and chemical analysis: The predominant species were manually chopped into pieces (2-3 cm) and then samples from the same species and sampling time were mixed, creating a total of 18 samples (6 predominant species, 3 sampling times). Representative samples (about 150 g) were dried in a forced draught oven at 60°C for 48 h and weighed again. Air-dried samples were ground through a 1-mm screen mill for analysis of crude ash, protein and fiber, DM and mineral (Ca, P, Fe, Cu, Mn and Zn) content.

DM and crude ash, protein and fiber were determined using the proximate analysis procedures described by the Association of Analytical Communities (2005). Samples for mineral analysis were prepared by wet digestion using concentrated sulfuric acid and hydrogen peroxide. The concentration of minerals was determined using an atomic absorption spectrophotometer (AAS, 1980). All results were reported on a DM basis.

Statistical analysis: Botanical composition and apparent frequencies of predominant forages were analyzed using simple descriptive statistics. Nutrient and mineral content of predominant forages were subjected to analysis of variance using a completely random design consisting of six predominant forage species and three replicates. Duncan's Multiple Range Test was applied to compare means. Differences were considered significant at $p<0.05$ (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

Diversity and predominance of forages: A wide variety of plant species are utilized as forages for goats in Payakumbuh. Table 1 shows a total of 47 plant species were recorded, consisting of 19 species of grasses (40.4%), 11 species of broadleaves (23.4%), 9 species of legumes (19.1%) and 4 species each of fern (8.5%) and tree leaves (8.5%). Six plant species were identified to be predominant forages (51.2% of total forages collected): *Axonopus compressus* (botanical composition: 23.4%; frequency: 97.5), *Centrocema pubescens* (botanical composition: 6.8%; frequency: 62.5), *A. gangetica* (botanical composition: 5.5%; frequency: 45.0), *Panicum maximum* (botanical composition: 5.3%; frequency: 37.5) and *Gliricidia sepium* (botanical composition: 5.2%; frequency: 30.0) and *Manihot utilissima* (botanical composition: 5.0%; frequency: 20.0) foliage.

Axonopus compressus was found to be the most important grass species for goats in Payakumbuh due to its high palatability and potential availability in the study sites. This shade-tolerant species is considered a weed and can be found in a wide variety of areas, like roadsides, river banks and crop plantations. The sub-districts of Lareh Sago Halaban, Harau, Mungka, Luhak, North and West Payakumbuh are dominated by annual, small-scale crop estates of cacao, coconut and banana. This kind of grass has become an integral part of crop plantations due to its positive effects on crop production by acting as a cover crop to suppress broadleaf weeds and soil erosion (Jurami, 2003; Samedani *et al.*, 2013).

Predominant legumes included *C. pubescens* and *Pueraria phaseoloides*, while *Desmodium* sp were predominantly *D. ovalifilium* and *D. trifolium*. Tree foliages consumed by goats in Payakumbuh included *G. sepium* (botanical composition: 30.0%) and cassava leaves (botanical composition: 20.0%; Table 1). *G. sepium* is commonly used as a live fence, while cassava root are widely used in snack foods.

Gangetica was the most predominant broadleaf plants recorded, followed by *Amaranthus spinosus* (botanical composition: 2.7%), *Borreria alata* (botanical composition: 2.6%) as well as *Synderella vialis*, *Typhonium flagelliforme*, *Pteridium esculentum* and *Oxelis barrelia* (botanical composition: 1.0-1.7%). Farmers in the study sites also fed ferns to their goats. The main species known to be palatable were *Lygodium flexuosum* (botanical composition: 2.8% and *Nephrolepis biserrata* (botanical composition: 1.5%; Table 1).

