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Potential digestibility of tropical grasses for swamp buffalo *(Bubalus bubalis*) in Thailand

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ABSTRACT

We evaluated the suitability of six tropical grasses, Digitaria eriantha Steud, Paspalum atratum Swallen, Panicum maximum Jacq., Setaria sphacelata (Schumacher) Moss, Bracharia brizantha Stapf, and Chloris gayana Kunth, as feed for swamp buffalo (Bubalus bubalis) in Thailand. The grasses were cultivated in Okinawa, Japan, and their nutritional characteristics were evaluated by measuring chemical composition and in vitro digestibility. We also compared in vitro dry matter digestibility (IVDMD) results obtained using three different methods. Crude protein content was highest in B. brizantha (7.2%) and lowest in D. eriantha (5.4%). Averaged across all six grasses, the neutral and acid detergent fiber contents were 64.2% and 34.7%, respectively. The IVDMD measured by the buffalo rumen inocula method ranged from 64.2% for C. gayana to 71.4% for P. atratum. In comparison, the IVDMD measured using the cattle rumen inocula method ranged from 54.3% in C. gayana to 63.4% in P. atratum. Thus, the IVDMD of all experimental grasses was higher in buffalo (66.2%) than in dairy cattle (57.7%). The IVDMD of the experimental grasses by swamp buffalo could be estimated based on the high correlation (r=0.9847) with the value obtained using the dairy cattle rumen inocula method. Our results showed that all six grasses would be suitable as basal feedstuffs to supply crude protein and fiber for swamp buffalo.

Key words: Buffalo, Crude protein, Detergent fiber, Digestibility, Tropical grass

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INTRODUCTION

Asian buffalo can be divided into two subspecies; riverine (water) buffalo (*Bubalus arnee*) and swamp buffalo (*Bubalus bubalis*). Although these subspecies have different genetic traits, body size, horn shape, and skin color, both are useful domestic animals for paddy cultivation in small farms, and are important for milk and for meat production in Asia [1, 2]. The world buffalo population is approximately 198 million [3], and 97% of the buffalo population is reared in Asia. Thailand has approximately 1.52 million buffalo, which are reared extensively by small farmers, mainly in the northeast region. Although there have been some reports on the growth rate, milk and meat production, and reproduction of buffalo [4, 5], there is still a need to collect robust data on buffalo growth and production. Inadequate availability of feed and low utilization of quality feedstuffs have contributed to poor buffalo production. Poor economic conditions also affect the ability of farmers to buy fertilizers, produce high-quality silage, and produce grain on a commercial scale. It is thought that buffalo are better able to digest low-quality feeds than are cattle. In particular, the buffalo rumen is able to degrade crude protein and plant fibers [6]. The longer retention time of plant material in the buffalo rumen results in higher degradability and digestibility. In ruminants, rumen microbes can convert plant protein and fibrous components into proteins and volatile fatty acids, which are used for various biological activities.

A previous study on more than 1500 forage samples from different parts of the world showed that the mean dry matter digestibility coefficient of tropical grasses was 54%, 13% lower than that of temperate grasses [7, 8]. The digestibility and protein content of tropical grasses is affected by the growth stage, cutting frequency, and soil fertility (amount of nitrogen fertilizer applied). The mean dry matter digestibility of *Digitaria decumbens* Stent, *Chloris gayana* Kunth, and *Panicum maximum* Jacq. was determined to be 60.0%, 58.0%, and 57.0%, respectively [9]. Jetana [10] studied the potential benefits of natural feed resources for buffalo in Thailand, and found that pangola (*Digitaria* spp.) hay and Ruzi grass were suitable as basal feed for buffalo. Improving the nutrient supply from plant materials with low lignin contents and higher contents of protein and carbohydrates that are fermentable in the buffalo rumen will increase buffalo production.

The aim of this study was to evaluate the suitability of six tropical grasses as feed for swamp buffalo *(B. bubalis*) in Thailand. To evaluate their nutritional profiles, we measured chemical composition and *in vitro* dry matter digestibility (IVDMD) of the six grasses using the buffalo and cattle rumen inocula methods, as well as an enzymatic method.

