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Utilization of *Sargassum* sp. to Improve Blood Plasma Minerals for Thin Tailed Weaning Ram

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ABSTRACT

The study aimed to determine the level of sun-drying *Sargassum* sp. seaweed as a mineral source in blood plasma of male thin-tailed sheep after weaning. The *Sargassum* sp. powder with sun-drying was fed for 3 months on 16 weaned thin-tailed rams, aged 5-6 months with average of initial body around 11.8 kg, using a 4x4 completely randomized design (CRD) with four treatments consisting of T1 = forage + concentrate + 0% minerals of concentrate, T2 = forage + concentrate + 0.38% cow booster minerals of concentrate, T3 = forage + concentrate + 5% *Sargassum* sp. of concentrate, T4 = forage + concentrate + 10% *Sargassum* sp. of concentrate. The observed research variables were feed intake dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), crude fiber (CF), nitrogen free extract (NFE), and total digestible nutrient (TDN), average daily gain (ADG), intake of macro minerals (Ca, Mg, K, and Na), intake of micro minerals (Cu, Fe, and Zn), the balance of macro minerals and micro minerals blood plasma before and after treatment with *Sargassum* sp. The results showed that the treatment did not effect on feed intake, but ADG had a significant effect ($p<0.05$) on mineral Ca intake, Mg, K, Na, Cu, Fe, and Zn. Blood plasma minerals before treatment did not differ on Mg, Na, Cu, Fe, Zn, but had a significant effect ($p<0.05$) on Ca and K. The treatment had a significant effect ($p<0.05$) on minerals Mg, Cu, and Fe in blood plasma, but did not effect on Ca, K, Na, and Zn. Based on the results, the use of 10% *Sargassum* sp. with sun-drying method on the concentrate method can increase the intake of macro and micro minerals as well as increase Mg, Cu, and Fe in the blood plasma of weaning rams.

Keywords: Seaweed, *Sargassum* sp, Thin-tailed sheep, Macro and micro minerals

Introduction

The mineral is one of the nutrients that are necessary for sheep in the growth phase of hyperplasia and hypertrophy. Shumye (2021) states that hyperplasia is a growth process by multiplying cells and bone growth that occurs early in life from the embryo to the adult body, while hypertrophy is growth after the body matures. Minerals function as enzymatic cofactors, structurally or functionally play a role in increasing the activity of enzymes, hormones, and vitamins (Costa *et al.,* 2021). Livestock growth requires complex nutrients other than minerals, specifically carbohydrates, protein, vitamins, and water, as well as hormones, genotypes, and the environment, where these components affect growth from the beginning, pre-weaning to post-weaning (Owens *et al.,* 2014). Sheep after weaning are classified as a growth phase, in dire need of macro and micro minerals to multiply cells and bone growth (Costa *et al*., 2021). Lack of minerals in the growth phase causes abnormal growth, for example calcium deficiency. Calcium provides a strong framework to support muscles and protect delicate organs and tissues, including bone marrow, but is also jointed to allow movement, and malleable to allow growth (Suttle, 2010).

Mineral sources for sheep or livestock generally come from feed plants that live on land, but the highest mineral source is food or feed that comes from the sea. Seaweed contains 10 to 20 times more minerals than plants on land (Kumar *et al.,* 2015). There are three types of seaweed, namely red seaweed, green seaweed, and blue seaweed (Van denHoek and Bayoumi, 2018) The highest mineral content is brown seaweed ranging from 14-35% DM (Makkar *et al.,* 2016) *Sargassum* sp. is a species of brown seaweed. Paga *et al.* (2021) reported that the sun-drying method, 55ºC oven and freeze dryer-20ºC affected the mineral content of calcium and magnesium, *Sargassum* sp. with sun-drying, has calcium, and magnesium content is higher than oven drying and freeze dryer.

Magnesium sun-drying 13.20 g/kg DM, oven drying 10.89 g/kg DM, and freeze-drying 11.10 g/kg DM.