Crude nutrient and mineral composition of *A. Gangetica* compared to other predominant plants: Table 2 shows the proximate nutrient composition and mineral content of *A. gangetica* compared to the five other predominant plant species found in the study sites. Although crude protein content of *A. gangetica* (23.2%) was lower than that of *G. sepium* (26.8%) and cassava leaves (25.3%), there was no significant difference (p>0.05). *G. sepium* foliage included young leaves, stalks, seeds and flowers which have a high nutritional value (Handayanta *et al*., 2014). Ajayi *et al*. (2005) reported that *G. sepium* foliage was a good protein source for goats, containing 29.3% crude protein. The crude protein content of *A. gangetica* was significantly higher than that of the grasses *Axonopus compressus* (11.3%) and *P. maximum* (13.1%; p<0.01) as well as legume *C. pubescens* (17.2%; p<0.05). While the crude protein content of *Axonopus compressus* and *P. maximum* were similar to that reported by Evitayani *et al*. (2004) in North Sumatra, Indonesia (10.6% and 15.1%, respectively), *A. gangetica* in the present study was slightly higher than that reported by Acipa *et al*. (2013) (18.9%), Bindelle *et al*. (2007) (21.6%) and Sobayo *et al*. (2012) (19.4%).

The crude fiber content of *A. gangetica* (25.6%) in the current study was lower than the grasses *Axonopus compressus* (35.3%) and *P. maximum* (37.4%) but higher than that reported by Sobayo *et al*. (2012) (15.5%) and Bindelle *et al*. (2007) (21.6%) in *A. gangetica* leaves. Considering its high protein and low fiber content, *A. gangetica* was found to be a good source of protein for goats in combination with native grasses.

In term of mineral composition, *A. gangetica* was found to be a good source of Ca (8.2 g/kg DM) and P (11.3 g/kg DM). It contained significantly higher Ca than that of the grasses (*Axonopus compressus*: 2.1 g/kg DM; *P. maximum*: 2.2 g/kg DM) and the legume *C. pubescens* (3.5 g/kg DM) (all p<0.05). The P content of *A. gangetica* was comparable to that of *C. pubescens* (12.6 g/kg DM) and cassava leaf (11.4 g/kg DM) (both p>0.05; Table 2). The Ca and P content of *A. gangetica* in the present study were higher than that reported by Acipa *et al*. (2013) (Ca: 3.5 g/kg DM; P: 7.9 g/kg DM and Agea *et al*. (2014) (Ca: 5.0 g/kg DM; P: 5.1 g/kg DM). Furthermore, the Ca: P ratio 1.5-2:1 of *A. gangetica* has nutritional importance. As a structural component, Ca combines with P to form the mineral portion of bone and teeth (Weaver and Heaney, 1999). However, because the P concentration herein was higher than that of Ca, *A. gangetica* should be mixed with *G. sepium* and/or cassava leaves, which contained the highest levels of Ca (20.1 and 15.0 g/kg DM, respectively; Table 2).

A. gangetica was also found to be relatively rich in Cu (12.2 mg/kg DM), Mn (232.6 mg/kg DM) and Zn (60.6 g/kg DM), which showed comparable levels in *Axonopus compressus* and *C. pubescens* (p>0.05). In the current study, *A. gangetica* was found to be higher in Mn but lower in Zn and Cu compared to a report by Agea *et al*. (2014) (Mn: 106.3 mg/kg DM; Zn: 82.3 mg/kg DM; Cu: 37.2 mg/kg DM). On the other hand, current results corresponded to Cu levels reported by Yeoh and Wong (1993) (9.0 mg/kg DM). Fe had the lowest concentration of all the minerals analyzed in *A. gangetica* (89.3 mg/kg DM; p<0.05). Interestingly, previous studies have shown the Fe concentration of this plant vary greatly, from 138.7 mg/kg DM (Acipa *et al*., 2013) to 43.7 mg/kg DM (Yeoh and Wong, 1993) and 183.4 mg/kg DM (Agea *et al*., 2014). Except for Fe, the native grasses *Axonopus compressus* and *P. maximum* were found to be relatively poor sources of Ca, P, Mn and Zn in the present study. These results correspond with earlier reports showing native forages were deficient in Ca, P, Mg and Cu, which lead to an increased incidence of mineral deficiency in goats grazing in West Sumatra (Warly *et al*., 2006a,b). Low levels of Ca, P, Cu and Zn in native grasses leading to their deficiency in grazing cattle has also been reported in South Sulawesi, Indonesia (Prabowo *et al*., 1991a,b).