MATERIALS AND METHODS

Preparation of plant samples and chemical analysis

Six tropical grasses, *Digitaria eriantha* Steud (cv. Tvansvarva), *Paspalum atratum* Swallen, *Panicum maximum* (cv. Ham. L), *Setaria sphacelata* (Schumacher) Moss (var. splendida cv. Splenda), *Bracharia brizantha* Stapf (cv. MG-5) and *Chloris gayana* (cv. Callide), were used in this experiment. All grasses were cultivated in an experimental field at the University of the Ryukyus, Okinawa, Japan, and cut at the first growing period. Fertilizer was applied according to a standardized formula used in the Ryukyu Islands, Okinawa. After harvesting, plant samples were dried to constant weight in an air-forced oven at 60°C. Then, each sample was ground through a 1-mm screen and stored in a plastic bottle at room temperature. Protein content in the samples was analyzed by the Kjeldahl method [11] and plant fiber was measured by the detergent fiber fractionation system [12].

Measurement of in vitro *dry matter digestibility*

The rumen contents of swamp buffalo were collected from four adult female buffaloes (average body weight, 505.2 kg). These animals were allowed to graze from 9:00 am to 3:00 pm in a native tropical grass field at Kasetsart University (Kamphaengsaen Campus, Thailand) and consumed 8.1 kg (on a dry matter basis) per day.

The rumen contents of dairy cattle were collected from two adult female Holstein cows at the Experimental Farm of the Tokyo University of Agriculture and Technology, Tokyo, Japan. The cows were fed roughage and concentrates (7:3, on an air-dry weight basis). Each rumen contents sample was filtered through double gauze and the rumen liquor was divided into aliquots to prepare the inocula. The IVDMD of all samples was measured using the two-stage technique described by Tilley and Terry [13]. Measurement of digestibility was also tested using an enzymatic pepsin-cellulase assay as described by Goto and Minson [14].

Statistical analysis

Data were subjected to analysis of variance to detect differences among means. Linear regressions between datasets were conducted using the correlation function as described by Yoshida [15].

RESULTS AND DISCUSSION

Chemical composition of experimental grasses

Table 1 shows the chemical composition of the six experimental grasses. The crude protein (CP) content was highest in *B. brizantha* (7.2%) and lowest in *D. eriantha* (5.4%). The neutral detergent fiber (NDF) content of *C. gayana* (68.0%) was slightly higher than that of *P. atratum* (59.0%). The acid detergent fiber (ADF) content ranged from 32.1% in *P. atratum* to 37.1% in *P. maximum*, but this difference was not statistically significant.

Table 1. Chemical composition of six experimental grasses (DM %)

Grass species	CP[1)]	NDF[2)]	ADF[3)]	HM[4)]
Digitaria eriantha	5.4	62.5	34.7	27.8
Paspalum atratum	6.7	59.0	32.1	26.9
Panicum maximum	6.2	65.5	37.1	28.4
Setaria sphacelata	6.0	65.2	35.1	30.1
Bracharia brizantha	7.2	65.2	34.5	30.7
Chloris gayana	5.7	68.0	34.5	33.5

1) Crude protein, 2) Neutral detergent fiber, 3) Acid detergent fiber
4) Hemicellulose (difference between NDF and ADF).

P. atratum is native to South America and Brazil, and the other five experimental grasses are native to Africa. All of the grasses are distributed in humid subtropical and tropical areas. The performance of livestock (cattle and sheep) grazing on grasses is affected by the leaf ratio, age (growth stage) and soil fertility (amount of nitrogen fertilizer applied) [16]. In general, the CP content of tropical grasses rapidly decreases after flowering and with increasing fiber contents in plant tissues. In our previous study [17], we compared the CP contents of *P. maximum* var. trichoglume and *C. gayana* cultivated in an experimental field in Kyushu, Japan, and found that the leaf CP content of *P. maximum* decreased from 13.4% at the pre-blooming stage to 7.9% at the blooming stage. In contrast, the CP content in the leaf and stem of *C. gayana* did not vary significantly between the pre-blooming (7.5% and 3.2%, respectively) and blooming (8.8% and 3.7%, respectively) stages.

