Journal of Scientific Agriculture 2017, 1: 209-215
doi: 10.25081/jsa.2017.v1.65
http://updatepublishing.com/journals/index.php/jsa

REGULAR ARTICLE

Comparisons on the nutritive values of local and introduced forages and feed mixture for ruminant feed in central dry zone of Myanmar

Soe Min Thein[1], Min Aung[1], Lwin Naing Oo[1], Moe Thidar Htun[1], Khin San Mu[1], Jenny E. Hanks[2], Werner W. Stur[3], Dennis P. Poppi[4] and Aung Aung[1*]

[1]*Department of Physiology and Biochemistry, University of Veterinary Science, Yezin, Nay Pyi Taw 05282 Myanmar.*

[2]*University of Melbourne, Melbourne, Australia.*

[3]*ACIAR, Australia.*

[4]*University of Queensland, Gatton, Queensland, Australia.*

Abstract

This study aimed to compare nutritive values of local (Sorghum) and introduced (Mombasa) forages and their feed mixtures for ruminant feed in central dry zone of Myanmar. Sorghum based feed mixtures (FeedMix-1, 2 and 3) were the commonly used feed mixtures for cattle in dry zone of Myanmar and other feed mixtures (FeedMix-4, 5 and 6) were based on Mombasa. The lower CP and higher fibre contents ($P<0.05$) were observed in sorghum and its feed mixtures. The highest gas volumes ($P<0.05$) were observed in the FeedMix-4 and 6, and then the lowest gas volume ($P<0.05$) was observed in FeedMix-3. The gas production from quickly soluble fraction (a) of sorghum was significantly higher ($P<0.05$) than that of Mombasa, inversely the gas production from insoluble fraction (b) of sorghum was significantly lower ($P<0.05$) than that of Mombasa. Moreover, potential gas production (a+b), ME, OMD and SCFA of sorghum were also significantly lower ($P<0.05$) than those of Mombasa. The value of "a" was lowest ($P<0.05$) in FeedMix-1, whereas the highest value was found in FeedMix-6. The lowest values ($P<0.05$) of "*b*", "*a+b*", ME, OMD and SCFA were observed in FeedMix-3 and the highest values ($P<0.05$) of those parameters were found in FeedMix-4. Thus, the higher nutritive values observed in the introduced forage, Mombasa and its feed mixtures were indicating that Mombasa should be used instead of sorghum for the feed of cattle in dry zone of Myanmar.

Key words: Sorghum, Mombasa, nutritive values, dry zone, Myanmar

Introduction

In Myanmar, usually the animal feed consists of crop residues and agricultural by-products. As the report of Min Aung et al. (2015a), the common available feedstuff in the dry zone of Myanmar were rice straw, natural grass, butter bean residue, lablab bean residue, sesame residue and sorghum stover, which have the valuable nutritional potential to use as feed for ruminant animals (Min Aung et al., 2015b). The farmers in dry zone of Myanmar grew sorghum, which were

Received 29 June 2017; Accepted 21 July 2017; Published 24 July 2017

*Corresponding Authors

Aung Aung

Department of Physiology and Biochemistry, University of Veterinary Science, Yezin, Nay Pyi Taw 05282 Myanmar.

Email: aung.aaung@gmail.com

fed to ruminant animals as both fresh and dry feed mix. However, there were two critical periods in a year in which farmers faced particularly severe feed shortages; (i) a short period of feed constraints in the late wet to early dry season before animals are moved to the cultivation area, and (ii) a long period of feed constraints in the mid to late dry and early wet seasons (Soe Min Thein et al., 2014). The possible way to eliminate the feed shortages in dry zone of Myanmar is the introduction of imported forages which can grow in dry zone and have high nutritional potential. Thus, the forages grasses such as Ruzi, Mombasa, Simaung, Toledo, Mulato II and Cayman were introduced and grew in dry zone of Myanmar. Among the introduced forage grasses, Mombasa possessed the highest sowing rate (Nan Khan Hline et al., 2015), greater forage yield and nutritive values (Unpublished data). However, it is still needed to clarify the nutritive and feeding values of those local forage (Sorghum) and introduced forage (Mombasa).

