Journal of Agriculture and Ecology Research International

Volume 24, Issue 5, Page 67-72, 2023; Article no.JAERI.101931
ISSN: 2394-1073

Study on the Impact of Season and Location on the Native Pastures' Quality in West Timor, Indonesia

I. Gusti N. Jelantik [a*] and Gemini E. M. Malelak [a]

[a] *Faculty of Animal Husbandry, Marine and Fishery, Universitas Nusa Cendana, Indonesia.*

Authors' contributions

This work was carried out in collaboration between both authors. Author IGNJ designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author GEMM managed the analyses of the study and the literature searches. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAERI/2023/v24i5543

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/101931

Original Research Article

Received: 19/04/2023
Accepted: 23/06/2023
Published: 29/06/2023

ABSTRACT

Aims: The objective of this experiment was to investigate the monthly changes of crude protein and NDF content of forages and the in vitro organic matter digestibility of forages obtained from native pastures in West Timor.
Place and Duration of Study: Native pastures were located in three districts of West Timor, Indonesia. The collected forage samples were determined for crude protein (CP) and neutral detergent fiber (NDF) in the laboratory of feed chemistry, the Faculty of Animal Husbandry, Marine and Fishery. The *in vitro* study was also conducted in the same laboratory. The study was conducted from December 2021 to October 2022.
Methodology: Pasture samples were taken from six native pastures in three districts, i.e. districts of Kupang, Timor Tengah Selatan and Timor Tengah Utara. In each pasture, as many as five 40x40 cm quadrants of forages were clipped bimonthly throughout the year at 5 cm from the soil. Forage was then dried and composited for each district and thereafter sub-sampled for chemical

**Corresponding author: E-mail: igustingurahjelantik@staf.undana.ac.id;*

analyses. Forage samples were determined for crude protein and NDF content as well as in vitro organic matter digestibility.
Results: Results showed forage quality fluctuated with months. The CP content and IVOMD were highest (*P*<.05) during the beginning of the rainy season and the lowest during the late dry season. In contrast, forage NDF content increased (*P*<.05) from 64% during the early wet season to 71-77% during the late wet season and dry season. There was no significant difference (*P*>.05) in the nutritive quality of native pasture among different districts in Timor.
Conclusion: Pasture quality fluctuates with months and its pattern is comparable among districts.

Keywords: Native pastures; crude protein; NDF; in-vitro digestibility; districts.

1. INTRODUCTION

The province of Nusa Tenggara Timur (NTT) has been considered as one of the largest cattle and ruminant producers in Indonesia since the mid of 70s. This is largely supported by the availability of vast native pastures as grazing land in the province. Although the area of grazing land continues to decline from year to year, the area of natural grazing land in NTT province is still quite large, reaching 1,931,722 ha [1]. In addition, the role of native pastures in cattle production in this area is still prominent [2,3,4]. The results of the national census on beef cattle, dairy cattle, and buffaloes in NTT in 2011 [5] recorded that the percentage of cattle and buffaloes kept under the grazing system reached 89.53%. Therefore, optimizing the utilization of the available native pastures in NTT is key to the success of cattle production from this region.

Information on the existing vegetation in native pastures is a key prerequisite for better pasture management and utilization for ruminant production [6,7]. This information may include types of vegetation (i.e. grasses, forages, trees, shrubs as well as others), botanical composition, herbage production, carrying capacity as well as the quality of the available native pastures. Previous studies showed that the available native pastures in NTT are dominated by low-quality native grass species such as *Heteropogon contortus* and *Paspalum conjugatum* which have low herbage production and low carrying capacity, e.g. 0.4-0.6 AU/ha [8]. In addition, the proportion of forage legumes on pasture was as low as 7.1% [8,9,10] which indicates the low quality of forages on pasture. That information is undoubtedly important, however monthly distribution of both forage availability and quality on pastures is also critically important for developing strategies to improve pasture productivity and utilization. These aspects are rarely studied for native pasture in NTT. Therefore, this study aimed to evaluate the monthly fluctuation of forage quality as well as to compare the pasture quality among different districts in West Timor the Province of NTT.

2. MATERIALS AND METHODS

2.1 Site and Location of Native Pastures

The experiment was conducted in three districts, i.e. Kupang, Timor Tengah Selatan (TTS), and Timor Tengah Utara (TTU) from December 2021 to October 2022. Those districts are located in the Island of Timor, The Province of Nusa Tenggara Timur (NTT), Indonesia. Native pastures in 6 villages from each district were purposively selected.

2.2 Forages Sampling and Sample Processing

Forage samples from the selected native pastures were collected by cutting all forages within 40 cm x 40 cm quadrants every two months. Five quadrants were sampled for each pasture. Forages were cut at 5 cm above the soil. The collected forages from each quadrant were sun-dried for two days, composited per district, and stored until the end of the experiment. The forage samples were ground using a Willey mill with a 1 mm screen size for further analyses of the content of CP, NDF, and in vitro organic matter digestibility (IVOMD).

