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Nutrient Intake, Feed Digestibility, and Growth Performance of Thin-Tailed Sheep Fed Complete Feed Containing Fermented Sargassum sp.

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ABSTRACT

The aim of this research was to identify the effect of feeding fermented Sargassum sp. as complete feed ingredient up to 20% of total feed on nutrient consumption and digestibility, and growth performance of thin-tailed sheep. Twelve female thin-tailed sheep aged 6 to 8 months with an average initial body weight of 14.13 ± 2.08 kg were divided into three groups. The treatments were control without fermented Sargassum sp. (S0), 10% fermented Sargassum sp. (S1), and 20% fermented Sargassum sp. (S2). Complete feed was formulated by isoprotein and isoenergy formulation, containing 16% of crude protein and 61% of total digestible nutrients. Complete feed was given at 3.5% of body weight (% dry matter) and drinking water was provided ad libitum. This research was done in 6 weeks with 14 days adaptation period and seven days of collection period. Growth performance was measured for 4 weeks after the adaptation period. The variables observed were dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), crude fiber (CF), nitrogen-free extract (NFE), and total digestible nutrients (TDN) consumption. The data obtained were subjected to one-way ANOVA (analysis of variance) and the difference existed (P value <0.05) between means were analyzed with Duncan's multiple range test. The results showed that there was no significant effect of feeding fermented Sargassum sp. on nutrient intake, and digestibility of nutrients (P>0.05), however, S0 treatment appeared to have CP, CF, and EE intake, as well as digestibility of DM, CP, CF, and NFE higher than S1 and S2 treatment. The results showed that there was no significant effect of feeding fermented Sargassum sp. on nutrient intake, digested and digestibility of nutrient, absolute and relative weight gain as well as feed conversion.

Keywords: Consumption, Digestibility, Performance, Sargassum sp., Thin-tailed sheep

Introduction

Complete feed contains adequate nutrients required at certain physiological stage. Complete feed is formulated and given as a sole feed to supply nutrients for maintenance and production purpose, without any other feed other than water (Hartadi *et al.*, 2017). Processing feedstuffs into complete feed can improve feed palatability and meet daily nutrient requirement (Ginting, 2009). Ruminant complete feed composed of high fiber-containing feedstuffs, energy source, protein source, vitamins, and minerals (Utomo, 2012).

Energy source can be supplied from agriculture and plantation products, agricultural by-product, and other sources such as aquatic resources. One of marine resources that has not been extensively used as animal feed is brown macroalgae of *Sargassum* genus. *Sargassum sp.* can be found in either tropical or subtropical area, mainly in Pacific, Indian, and Atlantic Oceans (Kasanah *et al.*, 2017). Sargassum sp. has not been widely used considering its lower economic value compared to green and red algae.

Sargassum sp. is a source of carbohydrate, mineral, protein, essential amino acids, beta-carotene, and vitamins (Kumar *et al.*, 2015). The use of *Sargassum sp*. as energy-supplying feed has limitation, thus, requiring additional processing. One of the limitations is its high content of salt. That particular limitation can cause diarrhea and growth abnormality (Dewi *et al.*, 2018).

Another limiting factor should be considered is the high-water content of Sargassum sp. (80-90%), which shorten its storage period. One of means to prolong the storage period is by reducing the water content up to <15% through drying process, then process it further by drying. The storing procedure for Sargassum sp. must be done in enclosed container to avoid it from captivating water from air (McHugh, 2003). Dried Sargassum sp., especially the grounded one, generally has fishy and strong odor. When used as feed for ruminant whose large number of taste bud, those feedstuffs with strong odor are suggested not to be mixed directly into the formulated diet bearing on its palatability reduction effect (Pramono *et al.*, 2013). Low palatability can compromise feed consumption, even further lose appetite of the animal.