The correct nutrition of animals can be achieved only through the proper evaluation of the nutritive values of feed supply. There are reports about chemical composition, *in vitro* gas production and many nutritional parameters in feed supply (Ammar et al., 2004; Kaya et al., 2016). Thus, this study was aimed to compare the nutritive values of local (Sorghum) and introduced (Mombasa) forages and their feed mixture for ruminant feed in central dry zone of Myanmar.

Materials and methods

Feedstuffs and feed mixtures

The feedstuffs used as local and introduced forages in the experiment were sorghum stover (SGS) and Mombasa grass (MBG), respectively. Moreover, the different inclusion rates of groundnut straw (GNS) and pigeon pea residue (PPR) were used to make feed mixtures. The feed mixtures used in this experiment were the feed mixture-1 (FeedMix-1) (SGS50% + GNS30% + PPR20%), FeedMix-2 (SGS60% + GNS20% + PPR20%), FeedMix-3 (SGS70% + GN30% + PPR00%), Feedmix-4 (MBG50% + GNS30% + PPR20%), Feedmix-5 (MBG60% + GNS20% + PPR20%), and Feedmin-6 (MG70% + GNS30% + PPR00%). The local forage, sorghum, based feed mixtures (FeedMix-1, 2 and 3) were the commonly used feed mixtures for cattle in dry zone of Myanmar and other feed mixtures (FeedMix-4, 5 and 6) were based on introduced forage, Mombasa, which was included instead of sorghum in feed mixtures.

Chemical analysis

The chemical analysis was conducted as explained previously (Min Aung et al., 2015b). The samples for local and introduced forages were collected for the chemical analysis. All samples were ground and analyzed for dry matter (DM), organic matter (OM) by the method described by AOAC (1990) and neutral detergent fibre (NDF) and acid detergent fibre (ADF) by Goering and Van Soest (1970). Nitrogen contents were analyzed by using Kjeldahl method (Foss 2020 digester and Foss 2100 Kjeltec distillation unit) and crude protein (CP) is calculated as 6.25 × N (AOAC, 1990).

In vitro gas production

The fistulated bull with 340 kg body weight (BW) was used as a donor of rumen inocula for the *in vitro* gas production. Prior to the experimental period, the animal was fed rice straw supplemented with groundnut cake (1.8kg/day) *ad libitum* and water is free accept for 14 days for the ruminal adaption of diets. After that, rumen juice was collected from the animals for the experiment. The procedure for *in vitro* gas production was as reported by Menke and Steingass (1988) and as explained previously (Min Aung et al., 2015b). The extent and rate of fermentation on gas production is determined by exponential model of Ørskov and McDonald (1979). The short chain fatty acid (SCFA), organic matter digestibility (OMD) and metabolizable energy (ME) values in experimental feedstuff were calculated using equation of Makkar (2005).

Statistical analysis

The data were subjected to the analysis of variance (ANOVA) and the significance of differences between treatments means were compared by DMRT (Steel and Torrie, 1980) using SPSS (version 16.0) software.

Results

Chemical compositions (%) of experimental feedstuffs and feed mixtures are shown in Table 1. The lower CP and higher fibre (NDF and ADF) contents ($p<0.05$) were observed in the local forage, sorghum, which was compared with the introduced forage, Mombasa. The chemical compositions were significantly different ($p<0.05$) among the experimental feed mixtures. Generally, the CP contents of sorghum based mixtures were lower than those of Mombasa based feed mixtures. Among the feed mixtures, the highest fibre content was observed in sorghum based feed mixture (FeedMix-3).

Table 1. Chemical composition of experimental feedstuffs and feed mixtures.

	Chemical compositions				
	DM	OM	CP	NDF	ADF
Feedstuffs					
SGS	93.53[a]	89.28[c]	4.29[d]	72.94[a]	57.43[a]
PPR	92.95[b]	93.82[a]	9.55[b]	61.49[c]	46.07[b]
GNS	91.61[c]	90.95[b]	11.96[a]	53.38[d]	45.15[c]
MBG	90.92[d]	90.24[b]	7.32[c]	71.15[b]	39.79[d]
SEM	0.31	0.52	0.85	2.38	1.94
p value	0.0001	0.0001	0.0001	0.0001	0.0001
Feed mixtures					
FeedMix-1	91.86[bc]	91.81[a]	7.45[c]	62.07[c]	42.38[c]
FeedMix-2	92.30[b]	91.79[a]	6.60[d]	64.50[ab]	43.61[b]
FeedMix-3	92.90[a]	90.92[b]	6.50[d]	66.16[a]	45.06[a]
FeedMix-4	91.62[bc]	90.75[c]	8.70[a]	65.80[a]	42.67[bc]
FeedMix-5	91.09[c]	90.71[c]	8.26[b]	64.56[ab]	41.50[cd]
FeedMix-6	91.95[b]	90.03[d]	8.37[ab]	63.02[bc]	40.97[d]
SEM	0.16	0.15	0.21	0.40	0.35
p value	0.005	0.0001	0.0001	0.002	0.0001