In vitro dry matter digestibility of experimental grasses

The IVDMD determined using rumen inocula of buffalo ranged from 64.2% in *C. gayana* to 71.4% in *P. atratum*. The IVDMD measured by the cattle rumen inocula method ranged from 54.3% in *C. gayana* to 63.4% in *P. atratum*. Thus, the IVDMD of all experiment grasses was higher in buffalo (66.2%) than in dairy cattle (57.7%).

Table 2. *In vitro* dry matter digestibility (%) of six grasses measured by three different methods

Grass species	Buffalo rumen inocula method	Cattle rumen inocula method	Enzymatic method[1)]
Digitaria eriantha	64.8 ± 0.90^{b}	59.0 ± 0.90^{b}	52.2 ± 1.10^{a}
Paspalum atratum	71.4 ± 0.90^{a}	63.4 ± 0.90^{a}	58.4 ± 0.90^{b}
Panicum maximum	64.3 ± 0.90^{b}	57.1 ± 0.90^{b}	51.5 ± 1.10^{b}
Setaria sphacelata	65.6 ± 0.90^{b}	55.1 ± 0.90^{c}	54.3 ± 1.10^{b}
Bracharia brizantha	66.9 ± 0.90^{b}	57.3 ± 0.90^{b}	48.8 ± 1.10^{c}
Chloris gayana	64.2 ± 0.90^{b}	54.3 ± 0.90^{c}	48.3 ± 1.10^{c}

1) Pepsin-cellulase assay
2) Mean ± standard deviation. Within a row, different superscripts indicate significant difference ($P<0.05$).

Bartocci et al. [18] compared the rumen ecology of buffalo and cattle kept under similar conditions, and found that buffalo utilize feed more efficiently, with 2%–3% higher feed digestibility. Pirmohammadi et al. [19] studied the relationship between the NDF content and chewing behavior of buffalo, and showed that digestibility of ADF and NDF significantly decreased as the fiber content increased. In our experiment, all the grasses were harvested at similar cutting intervals (40 to 50 days) and fertilized with the same amount of nitrogen, phosphorus, and potassium ($N:P_2O_5:K_2O$=7:4:5). The physical structure and susceptibility of the plant parts to microbial breakdown were related to differences in i*n vitro* digestibility.

Table 3. Chemical component and digestible matter yields of six grasses (DM kg/ha)

Grass species	CP[1)]	NDF[2)]	ADF[3)]	Digestible matter[4)]
Digitaria eriantha	240.5^{a}	2767.4	1537.2	2870.7
Paspalum atratum	153.9^{b}	1363.0	742.0	1650.3
Panicum maximum	125.3^{b}	1320.7	748.7	1297.2
Setaria sphacelata	138.5^{b}	1497.8	805.3	1507.0
Bracharia brizantha	87.9^{c}	799.4	422.7	820.0
Chloris gayana	86.7^{c}	1032.6	524.0	975.3

1) *Crude protein, 2) Neutral detergent fiber, 3) Acid detergent fiber*
4) Estimated value from in vitro dry matte digestibility by buffalo.
a,b,c: Within a column, different superscript letters indicate significant difference ($p<0.05$).

Yield of nutritional components of experimental grasses

The chemical component and digestible dry matter yields were calculated based on buffalo digestibility (Table 3). The CP yield was highest in *D. eriantha* (240.5 kg) and lowest in *C. gayana* (86.7 kg). The CP yield in *B. brizantha* was similar to that of *C. gayana*, but its NDF yield was lower than those of the other grasses.

The digestible dry matter yield was highest in *D. eriantha* (2870.7 kg) and lowest in *B. brizantha* (820.0 kg). Jetana [10] concluded that pangola hay, which is produced from *Digitaria* spp., was suitable as a basal diet for buffalo.