Another concern is once the water content dried algae increase to >25% level, the algae can be easily contaminated by fungi (Sieburth and Jensen, 1967). One way to avoid that issue is by fermentation which breaks complex molecules into smaller molecules, as well as alters color, odor, flavor, and texture; reduces antinutrient content and improves palatability (Christi *et al.*, 2018); and prolongs storing period owing to lactic acid formation (Utomo, 2015). Fermentation using EM4® for 7 days increases nutrient availability of Sargassum sp. (Alamsjah and Subangkit, 2013). This study aimed to study the consumption, nutrient digestibility, and growth of thin-tailed sheep fed with complete fed containing fermented Sargassum sp.

Materials and Methods

Time and place of experiment

The study was performed at Sinatria Farm Harjobinangun, Pakem, Sleman, Daerah Istimewa Yogyakarta. Proximate analysis was carried out at Laboratory of Feed Technology Faculty of Animal Science Universitas Gadjah Mada Yogyakarta.

Fermented *Sargassum* sp. preparation

Sargassum sp. used on this study was obtained from Drini Beach, Gunungkidul, Special Region of Yogyakarta. The algae were collected during recede period. Algae were washed three times using running water to reduce the salt content. Drying lasted three times until <10% of water content was achieved. Dried algae were ground using disc mill type FFC 15 with 6 mm filter. An anaerobic fermentation were maintained for 7 days by adding 10% (wt/wt) of molases which mixed with water to increase the water content up to 65% and SBP® microbes starter.

Experimental design and diets

The study was conducted for 6 weeks long in total, with 14 days of adaptation period and 7 days of collection period. The measurement of growth performance was carried out 4 weeks after adaptation period. The study was performed in one-way completely randomized design with 3 treatments groups and 4 replications. Twelve female thin-tailed sheep (6- 8 months old) with initial weight of 14.13 ± 2.08 kg were used for this study. Each animal was housed individually in a metabolic crate and fed with complete feed as much as 3.5% (DM basis) per body weight. Control group was fed without fermented *Sargassum sp*. (S0), while treatment group were given feed with fermented *Sargassum sp*. as many as 10% (S1) or 20% (S2) of body weight. The complete feed was formulated to be isoprotein and isoenergy with 16% of CP and 61% of TDN. Feeding was scheduled at 8 am and 4 pm. Body weight measurement was performed once in 7 days. The diet formulation is provided on Table 1. and chemical composition of feedstuffs is shown on Table 2.

Feed and fecal sample collection and preparation

The collection period was performed for 7 days at the end of study period. Feed sampling (new and remaining) was done each morning before feeding. One hundred gram of feed sample and 200 gram of fecal sample were collected daily. All samples were sun-dried for 3 days. Dried samples were ground and compositely sampled for proximate analysis that include the measurement of dry mattery (DM), organic matters (OM), crude protein (CP), extract ether.

Table 1. Ingredient and chemical composition of experimental diets (%DM)

Parameters	Treatments		
	S0	S1	S2
Feedstuffs:			
Dried water spinach	46.00	43.55	40.00
Wheat bran	37.00	31.00	26.50
Milled corn	10.00	8.60	6.60
Soybean meal	5.50	6.30	6.80
Mineral mix	1.00	0.55	0.10
Salt	0.50	-	-
Fermented *Sargassum* sp.	-	10.00	20.00
Total	100	100	100
Nutrient (%):			
Dry matter	88.10	83.56	79.00
Organic matter	88.62	88.13	87.28
Crude protein	16.27	16.28	16.29
Ether extract	5.04	4.67	4.28
Crude fiber	12.53	12.85	13.01
Nitrogen-free extract[a]	54.78	54.33	53.70
Total digestible nutrients[b]	61.11	61.35	61.61

[a]: the results of the formula of Hartadi *et al.* (2017)
[b]: the results of the formula of Harris *et al.* (1970) *cit.* Utomo (2012)
S0: complete feed without fermented *Sargassum* sp.; S1: complete feed with 10% fermented *Sargassum* sp.; S2: complete feed with 20% fermented *Sargassum* sp.