All values except DM are on DM basis. DM: dry matter, OM: organic matter, CP: crude protein, NDF: neutral detergent fibre, ADF: acid detergent fibre, SGS: sorghum stover, PPR: pigeon pea residue, GNS: groundnut straw, MBG: mombasa grass, SEM: standard error mean.
[a,b,c,d;] Mean value with different superscripts with the same columns are significantly different ($p<0.05$)

The *in vitro* cumulative gas volumes of experimental feedstuffs and feed mixtures at different incubation times are presented in Table 2. The cumulative gas volumes and effective net gas of introduced forage, Mombasa, were significantly higher ($p<0.05$) than those of local forage, sorghum, in all incubation times except 1hr, in which there were not significantly different ($p>0.05$). Mostly, the cumulative gas volumes and effective net gas of introduced forage, Mombasa, based feed mixtures were significantly higher ($p<0.05$) than those of local forage, sorghum, based feed mixtures. The highest gas volumes ($p<0.05$) were observed in the introduced forage based feed mixture, FeedMix-4 and -6, and the lowest gas volume ($p<0.05$) was observed in the local forage, sorghum, based feed mixture, FeedMix-3.

The fermentation kinetics and some estimated parameters of experimental feedstuffs and feed mixture were presented in Table 3. The gas production from quickly soluble fraction (*a*) of sorghum was significantly higher ($p<0.05$) than that of Mombasa, inversely the gas production from insoluble fraction (*b*) of sorghum was significantly lower ($p<0.05$) than that of Mombasa. Moreover, potential gas production (*a+b*), ME, OMD and SCFA of sorghum were also significantly lower ($p<0.05$) than those of Mombasa. The fermentation kinetics, ME, OMD and SCFA were significantly different ($p<0.05$) among the experimental feed mixtures. The lowest gas production ($p<0.05$) from quickly soluble fraction (*a*) was observed in FeedMix-1, sorghum based feed mixture, whereas the highest value was found in FeedMix-6, Mombasa based feed mixture. The gas production from insoluble fraction (*b*) and potential gas production (*a+b*) were higher in Mombasa based feed mixtures comparison with sorghum based feed mixtures. Specifically, the lowest values ($p<0.05$) of "*b*", "*a+b*", ME, OMD and SCFA were observed in FeedMix-3, sorghum based feed mixture and the highest values ($p<0.05$) of those parameters were found in FeedMix-4, Mombasa based feed mixture.

Table 2. *In vitro* gas volumes of experimental feedstuffs and feed mixture.

	Incubation times (hours)								Effective net gas
	1hr	3hr	6hr	12hr	24hr	48hr	72hr	96hr	
Feedstuffs									
SGS	2.30	3.88^{b}	6.12^{c}	10.21^{c}	17.05^{c}	26.61^{c}	32.48^{c}	36.10^{b}	21.83^{c}
PPR	1.84	4.78^{b}	8.74^{b}	15.32^{b}	24.40^{b}	33.21^{b}	36.44^{b}	37.64^{b}	26.03^{b}
GNS	1.74	6.77^{a}	13.23^{a}	23.03^{a}	34.36^{a}	42.24^{a}	44.00^{a}	44.39^{a}	33.80^{a}
MBG	1.63	6.76^{a}	13.31^{a}	23.20^{a}	34.57^{a}	42.35^{a}	44.05^{a}	44.42^{a}	33.60^{a}
SEM	0.19	0.43	0.95	1.67	2.23	2.02	1.55	1.23	1.57
p value	0.696	0.005	0.0001	0.0001	0.0001	0.0001	0.0001	0.001	0.0001
Feed mixture									
FeedMix-1	1.54	4.64	8.82	15.73^{ab}	25.22^{ab}	34.33^{b}	37.61^{bc}	38.79^{cd}	26.80^{bc}
FeedMix-2	2.00	4.44	7.82	13.65^{b}	22.37^{bc}	32.24^{bc}	36.75^{bc}	38.81^{cd}	25.40^{bc}
FeedMix-3	1.96	4.28	7.63	13.27^{b}	21.64^{c}	31.09c	35.48^{c}	37.59^{d}	24.63^{c}
FeedMix-4	2.23	5.36	9.63	16.83^{a}	27.10^{a}	37.77^{a}	42.12^{a}	43.91^{a}	29.67^{a}
FeedMix-5	1.67	4.53	8.44	15.08^{ab}	24.66^{abc}	34.79^{b}	39.02^{b}	40.65^{bc}	27.27^{b}
FeedMix-6	1.98	5.28	9.74	17.14^{a}	27.46^{a}	37.67^{a}	41.58^{a}	43.11^{ab}	29.57^{a}
SEM	0.15	0.17	0.27	0.45	0.63	0.68	0.65	0.63	0.52
p value	0.864	0.337	0.063	0.021	0.007	0.001	0.0001	0.001	0.001