Comparison of three methods to determine* in vitro *dry matter digestibility

The IVDMD results obtained using the *in vitro* cattle rumen inocula method were very strongly correlated with those obtained using the *in vitro* buffalo rumen inocula method (r=0.9847; Figure 1). The IVDMD results obtained using the enzymatic method were correlated with those obtained using the *in vitro* buffalo rumen inocula method (r=0.87399; Figure 2). However, there was a stronger correlation between the IVDMD obtained using the cattle rumen inocula method and the enzymatic method (r=0.9275; Figure 3).

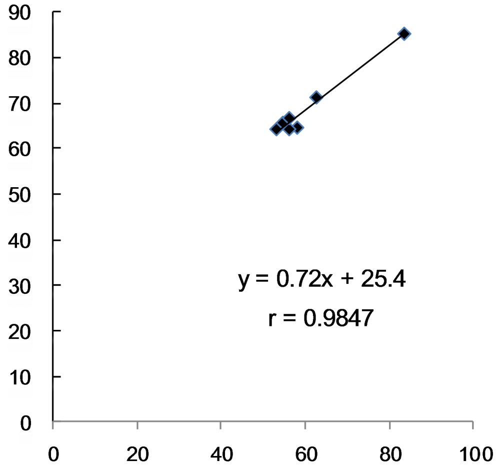

Figure 1. Relationship between *in vitro* dry matter digestibility (%) as found using cattle and buffalo rumen fluids.

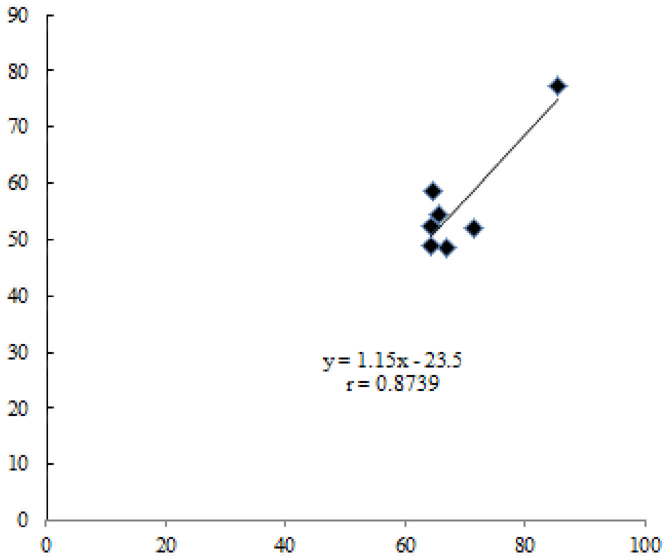

Figure 2. Relationship between *in vitro* dry matter digestibility (%) as found using buffalo rumen fluids and enzyme-cellulase

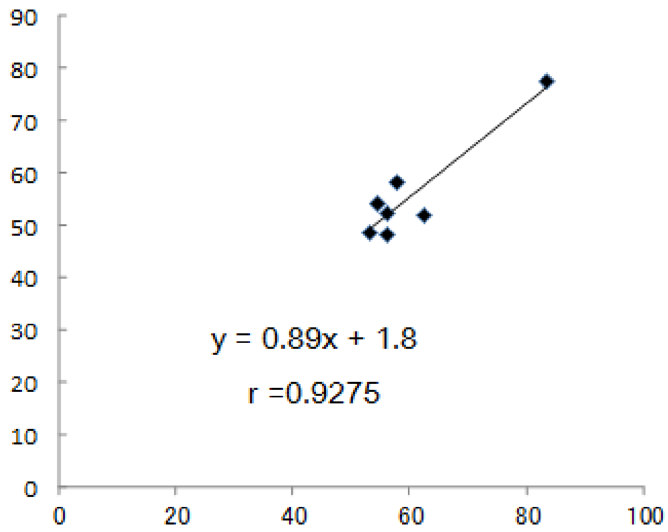

Figure 3. Relationship between *in vitro* dry matter digestibility (%) as found using cattle rumen fluids and enzyme-cellulase.

In this experiment, the IVDMD estimates were mainly based on the method described by Terry [13]. We found that the IVDMD for buffalo was strongly correlated with that estimated using the *in vitro* cattle rumen inocula method. These results showed that the *in vitro* method for measuring digestibility can be used to estimate the digestibility of grasses by buffalo.