2.3 Chemical Analyses and Determination of *In-vitro* Organic Matter Digestibility

Crude protein content was determined by the Kjeldahl method as total nitrogen multiplied by 6.25 as within Wende analysis following the procedures of AOAC [11]. Ash content was determined by burning the samples in a furnace at 600^{o}C for 4 hours. Meanwhile, NDF analysis was carried out following the method of Van Soest et al. [12].

The two-stage procedure of Tilley and Terry [13] was followed to estimate *in vitro* organic matter digestibility (IVOMD). In the first stage, 0.5 g of the sample was incubated in the test tube with 50 ml of a mixture of rumen fluid and buffer solution in a water bath at 38-39^{o}C for 48 hours. At the end of the first incubation period, 5 ml of 10% Na_2CO_3 solution was added to each tube and immediately centrifuged for 15 min at 2500 rpm. The supernatant was poured off and then 50 ml of pepsin-hydrochloric acid solution was added and thereafter incubated for another 48 hours in the second stage. After 48 hours, the tubes were centrifuged at 2500 rpm for 15 minutes. The residue was then transferred to a pre-weighed porcelain dish. The dish with the fermented sample was then dried for at least 20 hours at 105^{o}C and then weighed. In vitro, organic matter digestibility was calculated as the difference between the sample organic matter and the residue after fermentation.

2.4 Statistical Analysis

The data collected were statistically analyzed using the Analysis of Variance (ANOVA) using SPSS (version 23, IBM Corp. Released 2015) [14]. The effects of months and locations (districts) were declared significant at $P<.05$. Probabilities at $.05<P<.10$ were considered a trend toward significance.

3. RESULTS AND DISCUSSION

3.1 Protein Content, Fiber, and Organic Matter Digestibility *In-vitro*

The vast availability of native pastures does not fully guarantee the adequacy of feed for ruminants without information about the quality of the forages in the pastures. The commonly used quality indices of pasture quality include the chemical composition of forages such as crude protein and fiber (NDF) content and in vitro organic matter digestibility [15]. In addition, information on the monthly fluctuations of pasture quality is also required as a reference for efforts to optimize pasture management and utilization so that cattle production can be optimized. The results showed that both crude protein content, NDF, and in vitro digestibility fluctuated according to the month of sampling (Table 1). Forage crude protein content in December and February was significantly higher ($P<.001$) than that in the other months, i.e. reaching more than 10%. The CP content of pasture forages was intermediate (6.4%) during April and June and then it decreased to below 4% from August to October which is the dry season. A similar finding was previously reported by several researchers, including Manu [9] who reported that forage protein content in native pastures in Kupang District ranged from 8-9% during the period from December to April and then decreased to 6-8 at the beginning of the dry season (April-June) and 2-4% at the end of the dry season (August-October).

The NDF content increased linearly from December to October. Meanwhile, IVOMD decreased linearly from 63.5% in December to 40.6% during October. As expected, the NDF content was inversely related to CP content and IVOMD. NDF is the measure of cell wall fraction, meanwhile, CP is mostly contained in intracellular organelles [15]. As forages advance maturity, part of intercellular materials is converted to the thickening cell walls [16,17] .

Our results indicate that native pastures in NTT were dominated by low-quality forages for a much longer period of the year, i.e. 8 months, than the period with reasonably high quality, i.e. 4 months. This has been argued as one of the most possible factors contributing to the low productivity of grazing ruminants in the area. The high calf mortality rate for Bali cattle, which reaches 35.4%, is reported due to low milk production [18] as a result of nutritional deficiencies experienced by Bali cows during the dry season [19]. This native cattle species has a distinctive calving season which is concentrated during the early dry season. During the dry season, ruminant animals in NTT at all age levels are losing weight which may reach 230 g/d in cattle [20]. In contrast, supported by high-quality forage, Bali cattle can grow up to 0.4 kg/day, but then lose weight when forage quality declines drastically during the dry season so that the total annual weight gain is low, perhaps only 230 g/day [20].

It is commonly argued that the dominant factor causing fluctuations in forage quality is water availability. Almost all pastures in NTT are native pastures, hence the availability of water is highly dependent on existing rainfall. The rainy season on the island of Timor generally falls from November/December to March or April. However, when considered in more detail, it appears that the decrease in the forage quality, i.e. as indicated by a decrease in protein content and an increase in NDF content does not fully match the rainfall pattern. The decrease in

protein content and the increase in NDF started during periods where groundwater availability may be still adequate, i.e. 1-2 months after the rainy season. This fact indicates that other factors may have a greater influence on these fluctuations. One of the most important is the result of maturity. With advancing maturity stage, the forages' stem: leaf ratio and the lignin content of cell walls increase and this can reduce their digestibility [21,22]. Meanwhile, Dummont et al. [23] reported that an increase in temperature and sunlight intensity can be the dominant factor in reducing the quality of forage in pastures. Increasing temperature stimulates increased lignification of the cell walls [24] and decreases the digestibility of forage [25].