SGS: sorghum stover, PPR: pigeon pea residue, GNS: groundnut straw, MBG: mombasa grass, SEM: standard error mean

[a,b,c,d;] Mean value with different superscripts with the same columns are significantly different ($p<0.05$)

Table 3. Fermentation kinetics and some estimated parameters of experimental feedstuffs and feed mixture

	Fermentation kinetics				Some estimated parameters		
	a	*b*	*c*	*a+b*	ME	OMD	SCFA
Feedstuffs							
SGS	1.50^{a}	40.44^{b}	0.0200^{c}	41.93^{b}	4.72^{d}	32.41^{d}	0.37^{c}
PPR	0.64^{b}	38.07^{b}	0.0433^{b}	38.71^{c}	6.28^{c}	42.70^{c}	0.57^{b}
GNS	0.18^{c}	45.54^{a}	0.0633^{a}	45.72^{a}	7.79^{a}	52.95^{a}	0.80^{a}
MBG	0.25^{bc}	45.71^{a}	0.0633^{a}	45.96^{a}	7.52^{b}	50.88^{b}	0.80^{a}
SEM	0.17	1.07	0.006	0.99	0.37	2.45	0.01
p value	0.0001	0.001	0.0001	0.002	0.0001	0.0001	0.0001
Feed mixture							
FeedMix-1	0.12^{b}	39.56^{cd}	0.0400	39.68^{c}	6.40^{a}	43.46^{a}	0.61^{a}
FeedMix-2	0.72^{a}	39.84^{cd}	0.0300	40.56^{bc}	5.78^{bc}	39.35^{bc}	0.52^{b}
FeedMix-3	0.71^{a}	39.11^{d}	0.0333	39.82^{c}	5.62^{c}	38.33^{c}	0.49^{b}
FeedMix-4	1.10^{a}	44.63^{a}	0.0367	45.73^{a}	6.53^{a}	44.44^{a}	0.62^{a}
FeedMix-5	0.59^{ab}	41.96^{bc}	0.0333	42.55^{b}	6.11^{ab}	41.70^{ab}	0.56^{ab}
FeedMix-6	1.16^{a}	43.89^{ab}	0.0400	45.05^{a}	6.44^{a}	43.86^{a}	0.61^{a}
SEM	0.10	0.59	0.002	0.65	0.10	0.65	0.01
p value	0.014	0.001	0.470	0.0001	0.003	0.002	0.009

SGS: sorghum stover, PPR: pigeon pea residue, GNS: groundnut straw, MBG: mombasa grass, *a*: gas production (ml) from quickly soluble fraction, *b*: gas production (ml) from insoluble fraction, *c*: gas production rate, *a+b:* potential gas production, ME: metabolizable energy, OMD: organic matter digestibility, SCFA: short chain fatty acid, SEM: standard error mean

[a,b,c,d;] Mean value with different superscripts with the same columns are significantly different ($p<0.05$)

Discussion

The chemical compositions of sorghum in this study were different from the earlier reports of the researchers (Lwin Naing Oo et al., 2014; Min Aung et al., 2015a) and those of Mombasa were also unlike with the finding of Nan Kham Hline et al. (2015). There are many factors which determine the variation like stage of growth, maturity, species or variety, drying method, growth environment and soil types (Von Keyserlingk et al., 1996; Agbagla-Dohanni et al., 2001; Promkot and Wanapat, 2004; Mupangwa et al., 1997; Thu and Preston, 1997). Moreover, it might also be due to the different geographic and agronomic sources from which feedstuffs were collected, climate condition, different soil type, different usage of fertilizer, different stage of growth (Buxton and Fales, 2004; Mahyuddin, 2007).