CONCLUSION

We cultivated six tropical grasses (*D. eriantha*, *P. atratum*, *P. maximum*, *S. sphacelata*, *B. brizantha*, and *C. gayana*) in Okinawa, Japan, and measured their chemical composition and *in vitro* digestibility. Then, we evaluated their dietary suitability for rearing swamp buffalo in Thailand. The CP content was highest in *B. brizantha* (7.2%), and the NDF and ADF contents averaged across the six experimental grasses were 64.2% and 34.7%, respectively. The IVDMD of all experimental grasses was higher in buffalo (66.2%) than in dairy cattle (57.7%). We also found that IVDMD of experimental grasses by swamp buffalo could be estimated based on the high correlation (r=0.9847) with the value obtained using the *in vitro* cattle rumen inocula method. Therefore, our results show that all of these grasses are suitable as basal feedstuffs for swamp buffalo to supply crude protein and fiber to the diet.

Although these results could be used to devise a feeding program for buffalo, further research is required to determine the persistence of each grass in Thai soil, their palatability to buffalo, and their *in vivo* digestibility. Furthermore, it would be interesting to compare our laboratory-scale results with those collected on a larger (e.g., farm) scale.

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REFERENCES

[1] Sarwar M, Khan MA, Nisa M, Bhatti SA, Shahzad MA, *Asian-Aust. J. Anim. Sci.*, **2009**, 22, 1060.
[2] Wanapat M, Wachirapakorn C, *Asian-Aust. J. Anim. Sci.*, **2000**, 3, 195.
[3] FAOSTAT, *Food and Agriculture Organization of the United Nations*, **2012**, http://faostat.fao.org.
[4] Sahoo A, Elangovan AV, Mehra UR, Singh UB, *Asian-Aust. J. Anim. Sci.*, **2004**, 17, 621.

[5] Wynn PC, Warriach HM, Morgan A, McGill DM, Hanif S, Sarwar M, Iqbal A, Sheehy PA, Bush RD, *Asian-Aust. J. Anim. Sci.*, **2009**, 22, 756.
[6] Agarwal N, Kamra DN, Chatterjee PN, Kumar R, Chaudhary LC, *Asian-Aust. J. Anim. Sci.*, **2008**, 21, 818.
[7] Minson DJ, Forage in ruminat nutrition, AcademicPress, Inc., California, **1990**.
[8] Minson DJ, Wilson JR, *J. Aust. Inst. Agric. Sci*., **1980**, 46, 247.
[9] Minson DJ, McLeod MN, *Tropical pastures technical paper*, Commonwealth Scientific Industrial Res. Organ. **1972**, No. 8, p. 1.
[10] Jetana T, Bintbihok A, *Buffalo Bulletin*, **2013**, 32, 942.
[11] Association of Official Analytical Chemist (AOAC), *Official Methods of Analysis*, 12th edn. Association of Official Analytical Chemist, Arlington, Verginia. **1985**.
[12] Goering HK, Van Soest PJ, *Agriculture Handbook* (USDA), No. 379, **1970**.
[13] Tilley JMA, Terry RA, *Journal of British Grassland Society*, **1963**, 18, 104.
[14] Goto I, Minson DJ, *Anim. Feed Sci. Technol*., **1977**, 2, 247.
[15] Yoshida M, *Design of experiments for animal husbandry*, Youkendo, Tokyo, **1980**.
[16] Bogdan AN, *Tropical pasture and fodder plants (Grass and legumes)*, Longman, London, **1977**.
[17] N. Tokita, H. Akiyama, S. Kawamura, M. Konta, M. Shimoji, Y. Masuda, *Nihon Chikusan Gakkaiho*, **2004**, 75, 193.
[18] Bartocci S, Amici A, Verna M, Terramoccia S, Martillotti F, Livest. *Prod. Sci*., **1977**, 52, 201.
[19] Pirmohammadi R, Teimouri AY, Afshar BH, Manafiazai GH, *Ital. J. Anim. Sci*., **2007**, 6, 476.