Table 2. Chemical composition of feedstuffs (%DM)

Feedstuffs	DM	OM	CP	EE	CF	NFE	TDN
Dried water spinach	87.47	84.72	9.54	4.67	20.80	49.71	41.46
Wheat bran	88.17	94.61	21.74	5.21	6.44	61.22	79.77
Milled corn	88.20	96.28	10.41	8.20	2.31	75.36	82.70
Soybean meal	90.03	91.14	50.82	2.57	6.37	31.38	77.38
Mineral mix	97.65	-	-	-	-	-	-
Salt	97.74	-	-	-	-	-	-
Fermented *Sargassum* sp.	43.41	78.83	12.86	1.57	11.97	52.44	65.82

Statistical analysis

Data were subjected to one-way analysis of variance (ANOVA) followed by Duncan's Multiple Range Test (Petrie and Watson, 2013).

Results and Discussion

Nutrient intake

Nutrient consumption of thin-tailed sheep during study period is provided on Table 3a. There was no significant difference of nutrient consumption among groups (P value >0.05) as expected as the diet was formulated to be isoenergy and isoprotein. Consumption of CP, CF and EE per metabolic body weight of thin-tailed sheep on S1 and S2 groups were lower to S0 (P value <0.05). It can be a result of their slightly different body weight during collection period.

The average of daily DM consumption was 547.21 to 573.73 g/head/d, while for CP was 73.55 to 81.77 g/head/d. Sheep with 15 kg of body weight and 100 gram of ADG target requires 490 gram of DM and 80.4 gram of CP (Ranjhan, 1981). The DM consumption of all three groups in this study have met the requirement, yet their CP consumption are lower than the recommendation. Several factors affecting DM consumption include fiber content, particle size, particle conformity, fat content, and ability of animal in digesting protein (Allen, 2000). DM intake is crucial for maintenance and growth (Utomo and Pertiwi, 2010).

Digestible nutrient

The average values of digestible nutrient were not affected by treatments (P value >0.05) (Table 3b). However, digestible CP and EE values per metabolic body weight of S1 and S2 groups were lower than control (P value <0.05). The finding is in accordance with lower consumption of CP and EE consumption per metabolic body weight. Tillman *et al.* (1998), nutrient digestibility is influenced by feed composition, processing, other factors arising from the animal, and the amount of feed intake.

The percentage of digestible DM, CP, CF, NFE of treatments groups significantly differ from control group (P value <0.05). Fermented *Sargassum sp*. contains relatively high-water content (56.59%), thus, can reduce the DM content of complete feed. The percentage of digestible nutrient can be obtained by multiplying nutrient digestibility coefficient by nutrient content of feed (Utomo, 2012). The CP content of *Sargassum* is categorized into less degradable class in rumen digestion, leading to the low digestible protein value (Gojon-Báez *et al*., 1998). According to TDN calculation of three groups in this study, there was no significant different among those three groups in respect to their corresponding TDN value.

Nutrient digestibility

The average of nutrient digestibility can be seen on Table 4. The average of nutrient digestibility had no significant different among groups (P value >0.05), except for CP digestibility (P value <0.05). The finding is in accordance with CP consumption (based on g/BW$^{0.75}$/day) and digestible CP (based on g/BW$^{0.75}$/day and %) of S1 and S2 groups which were lower than S0 group. The study found that CP digestibility were ranging from 60.62% to 71.16%. That result was lower than Marín *et al.* (2009) finding, who reported the protein digestibility coefficient of sheep fed with fermented *Sargassum sp*. in multiple levels, i.e. 10, 20, and, 30% are 80, 86, and 85%, respectively. The florotanin of Sargassum is hypothesized causing low protein digestibility coefficient. Wang *et al.* (2008) reported that florotanin can only be found

Table 3a. Nutrient intake of thin-tailed sheep fed complete feed containing fermented *Sargassum* sp.