The explanations for the higher values of cumulative gas volumes and effective net gas observed in the introduced forage and its feed mixtures compare with the local forage and its feed mixtures were due to the higher CP and lower ADF contents of introduced forage. Haddi et al. (2003) stated that the higher ADF and NDF contents in feedstuffs could decrease the gas production because they have high crude fibre content and, low CP and digestibility values. The researchers (De Boever et al., 2005; Heidary and Kafilzadhe, 2012) reported that the *in vitro* gas production was negatively related with the NDF and ADF contents and positively with starch. Moreover, Najidda and Nasiru (2010) and Lwin Naing Oo et al. (2014) pointed out that gas production might be increased in the higher nitrogen free extract (NFE) and CP contents of the samples, respectively.

On the other hand, the lower value of "*a*" and higher values of "*b*", "*c*" and "*a+b*" were observed in introduced forage, Mombasa, and its feed mixtures compare with local forage, sorghum, and its feed mixtures. These findings were also as the results of differences in chemical compositions, higher CP and lower fibre contents of Mombasa. The gas production and their fermentation kinetics might be influenced by the level of quickly soluble carbohydrate fraction readily available to the microbial population and level of slowly fermented carbohydrates (NDF and ADF) which needs more time for the attachment of microorganism to fibre. This assumption was supported with the findings of Hillman et al. (1993) and van Soest (1994). Hillman et al. (1993) showed that the gas production was positively related to microbial protein synthesis and van Soest (1994) reported that if the fibre content is low which will increase the use of feed by ruminal microbes and will improve the digestibility of feed. Blummel and Becker (1997) also reported that the the production of gas is directly proportional to the degradable carbohydrate. Hall (2000) also expressed that the high potential extent of gas production and fractional rate of gas production may be attributed to the high content of neutral detergent soluble fibre fraction (NDS) in the pulse legume seeds. Moreover, Deaville and Given (2001) and Sallam et al. (2008) reported that gas productions and fermentation kinetics of feed in buffered rumen fluid were associated with feed fermentation and carbohydrate fraction.

The least SCFA predicted for sorghum and sorghum based feed mixtures were due to a lower gas production which was clear from the incubation done in first 24hrs. The gas production occurring from straws of cereal and feeds, which were incubated *in vitro* in buffered rumen fluid was in relation with the production of SCFA and in turn depend upon carbohydrate fermentation (Blummel et al. 1990). SCFA denotes the energy availability to the animal. The energy value (ME) was also lower in sorghum and its feed mixtures, which possessed higher fibre content. Madibela and Modiakgotla (2004) reported that ADF has a negative effect on energy content of forages and caused negative correlation between ADF and *in vitro* digestibility. The digestibility of organic matter (OMD) obtained in Mombasa and its feed mixtures were high compare with sorghum and sorghum and its feed mixtures because the major carbohydrate of Mombasa and its feed mixtures were starch, which is fermented by amylolytic bacteria and protozoa (Kotarski et al., 1992).

Conclusion

The introduced forage, Mombasa and its feed mixtures gave the higher gas volumes, effective net gas, fermentation kinetics, ME, OMD and SCFA compare with the local forage, sorghum and its feed mixtures. Thus, for the feed of cattle in dry zone, Mombasa should be used instead of sorghum because of its higher nutritive values and ability of sowing in dry zone of Myanmar. However, for the further study, it would be suggested that the comparison on the forage of yield of sorghum and Mombasa should be conducted.

Acknowledgements

We would like to thank all laboratory staff from the Department of Physiology and Biochemistry, University of Veterinary Science for their helps in the process of chemical analysis and animal care. This experiment was funded by the DAT HAT PAN Project, Myanmar (ACIAR) and we want to express our gratitude to all project members for their helps throughout the experiments.

Author's contributions

SMT mainly carried out sample collection, chemical analysis and *in vitro* gas experiment. LNO, MTH, KSM, JH, WS, DP and AA designed the experiment. MA performed data analysis and interpretation. SMT drafted the manuscript and MA, LNO, MTH, KSM, JH, WS, DP and AA completed the critical revision of the article. All authors read and approved the final version of manuscript.