The use of seaweed for sheep has previously been carried out by several researchers. Ktita *et al.* (2019) in Tunisia reported the use of green seaweed (*Ruppia maritima* and *Chaetomorpha linum*) as much as 20% as a substitute for barley concentrates in 5-month-old sheep with a bodyweight of 21.1±2.7 kg, there was a decrease in dry matter intake of *Ruppia maritima* by 79 g/d and *Chaetomorpha linum* as much as 75 g/d and digestibility of dry matter, organic matter, and crude protein of *Ruppia maritima* of 3.5; 3.3; and 4.5% and *Chaetomorpha linum* 3.7; 2.5; and 5.4%. El-Waziry *et al.* (2015) reported that the use of green seaweed (*Ulva latuca*) as a substitute for 3% and 5% alfalfa hay in young rams weighing 22.78±0.24 kg on growth performance could increase feed conversion by 0.63 for 3% substitution and 0.46 for the 5% substitution and the low daily body weight gain was 2.17 kg for the 3% substitution and 1.50 kg for the 5% substitution. Muwel *et al.* (2018) in India reported that the use of brown seaweed as mineral supplementation in goats resulted in a decrease in methane gas production and an increase in crude protein digestibility, while Singh *et al.* (2017) in India reported that the use of brown seaweed (*Sargassum wightii*) 20% as a substitute for pollard and mustard cake in lactating cows resulted in an increase in calcium intake and a decrease in phosphorus intake. Research on *Sargassum* sp. seaweed as mineral supplementation in weaned thin-tailed rams has not been conducted elsewhere. Based on this description, exploratory research on utilization has been carried out to study the blood plasma minerals of weaned thin-tailed rams before the administration of *Sargassum* sp. as a source of minerals.

Materials and Methods

Location

This research was conducted in teaching farm of the Faculty of Animal Science and the Integrated Research and Testing Laboratory, Gadjah Mada University, Yogyakarta Indonesia.

Design and treatment

Sixteen weaned thin-tailed rams were used with an average weight of initial around around 11.8 kg. This study used a 4x4 completely randomized design. Four treatments were given, consisting of T1 = forage + concentrate + 0% minerals from concentrate; T2 = forage + concentrate + 0.38% mineral booster cow of concentrate, T3 = forage + concentrate + 5% *Sargassum* sp. of concentrate, T4 = forage + concentrate + 10% *Sargassum* sp. of concentrate. Feed composition and nutrient composition are presented in Table 1.

Feed and management

Feed in the form of a total mixed ration (TMR) was given to the sheep twice a day, at 8 am, and 4 pm (Adiwinarta *et al.,* 2018). The experiment lasted for 114 d. The sheep adaptation period to the new feed was 14 d and the next 90 d were the treatment period. The sheep blood collection was done at the beginning of entering the pen before treatment to find out how much mineral content in the blood and on the day 90th of the treatment period. Blood was collected from the jugular vein in the neck using a 10 mL vacuum venoject tube containing anticoagulant ethyl diamine tetraacetic acid (EDTA) (Ziehank *et al.,* 2008; Pal *et al*., 2010). The blood was centrifuged at 3000 rpm for ± 30 min, to separate serum from plasma. The plasma that has been formed was aspirated using a dropper and then placed in a test tube,which then marked and stored in a cool box that has been added with ice cubes to be taken to the Gadjah Mada University Integrated Research and Testing Laboratory for analysis of plasma minerals. Laboratory analyses using the Atomic Absorbance Spectrophotometer (AAS) (Ziehank *et al.,* 2008). Blood was also analyzed using the AAS (Ziehank *et al.,* 2008).

Chemical composition analyses

Standard methods The Association of Official Analytical Chemists was (AOAC, 1984). Used to determine moisture, crude protein, fat, total ash and crude fiber content of each sample. The moisture content was determined by heating 2.0 g into the crucible as the standard weight of each fresh sample placed in an oven maintained at 105^{o}C. dry A thing was used to define another parameter. Crude protein (% total nitrogen x 6.25) was determined by the Kjeldahl method using 2.0 g samples; crude fat was thoroughly obtained extracting 5.0 g of each sample using a Soxhlet apparatus using petroleum ether (boiling point range 40-60°C) as extractive Ashes were determined by burning. The 10.0 g samples placed in the muffle furnace are saved at 550°C for 5 h. Crude fibre was obtained by digesting 2.0 g of sample with H_2SO_4 and NaOH and incinerating the residue in a muffle furnace maintained at 550°C for 5 h. Moisture content was determined by heating 2.0 g of each sample to a constant weight in a crucible placed in an oven maintained at 105°C. Every analysis was done in threes.

Mineral analyses

Samples were dissolved in 1 M NHO_3 and H_2O_2 (Milestone, Ethos 1, Italy) using microwaves before digestion to remove macrominerals (calcium, magnesium, potassium, sodium, phosphorus) and trace minerals (iron, copper). zinc, cobalt and manganese). Concentrations of inorganic elements in dried algae samples were determined using an atomic absorption spectrophotometer (FS95, Thermo, England) equipped with a hollow cathode lamp, following the method described in MOOPAM (1989) and (Ruperez, 2002). I did seaweed mineral concentration was calculated from the calibration curve of each standard element.