Fodder leaves of cassava and *G. sepium* were found to be good sources of Ca, possessing the highest content of all the predominant forages in the study sites (15-20 g/kg DM). Cassava leaves also contained the highest Fe (308.4 mg/kg) and Zn (94.1 mg/kg DM) content. High concentrations of Ca and Fe in cassava leaves has also been reported by Fasuyi (2005). Furthermore, Adiwimarta *et al*. (2010) reported that cassava leaves were not only a good source of protein, but also had an anthelmintic effect in goats.

Overall, the total DM content of *A. gangetica* (14.6%) was significantly lower than the grasses (23-24%) and tree leaves (25-29%) examined herein. The current DM content of this plant was comparable to that of *A. gangetica* leaf meal reported by Sobayo *et al*. (2012) and Odhav *et al*. (2007) (14.5 and 15.0%, respectively), but higher than that reported by Bindelle *et al*. (2007) (10.5%). Due to the

Table 1: Forages for goats in Payakumbuh region of Indonesia

Forage groups	Plant species (Botanical composition, %)	Total No. of plants
Grasses	*Axonopus compressus* (23.4), *Panicum maximum* (5.3), *Brachiaria decumbens* (2.6), *Pennisetum pupureum* (2.5), *Paspalum conjugatum* (2.3), *Cynodon dactylon* (2.0), *Chloris gayana* (1.9), *B. miliiformis* (1.6), *B. mutica* (1.4), *Setaria plicata* (1.4), *Ottochloa nodosa* (1.1), *Imperata cylindrical* (1.1), *Cyperus rotundus* (1.0), *C. plectostachyus* (0.9), *Eleusine indica* (0.6), *B. humidicola* (0.3), *Chrysopogon acylatus* (0.2), *Digitaria ascendens* (0.2) and *Ischaemum muticum* (0.1)	19
	Sub-total: 49.9%	
Broad leaves	*Asystasia gangetica* (5.5), *Amaranthus spinosus* (2.7), *Borreria alata* (2.6), *Synedrella vialis* (1.7), *Typhonium flagelliforme* (1.6), *Pteridium esculentum* (1.1), *Oxelis barrelia* (1.0), *Cleome rutidosperma* (0.4), *Borreria laevis* (0.4), *Dactyloctenium aegyptium* (0.3) and *Euphorbia hirta* L. (0.3)	11
	Sub-total: 17.6%	
Legumes	*Centrosema pubescens* (6.8), *Pueraria phaseoloides* (2.7), *Mimosa pudica* (1.7), *Desmodium triflorum* (1.6), *Desmodium ovalifolium* (1.6), *Arachis hypogaea L* (0.7), *Macrophlium atropurpureum* (0.3), *Macarophlium axillare (0.3)* and *Vigna hateola* (0.1)	9
	Sub-total: 15.8%	
Green leaves	*Gliricidia sepium* (5.2), *Manihot utilissima* (5.0), *Theobroma cacao* (1.2) and *Artocarpus heterophyllus* (0.1)	4
Fern	*Lygodium flexuosum* (2.7), *Nephrolepis biserrata* (1.5), *Dicraopteris linearis* (0.8) and *Stenochaena palustris* (0.2)	4
	Sub-total: 5.2%	
	Total number of plants	47

Table 2: Crude nutrient, dry matter (DM) and mineral content of six predominant species of forages for goats in the Payakumbuh region of Indonesia