The monthly fluctuation pattern of herbage quality on the native pasture in West Timor observed in this study provides a valuable reference for the development of the strategy to improve the utilization of the available native pasture for optimal ruminant production from the area. The study reveals that good quality feeds on native pastures are only available for a very short period during the early to mid-rainy season, i.e. as late as March, and this demands a strategy to optimize the ruminant production from the area. Afterward, a strategic supplementation strategy definitely can be developed using the observed data. For example, crude protein supplementation may need to be started as early as April since the CP content has been already lower than 8% which is the level reported by Minson [15] to be the level of CP in forages below which the rumen microbial requirement for nitrogen, amino acids, and peptide cannot be sufficed. The extent of CP supplementation needs to be elevated towards the end of the dry season as the pasture CP content falls. Similarly, strategies need to be developed to delay the decline of pasture CP by appropriate grazing management or by introducing pasture plants to extend the 'period' of plant growth in the pasture.

3.2 The Effect of Pasture Locations

As shown in Table 2, CP and NDF as well as IVOMD did not differ between the three districts (*P*>.05). It was previously expected that those pasture quality indices are different among districts since there is considerable variation in rainfall, vegetation, level of grazing, livestock rearing practices, elevation, etc. among the three districts. For example, TTS is an area with an altitude of 500-600 m a.s.l. with a higher level of rainfall compared to other districts. In addition, this will result in a smaller number of herding groups and maintenance systems compared to other districts. In one study, Jelantik et al. [18] found that the response of calves to supplementation was higher in TTS compared to other districts which illustrated that the forage in the pasture was of higher quality than in Kupang or TTU. Different from our result, Seu et al. [8] reported significant variation in herbage nutritive value especially the CP content among different locations. The author argued that those variations were caused by different species of grasses as well as legumes and herbs grown on the native pastures in West Timor. The difference found by Seu et al. [8] is from samples of pasture

Table 1. Monthly Fluctuation of the content of crude protein (CP) and neutral detergent fiber (NDF) and the In vitro organic matter digestibility (IVOMD) of native pastures in West Timor

Variable	Month						SEM	*P*-value
	Dec	Feb	Apr	Jun	Aug	Oct		
CP	10.80^{a}	10.10^{a}	6.44^{b}	4.91^{bc}	3.32^{c}	3.10^{c}	0.449	<.001
NDF	64.13^{a}	61.63^{a}	70.17^{ab}	71.67^{ab}	71.07^{ab}	77.20^{b}	2.961	.040
IVOMD	63.47^{a}	57.87^{a}	55.36^{a}	46.93^{b}	45.30^{b}	40.57^{b}	2.562	.001

^{a,b,c} *different superscript within rows shows significant difference (P<.05)*
SEM: standard error of means difference

Table 2. Effects of pastures location on the content of crude protein (CP) and neutral detergent fiber (NDF) and the In vitro organic matter digestibility (IVOMD) of pasture forages samples

Variable	Kabupaten			SEM	*P*-value
	Kupang	TTS	TTU		
CP	7.33	7.58	7,42	0.449	.925
NDF	69.98	70,15	67,80	2.093	.685
IVOMD	53.38	48,80	52,57	1.812	.212

SEM: standard error of means difference

forages that were collected during the rainy season. Meanwhile, our pasture samples were the composite samples that were collected bimonthly throughout the year. It seems that pasture samples during the dry season which lasts far longer than the rainy season cancel out the possible variation among different pasture locations.

4. CONCLUSION

Protein content and IVOMD are relatively high during the early rainy season but then decrease during the dry season. In contrast, the NDF content of forage in pasture increased from 64% at the start of the rainy season to 71-77% during the late rainy season and the dry season. Forage quality did not differ between location districts on pastures. The right strategy is needed under environmental conditions and grazing systems to be able to optimize ruminant production on the island of Timor.

ETHICAL APPROVAL

All authors hereby declare that "Principles of laboratory animal care" (NIH publication No. 85-23, revised 1985) were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee.