Variable measured	Treatments		
	S0	S1	S2
Nutrient Intake (g/head/d)			
Dry matter[ns]	564.98 ± 82.52	573.73 ± 85.31	547.21 ± 98.31
Organic matter[ns]	512.71 ± 74.87	525.35 ± 77.87	495.67 ± 89.05
Crude protein[ns]	81.77 ± 11.92	76.47 ± 11.07	73.55 ± 13.21
Ether extract[ns]	24.55 ± 3.58	22.32 ± 3.30	19.60 ± 3.52
Crude fiber[ns]	128.48 ± 18.76	119.86 ± 17.94	117.38 ± 21.08
NFE[ns]	277.97 ± 40.60	306.95 ± 45.33	285.21 ± 51.24
Nutrient intake (g/W$^{0.75}$/d)			
Dry matter[ns]	67.91 ± 2.45	65.78 ± 3.32	65.68 ± 3.04
Organic matter[ns]	61.63 ± 2.22	60.23 ± 3.00	59.49 ± 2.76
Crude protein	9.83 ± 0.35^{a}	8.77 ± 0.40^{b}	8.83 ± 0.41^{b}
Ether extract	2.95 ± 0.11^{a}	2.56 ± 0.13^{b}	2.35 ± 0.11^{c}
Crude fiber	15.44 ± 0.56^{a}	13.74 ± 0.71^{b}	14.09 ± 0.65^{b}
NFE[ns]	33.41 ± 1.21	35.19 ± 1.73	34.23 ± 1.57

[a,b] means with different superscript within the same row are significantly different (P<0.05)
[ns] not significantly different

Table 3b. Digested nutrient of thin-tailed sheep fed complete feed containing fermented *Sargassum* sp.

Variable measured	Treatments		
	S0	S1	S2
Digested Nutrient (g/head/d)			
Dry matter^{ns}	367.63 ± 67.34	369.19 ± 72.23	336.19 ± 62.73
Organic matter^{ns}	339.42 ± 60.35	346.65 ± 67.08	311.92 ± 56.50
Crude protein^{ns}	55.91 ± 10.16	49.24 ± 9.64	44.87 ± 9.09
Ether extract^{ns}	19.07 ± 3.85	16.72 ± 4.00	14.69 ± 1.77
Crude fiber^{ns}	72.90 ± 13.97	60.60 ± 16.44	59.29 ± 11.48
NFE^{ns}	191.60 ± 32.90	219.83 ± 38.17	193.78 ± 32.43
Digested Nutrient (g/W$^{0.75}$/d)			
Dry matter^{ns}	44.14 ± 4.32	42.18 ± 4.26	40.45 ± 3.50
Organic matter^{ns}	40.77 ± 3.75	39.62 ± 3.92	37.54 ± 2.30
Crude protein	6.71 ± 0.60^{a}	5.62 ± 0.57^{b}	5.40 ± 0.54^{b}
Ether extract	2.28 ± 0.25^{a}	1.90 ± 0.28^{ab}	1.79 ± 0.24^{b}
Crude fiber^{ns}	8.76 ± 1.07	6.89 ± 1.28	7.16 ± 0.98
NFE^{ns}	23.02 ± 1.93	25.16 ± 1.92	23.33 ± 1.27
Digested Nutrient (%)			
Dry matter	55.03 ± 4.50^{a}	48.71 ± 3.11^{b}	44.01 ± 3.91^{b}
Organic matter^{ns}	61.00 ± 4.36	61.55 ± 3.92	58.54 ± 4.65
Crude protein	10.29 ± 0.63^{a}	8.49 ± 0.57^{b}	8.15 ± 0.90^{b}
Ether extract^{ns}	3.67 ± 0.37	3.13 ± 0.40	2.93 ± 0.72
Crude fiber	10.67 ± 1.87^{a}	6.38 ± 2.78^{b}	7.87 ± 2.68^{ab}
NFE	35.58 ± 2.04^{a}	41.31 ± 1.15^{b}	38.38 ± 1.79^{c}
TDN^{ns}	64.70 ± 4.57	63.21 ± 5.07	60.99 ± 4.78

^{a,b} means with different superscript within the same row are significantly different (P<0.05)
^{ns} not significantly different

Table 4. Nutrient digestibility of thin-tailed sheep fed with complete feed containing fermented *Sargassum* sp.