Table 1. Feed and nutrient composition

Feed ingredients (%) (as *fed*)	Treatment[1]			
	T1	T2	T3	T4
P. purpureum cv. mott	38.09	38.09	38.09	38.09
pollard	23.81	23.81	23.81	23.81
pile	9.52	9.52	9.52	9.52
Oil palm meal	14.29	14.29	14.29	14.29
Soybean meal	14.29	14.29	14.29	14.29
Cow mineral booster	0	0.38	0	0
Sargassum sp.	0	0	1.14	2.28
Total	100	100.38	101.14	102.28
Nutritional compositions[2]				
DM (%)	86.66	91.36	86.59	86.42
OM (%)	87.88	82.90	84.13	83.09
Ash (%)	12.12	17.1	15.87	16.91
CP (%)	16.73	15.52	16.73	16.41
EE (%)	1.15	1.19	1.99	1.78
CF (%)	21.15	17.96	18.92	17.94
NFE (%)	48.85	48.23	46.49	46.96
TDN (%)	64.27	61.91	60.09	60.46
Ca (mg/kg)	1354.76	7262.66	4672.14	2612.01
Mg (mg/kg)	2882.47	4435.64	3744.66	4297.14
K (%)	1.13	0.92	1.30	1.51
Na (mg/kg)	909.06	2154.40	2099.18	3314.62
Cu (mg/kg)	3.92	4.08	3.37	5.15
Fe (mg/kg)	249.91	389.90	295.34	287.70
Zn (mg/kg)	43.17	48.67	40.98	38.36

[1]T1: forage + concentrate + 0% minerals of concentrate; T2: forage + concentrate + 0.38% cow booster minerals of concentrate; T3: forage + concentrate + 5% *Sargassum* sp. of concentrate; T4: forage + concentrate + 10% *Sargassum* sp. of concentrate.

[2]DM: dry matter; OM: organic matter; CP: crude protein; EE: ether extract; CF: crude fiber; NFE: nitrogen free extract; TDN: total digestible nutrient; Ca: calcium; Mg: magnesium; K: potassium; Na: sodium; Cu: *cuprum;* Fe: iron; Zn: zinc.

Statistical analysis

The data obtained were analyzed by one-way analysis of variance using Windows IBM SPSS 23.0 (IBM Corporation, New York, USA), and significance was set at p<0.05. Differences between treatment means were analyzed using Duncan's multiple range test (Steel *et al.,* 1997).

Results and Discussion

Feed intake

Average feed intake and ADGADG treated with *Sargassum* sp. in weaning *male thin-tailed sheep* are presented in Table 2. Feed intake of dry matter, crude protein, organic matter, ether extract, nitrogen-free extract, and total digestible nutrients showed no significant difference (p>0.05). This could be due to the feed ingredients given as treatment in this study have the same level of preference or palatability. Feed ingredients were given in the form of a total mixed ration (TMR) so that they had the same scent and taste. Michael (2014) stated that the scent of rations with the same nutrient content and the flow in the digestive tract are also almost the same so that it does not affect feed intake. The rations given in the form of TMR were of good quality with relatively nearly the same level of administration so intake levels did not differ either. The absence of effect on feed intake indicated that the rations given for each treatment had the same palatability value so the experimental livestock intake was almost the same amount of rations. Mokoboki *et al*. (2011) stated that feed with the same palatability provides stimulation to the same color, taste, smell and texture so it did not effect on feed intake. The treatment of *Sargassum* sp. as a mineral source in weaning male thin-tailed sheep had a significant (p<0.05) effect on ether extract intake. Significantly affected the crude fat intake, presumably the fat content of the ration treated with *Sargassum* sp. (T3 and T4) were higher than the treatment without *Sargassum* sp. (T0 and T1). In addition, it is suspected that minerals have an effect on the process of fat metabolism. Adawiah *et al*. (2006) stated that minerals affect the process of fat metabolism.

Table 2. Effect of *Sargassum* sp. in the ration on feed intake and ADG in male thin-tailed sheep after weaning

Variable (g/head/d)[1]	Treatment[2]			
	T1	T2	T3	T4
DM	642 ± 65.6	748.4 ± 90.6	697.1 ± 73.5	655.5 ±117.5
OM	516 ± 74.1	584.4 ± 76.1	544.8 ± 65.6	498.5 ± 113
CP	89.0 ± 14.7	110.5±13.7	98.61±12.6	88.0 ± 20.9
EE	6.90 ± 0.90[a]	8.50 ± 1.10[a]	13.4 ± 1.50[b]	11.1 ± 2.20[b]
CF	116.3 ± 16.4	124.4 ± 17.2	124.2 ± 14.4	110.4 ± 23.5
NFE	289 ± 38.7	341 ± 46.8	302 ± 38.3	283.2 ± 64.5
TDN	374 ± 56.7	437.6 ± 56.6	385.5 ± 46.6	358.9 ± 83.8
ADG	0.11 ± 0.01	0.13 ± 0.02	0.11 ± 0.01	0.13 ± 0.03

[a,b,c] Mean values within rows without common superscript differ at p<0.05.