References

Agbagla-Dohnani, A., Noziere, P., Clement, G., & Doreau, M. (2001). *In sacco* degradability, chemical and morphorlogical composition of 15 varieties of European rice straw. *Animal Feed Science and Technology*, 94, 15-27.

Ammar, H., Lopez, S., Gonzalez, J. S., & Ranilla, M. J. (2004). Chemical composition and *in vitro* digestibility of some Spanish browse plant species. *Journal of the Science of Food and Agriculture,* 84, 197-204.

AOAC (1990). Official Methods of Analysis. 15th ed. Association of Official Analytical Chemists, Washington D.C. pp. 69-88.

Blümme, M., Ørskov, E. R., Becker, K., & Soller, H. (1990). Anwendung des Hohenheimer Gastests zur Schatzung Kinetischer Parameter der Pansen fermentation. *Jounal of Animal Physiology and Animal Nutrition,* 64, 56-57.

Blummel, M., & Becker, K. (1997). The degradation characteristics of fifty-four roughages and neutral detergent fibers as described by *in vitro* gas production and their relationship to voluntary feed intake. *British Journal of Nutrition,* 77, 757-768.

Buxton, D. R., & Fales, S. L. (1994). Plant environment and quality. In: Forage quality, evaluation, and utilization, Eds Jr Fahey GC *et al.* American Society of Agronomy, Madison WI, USA. pp 155-199.

De Boever, J. L., Aerts, J. M., & De Brabader, D. L. (2005). Evaluation of the nutritive value of maize silages using gas production techniques. *Animal Feed Science and Technology,* 123-124, 255-265.

Deaville, E. R., & Givens, D. I. (2001). Use of the automated gas production technique to determine the fermentation kinetics of carbohydrate fractions in maize silage. *Animal Feed Science and Technology,* 93, 205-215.

Goering, K. H., & Van Soest, P. J. (1970). Forage fibre Analysis. Agricultural Hand book. 379. USDA, Washinton D.C. pp. 8-12.

Haddi, M. L., Filacorda, S., Meniai, K., Rollin, F., & Susmel, P. (2003). In vitro fermentation kinetics of some halophyte shrubs sampled at three stage maturity. *Animal Feed Science and Technology,* 104, 215-225.

Hall, B. M. (2000). Neutral detergent soluble carbohydrates. Laboratory manual, Institute of Food and Agricultural Science, University of Florida. pp. 76.

Heidary, N., & Kafilzadeh, F. (2012). Determining of chemical composition, in vitro digestibility and kinetics of fermentation of whole crop forage from 18 different varieties of oat. *Iranian Journal of Animal Science Research*, 22, 91-106.

Hillman, H. K., Newbold, C. J., & Steward, C. S. (1993). The contribution of bacteria and protozoa to ruminal forage fermentation in vitro as determined by microbial gas production. *Animal Feed Science and Technology,* 36, 193-208.

Kaya, E., Canbolat, O., Atalay, A. I., Kurt, O., & Kamalak, A. (2016). Potential nutritive value and methane production of pods, seed and senescent leaves of *Gleditsia triacanthos* trees. *Livstock Research and Rural Development,* 28, 123.

Kotarski, S. F., Waniska, R. D., & Thurn, K. K. (1992). Starch hydrolysis by the ruminant micro flora. *Journal of Nutrition,* 122, 178-190.

Lwin Naing Oo, Soe Min Thein, Moe Thida Htun, Khin San Mu, Aung Aung & Tin Ngwe (2014). Effect of diet containing different proportion of roughage and concentrate on degradation characteristic and energy-protein synchronization. In: Proceedings of First international conference and annual meeting of Myanmar Veterinary Association. Myanmar convention centre, December, Yangon, Myanmar. pp. 53-62.

Madibela, O. R., & Modiakgotla, E. (2004). Chemical composition and *in vitro* dry matter digestibility of indigenous finger millet (Eleusinecoracana) in Botawana. *Livstock Research and Rural Development,* 16, 4.

Mahyuddin, P. (2007). Chemical composition of leaf and stem of tropical grasses at different stage of growth. *Journal of Produksi Ternak*, 9 (3), 153-159.