Variable measured	Treatments		
	S0	S1	S2
Nutrient Digestibility (%)			
Dry matter^{ns}	64.97 ± 5.31	64.04 ± 4.09	61.66 ± 5.49
Organic matter^{ns}	67.22 ± 4.80	67.24 ± 4.29	64.63 ± 5.13
Crude protein	71.16 ± 4.36^{a}	63.89 ± 4.31^{ab}	60.62 ± 6.67^{b}
Ether extract^{ns}	84.57 ± 8.46	80.60 ± 10.30	81.86 ± 20.19
Crude fiber^{ns}	46.47 ± 8.21	30.50 ± 13.31	36.69 ± 12.51
NFE^{ns}	72.31 ± 4.15	77.31 ± 2.15	73.63 ± 3.42

^{a,b} means with different superscript within the same row are significantly different (P<0.05)
^{ns} not significantly different

on brown seaweed. Stern *et al.* (1996), the content of florotanin on *Sargassum sp*. is closely associated with protein, hence, compromised protein digestion along digestive tract seen.

Weight gain and feed conversion

Absolute value of average daily gain (ADG) is assessed to evaluate the rate of animal growth based daily gain. Relative ADG value is calculated to evaluate the percentage of growth efficiency according to initial body weight (Elieser, 2012). The average of absolute and relative daily body weight gain, as well as feed conversion can be seen on Table 5. The treatments in this study did not cause significant different (P value >0.05) on both absolute and relative daily body weight gain, and feed conversion. Local sheep fed with 11% isoprotein and 70% isoenergy diet did not show differences on absolute ADG (Wulandari *et al.*, 2014). Although digestible CP value of treatment groups is significantly different (P value <0.05) compared to control group, other nutrients digestibility (DM and OM) are not significantly different (P value >0.05), thus the growth of the sheep are not different. The result is in accordance with El-Waziry *et al.* (2015) report in which daily weight gain of sheep fed with green seaweed *Ulva lactuca* are not significantly different compared to control. Body weight gain can be influenced by DM and CP consumption, as well as protein digestibility and metabolism (Mayulu and Suhardi, 2016).

Feed conversion was not also affected by treatments (P value >0.05). The average feed conversion value of S0, S1, and S2 groups are 6.98, 6.96, and 7.57 respectively. The feed conversion value in this study are higher than El-Waziry *et al.* (2015) who used green seaweed (Ulva lactuta) at level of 0, 3, and 5% (4.97, 5.65, and 5.43, respectively). Tadesse *et al.* (2016) reported that feed conversion ratio is a comparison of DM consumption to body weight gain. The average feed conversion in this study is categorized into fair category according to Gatenby (1986), the average of feed conversion ratio

Table 5. Performance and FCR of thin-tailed sheep fed with complete feed containing fermented *Sargassum* sp.

Parameter^{ns}	Treatments		
	K	S1	S2
Initial body weight (kg)	14.15 ± 2.20	14.20 ± 2.15	14.06 ± 2.52
Final body weight (kg)	17.54 ± 2.53	18.30 ± 2.15	17.37 ± 3.16
Absolute weight gain (g/head/d)	85.45 ± 21.94	85.00 ± 16.79	72.50 ± 17.74
Relative weight gain (%)	0.58 ± 0.18	0.55 ± 0.14	0.45 ± 0.79
Feed conversion ratio	6.98 ± 2.16	6.96 ± 1.72	7.57 ± 0.30

^{ns} not significantly different

in tropical area ranges from 7 to 15. Smaller feed conversion ratio indicates efficient nutrient utilization by the animal (Tillman *et al.*, 1998).

Conclusions

The treatments did not affect nutrient intake, digestible nutrient, and nutrient digestibility, absolute and relative weight gain as well as feed conversion in thin-tailed sheep fed complete feed containing fermented *Sargassum* sp. up to 20%.

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