ACKNOWLEDGEMENTS

The authors wish to thank all individuals who provide technical support for this study as well as The Ministry of Higher Education for its financial support.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. DISNAK NTT. Animal Husbandry Statistics of East Nusa Tenggara Province. Kupang; 2017.
2. Habaora F, Fuah AM, Abdullah L, Priyanto R, Yani A, Purwanto BP. Importance-Performance Analysis toward productivity of Bali cattle based on agroecosystem in Timor Island. Journal of Animal and Veterinary Advances. 2020;19(5):57-66.
3. Riwukore JR, Purwanto BP, Yani A, Priyanto R, Abdullah L, Fuah AM, Habaora F. SWOT Analysis developing pasture agroecosystem of Bali cattle in Indonesia (Case study in Fatuana pasture of North Central Timor District). International Journal of Multidisciplinary Research and Publications. 2020;2(11):24-30.
4. Riwukore JR, Habaora F. Perception of farmers on the performance of extensionist in the pasture agroecosystem of Timor Tengah Utara District. Asian Journal of Agricultural Extension, Economics & Sociology. 2019;29(2):1-10.
5. PSPK. East Nusa Tenggara Province. Central Bureau of Statistics. Jakarta; 2011.
6. Cezimbra IM, de Albuquerque Nunes PA, de Souza Filho W, Tischler MR, Genro TCM, Bayer C, de Faccio Carvalho PC. Potential of grazing management to improve beef cattle production and mitigate methane emissions in native grasslands of the Pampa biome. Science of The Total Environment. 2021; 780:146582.
7. Zabel F, Putzenlechner B, Mauser W. Global agricultural land resources - a high resolution suitability evaluation and its perspectives until 2100 under climate change conditions. PLoS One. 2014;9: 1–12.
Available:https://doi.org/10.1371/journal.pone.0107522.
8. Se'u VE, Karti PDMH, Abdullah L. Botanical composition, grass production, and carrying capacity of pasture in Timor Tengah Selatan District. Media Peternakan. 2015;38(3):176-182.
9. Manu AE. Productivity of West Timor savanna grazing. J. Pastura. 2013;3:25-29.
10. Habaora F, Fuah AM, Abdullah L, Yani A, Purwanto BP. Botanical composition and carrying capacity in various agroecosystems on the Timor Island. Jurnal Ilmu Produksi dan Teknologi Hasil Peternakan. 2020;8(2):72-79.
11. Association of Official Analytical Chemists (AOAC) Official Methods of Analyses. 15th Edition AOAC, Washington D.C. 1990;1:62.
12. Van Soest PV, Robertson JB, Lewis B. A Methods for dietary fiber, neutral detergent fiber, and non starch polysaccharides in relation to animal nutrition. Journal of dairy science. 1991;74(10):3583-3597.
13. Tilley JMA, Terry DR. A two-stage technique for the in vitro digestion of forage crops. Grass and Forage Science. 1963;18(2):104-111.

14. IBM Corp. Released. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp; 2015.
15. Minson DJ. Forage in Ruminant Nutrition. Academic Press. London; 1990.
16. Mahyuddin P. Chemical composition of leaf and stem of tropical grasses at different stages of growth. Animal Production. 2007;9(3).
17. Lopez HA, Brum, Gracia, Ranilla M. Composition and in vitro digestibility of leaves and stems of grasses and legumes harvested from permanent mountain Meadows at different stages of maturity. Journal of Animal and Feed Sciences. 1999;8: 599 - 610.
18. Jelantik IGN, Mullik ML, Copland R, Leo-Penu C. Factors affecting the responses of Bali cattle calves to supplementation prior to weaning. Animal Production Science. 2010;50:493-496
19. Jelantik IGN, Mullik ML, Leo-Penu C, Jeremias J, Copland R. Improving calf survival and performance by supplementation in Bali cattle. Australian Journal of Experimental Agriculture. 2008;48(7):954-956.
20. Mullik ML, Jelantik IGN, Basuki T, de Rosari B. Restore NTT's glory as a national cattle warehouse. In: Syakir, E. P. M. and M. P. Yupdy (editors) Synergy of Policy and Technology Innovation towards Farmer Welfare. IAARD Press, Jakarta; 2018.
21. Li X. Plant cell wall chemistry: Implications for ruminant utilisation. Journal of Applied Animal Nutrition. 2021;9(1):31-56.
22. Akin DE. Structural characteristics limiting digestion of forage fiber. In Proceedings of the XIV International Grassland Congress, CRC Press. 2019; 511-514.
23. Dumont B, Farruggia A, Garel JP, Bachelard P, Boitier E, Frain M. How does grazing intensity influence the diversity of plants and insects in a species-rich upland grassland on basalt soils? Grass and Forage Science. 2009;64:92–105.
24. Crivellaro A, Büntgen U. New evidence of thermally constrained plant cell wall lignification. Trends in Plant Science. 2020; 25(4):322-324.
25. Zhong H, Zhou J, Abdelrahman M, Xu H, Wu Z, Cui L, Li X. The effect of lignin composition on ruminal fiber fractions degradation from different roughage sources in water buffalo (*Bubalus bubalis*). Agriculture. 2021;11(10):1015.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/101931