Makkar, H. P. S. (2005). *In vitro* gas methods for evaluation of feeds containing phytochemicals. *Animal Feed Science and Technology,* 123–124, 291–302.

Menke, K. H., & Steingass, H. (1988). Estimation of the energetic feed value obtained from chemical analysis and in vitro gas production using rumen fluid. *Animal Research and Development,* 28, 7-55.

Min Aung, Myo Khaing, Tin Ngwe, Khin San Mu, Moe Thida Htun, Lwin Naing Oo and Aung Aung (2015a). Preliminary survey on the dairy cattle production system and conventional feed resources in the central dry zone of Myanmar. *Global Journal of Animal Scientific Research,* 3, 383-387.

Min Aung, M., Kyawt, Y. Y., Khaing, M., San Mu, K., Htun, M. T., Oo, L. N., & Aung, A. (2015b). Nutritional Evaluation of Conventional Feedstuffs for Ruminants using InVitro Gas Production Technique. *Global Journal of Animal Scientific Research*, *3*(2), 518-523.

Mupangwa, J. F., Ngongoni, N. T., Topps, J. H., & Ndlovu, N. (1997). Chemical composition and dry matter of forage legumes *Cassia rotunifolia* cv. Wynn, *Lablab purpureus* cv. Highworth and *Maccroptilium atropurpureum* cv. Siratro at 8 weeks of growth (pre-anthesis). *Animal Feed Science and Technology,* 69, 167-178.

Nang Khan Hline, Khin San Mu, Moe Thida Htun, Lwin Naing Oo, Soe Min Thein, Dezin Soe Lwin, Jue Jue, Jenny Hanks, Ganda Nakamanee and Werner Stur (2015). Sustainable use of gressland resources for forage production, biodiversity and environmental protection. Selection of Suitable Varieties of Grasses for Myanmar. In*:* Proceeding of XXIII International Grassland Congress, November 20-24, New Delhi, India. pp. 989.

Njidda, A. A., & Nasiru, A. (2010). *In vitro* gas production and dry matter digestibility of tannin-containint forages of semi-arid region of North-Eastern Nigeria. *Pakistan Journal of Nutrition,* 9, 0-66.

Ørskov, E. R., & McDonald, L. M. (1979). Estimation of protein degradability in the rumen from incubation measurement weighted according to rate of passage. *Journal of Agricultural Science,* 92, 499-503.

Promkot, C., & Wanapat, M. (2004). Ruminant degradation and intestinal digestion of rude protein of tropical resources using nylon bag and three step in vitro procedure in dairy cattle. In: Proceedings of the Agricultural Seminar, Animal Science/Animal Husbnadry. Held at Sofitel Raja Orchid Hotel, 27-28 January, 2004.

Sallam, S. M. A., Bueno, I. C. S., Godoy, P. B., Nozella, E. F., Vitti, D. M., & Al-Abdalla, S. S. (2008). Nutritive value in the value assessment of the artichoke (*Cynara scolyms*) by products as an alternative feed resource for ruminant. *Tropical and Subtropical Agriecosystems,* 8, 181-189.

Soe Min Thein, Aung Aung, Kyaw Naing Oo, Nan Kham Hlain, Win Myint Thein, Lwin Naing Oo, Zin Min Latt, Tu Tu Zaw Win, Hanks J and Stur W (2014). Assessement of feed availability for cattle, sheep and goats in two villages in the central dry zone of Myanmar. In: Proceeding of 16thAAAP *animal science congress*. November 10-14, Yogyakarta, Indonesia.pp. 915-918.

SPSS (2007). Statistical Package for the Social Sciences. Version 16.0.SPSS Inc. United State of America. www.spss.com

Steel, R. G., & Torrie, J. H. (1980). Principles and procedures of statistics. A biometrical approach 2nd ed. Mc Graw-Hill Block Company, New York.

Thu, N. V., & Preston, T. R. (1997). Rumen environment and feed degradability in Swamp Buffaloes fed different supplements. *Livestock Research and Rural Development,* 11, 1-7.

van Soest, P. J. (1994). Nutritional ecology of the ruminant. Corvallis, 2nd ed. Cornell University Press, Ithaca, USA. Pp. 476.

Von Keyserlink, V. M. A. G., Swift, M. L., Puchala, R., & Shelford, A. (1996). Degradability characteristics of dry matter and acrude protein of forages in ruminants. *Animal Feed Science and Technology,* 57, 291-311.