	Predominant plant species					
	Axonopus compressus	*Centrosema pubescens*	*Asystasia gangetica*	*Panicum maximum*	*Gliricidia sepium*	*Manihot utilissima*
Dominance parameters (±SEM[1])						
Botanical composition, %	23.4±3.4	6.8±2.4	5.5±1.1	5.3±1.3	5.2±1.9	5.0±2.6
Apparent frequency, %	97.5±2.5	62.5±15.3	45.0±14.0	37.5±16.7	30.0±14.6	20.0±12.5
Crude nutrients (% DM±SEM)						
Crude protein[2)]	$11.3±0.3^{c}$	$17.2±1.4^{b}$	$23.2±0.3^{a}$	$13.1±0.2^{c}$	$26.8±1.0^{a}$	$25.3±1.7^{a}$
Crude fiber	$35.3±3.5^{a}$	$29.2±2.6^{ab}$	$25.6±3.2^{b}$	$37.4±1.9^{a}$	$12.7±1.2^{c}$	$22.7±1.2^{b}$
Crude ash	$10.4±0.4^{b}$	$11.8±0.7^{b}$	$12.7±0.3^{b}$	$12.5±0.8^{b}$	$8.0±0.2^{b}$	$27.1±1.0^{a}$
DM, % FW[3)]	$23.9±0.2^{a}$	$17.1±0.2^{ab}$	$14.6±0.1^{b}$	$22.7±0.6^{a}$	$24.9±0.2^{a}$	$28.5±1.0^{a}$
Minerals (±SEM)						
Ca, g/kg DM	$2.1±0.3^{c}$	$3.5±0.5^{c}$	$8.2±1.7^{b}$	$2.2±0.1^{c}$	$20.1±1.9^{a}$	$15.0±0.4^{a}$
P, g/kg DM	$8.1±0.7^{ab}$	$12.6±0.5^{a}$	$11.3±2.4^{a}$	$5.8±1.1^{b}$	$7.4±0.9^{ab}$	$11.4±0.9^{a}$
Fe,mg/kg DM	$243.2±49.2^{a}$	$309.3±15.1^{a}$	$89.3±4.9^{b}$	$196.6±16.5^{a}$	$166.3±7.6^{ab}$	$308.4±0.6^{a}$
Cu,mg/kg DM	$10.3±2.3^{ab}$	$17.3±1.7^{a}$	$12.2±3.2^{ab}$	$9.4±0.7^{ab}$	$3.9±0.6^{c}$	$7.1±0.5^{ab}$
Mn, mg/kgDM	$178.5±7.3^{b}$	$164.3±7.3^{b}$	$232.6±12.0^{b}$	$73.0±4.1^{c}$	$179.7±22.0^{b}$	$374.6±16.2^{a}$
Zn, mg/kg DM	$41.7±1.6^{b}$	$99.5±21.6^{a}$	$60.6±2.8^{ab}$	$48.1±2.4^{b}$	$42.4±4.5^{b}$	$94.1±10.2^{a}$

[1)]SEM: standard error of the mean. [2)abc]Means within same row with different superscripts are significantly different ($p<0.05$). [3)]FW: Fresh weigh

relatively low total DM content of this plant, it is therefore necessary to combine *A. gangetica* with *G. sepium* and cassava leaves in order to ensure that goats fed under confinement ingest the quantity of fresh forages required to meet nutrient and DM needs. As shown in Table 2, the leaves of *G. sepium* and cassava contained the highest total DM (24.5 and 28.5%, respectively; $p<0.05$). Cassava leaves were offered to goats in wilted form by sun drying to minimize negative toxic effects. Feeding a variety of preferred plants available to goats would ensure adequate DM and nutrient intake from the forage and help to overcome low DM intake, a constraint to the use of browse plants in small ruminant feeding.

In general, even though grasses accounted for the majority plant forages in the study sites, had lower crude protein and minerals but higher crude fiber content, combining them with other predominant plant species, including *A. gangetica*, *C. pusbescens* and foliages high in crude protein and minerals, make them good forages. Furthermore, feeding of *A. gangetica* and fodder from cassava and tree leaves to goats should be increased due to their high nutritional content. Because of relatively good fodder feeds, the average milk production has been reported to be about 0.8 L/head/d in Payakumbuh by Kurnia *et al.* (2015) and 0.5-0.9 L/d by Novita *et al.* (2006). Current findings also show that farmers in the Payakumbuh area of Indonesia were able to explore the potential of various forage sources for their goats.

Conclusions: Of the 47 total kinds of vegetation fed to goats in Payakumbuh, the six predominant forages included *Axonopus compressus* (23.4%), *C. pubescens* (6.8%), *A. gangetica* (5.5%), *P. maximum* (5.3%) and foliage of *G. sepium* (5.2%) and *Manihot utilissima* (5.0%). Levels of crude protein and Ca in *A. gangetica* were significantly higher than the grasses, but lower than in *G. sepium* and cassava leaves. The crude nutrient and mineral content of the *A. gangetica* shows it is a good source of protein, Ca, P, Mn, Zn and Cu. Thus, it was concluded that *A. gangetica* could be used as a good complementary source of foliage protein and minerals for goats.

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