[1]DM: dry matter; OM: organic matter; CP: crude protein; EE: ether extract; CF: crude fibre; NFE: nitrogen-free extract; TDN: total digestible nutrient; ADG: average daily gain.

[2]T1: forage + concentrate + 0% minerals of concentrate; T2: forage + concentrate + 0.38% cow booster minerals of concentrate; T3: forage + concentrate + 5% *Sargassum* sp. of concentrate; T4: forage + concentrate + 10% *Sargassum* sp. of concentrate.

Average daily gain

The treatment of mineral *Sargassum* sp. in male thin-tailed sheep after weaning with the TMR diet, did not show any significant difference with p>0.05 to daily body weight gain. It was the with the feed intake and chemical composition, might result a similar ADG It was suspected that the feed ingredients given in the form of TMR had the same palatability so there was no difference in body weight gain, other than that the feed intake is also no different. Salido *et al.* (2016) stated that the level of feed intake was not significantly different between treatments, so it did not significantly affect the body weight gain.

Macro minerals intake

Data on the intake of macro minerals calcium (Ca), magnesium (Mg), potassium (K), and sodium (Na), as well as micro minerals: copper (Cu), iron (Fe), and zinc (Zn) treated with seaweed *Sargassum* sp. in weaning rams, are presented in Table 3.

The results showed that the addition of the mineral *Sargassum* sp. in weaning male thin tails with TMR pattern feeding had a significant effect (p<0.05) on the intake of minerals Ca, Mg, K and Na. The results of the study of Ca intake showed that the T2 treatment was higher than the T1, T3, and T4 treatments. Mg intake in T2 treatment was higher than T1 and T3 treatments but did not differ from T4 treatment. Mg intake in T3 treatment was not different from T4. The high intake of Ca in T2 treatment was suspected to have the highest Ca content in the ration at 7.26 g/kg while T1, T3, and T4 were lower, respectively, at 1.35 g/kg; 4.67 g/kg, and 2.61 mg/kg. The high Ca intake in the T2 treatment was probably due to the high Ca content in the mineral booster cattle, which was 243.4 g/kg while in *Sargassum* sp. low Ca content of 38.5 mg/kg. Ca intake in experimental sheep has met the needs. Fujihara *et al.* (1995) stated that Ca intake in sheep ranged from 2.0 to 8.2 g/head/d with a tolerance of 20 g/head/d.

The high intake of Mg in the T2 treatment was not different from T4 treatment, it is suspected that the Mg content of the ration in T2 treatment was almost the same as T4 treatment, specifically T2 Mg treatment was 4.43 g/kg; while T4 Mg was 4.30 g/kg. High Mg intake in T2 treatment was due to the Mg content in the mineral booster cattle being high, namely 1.8 g/kg while the Mg content in *Sargassum* sp. was low, namely 13.2 mg/kg. Intake of Mg in experimental sheep has met the needs of livestock. Fujihara *et al.* (1995) stated that the intake of Mg in sheep ranged from 1.2 to 1.8 g/head/d with a tolerance of 4 g/head/d.

The results showed that the intake of K in the T4 treatment was higher than the T1 and T2 treatments but did not differ from the T3 treatment. The intake of high potassium minerals in the T4 treatment was suspected to have the highest K content in the TMR T4 ration, namely 1.51% from T1: 1.13%, and T2 0.92%, while the T3 treatment was almost the same, namely 1.30%. Na intake in T4 treatment was the highest from the T1, T2, and T3 treatments. While the T2 treatment was not different from the T3 treatment. The high intake of Na in the T4 treatment was thought to have the highest Na content in the T4 ration at 3.32 g/kg compared to Na in the T1, T2, and T3 treatments, respectively, which was 0.91; 2.15; 2.10 g/kg.

Micro minerals intake

The results showed that the addition of the mineral *Sargassum* sp. in weaning rams with TMR pattern feeding had a significant effect (p<0.05) on the intake of minerals Cu, Fe, and Zn. The results of DMRT Cu intake in T4 treatment were the highest from T3 treatment but did not differ from T1 and T2 treatments, while T3 treatment did not differ from T1 treatment. The high intake of Cu in the T4 treatment was suspected that the Cu content in the T4 ration was the highest at 5.15 mg/kg, while T1, T2, and T3 were lower, respectively, at 3.92; 4.08; 3.37 mg/kg.

The results showed that the intake of Fe was highest in treatment T2 compared to treatment T1, T3, and T4 and lowest in treatment T1. The high intake of Fe in the T2 treatment was suspected that the Fe content in the T2 ration was the highest compared to the Fe in the T1, T2, and T3 rations. The content of Fe in the T2 ration is 0.39 g/kg; while the Fe in the T1, T3, and T4 rations were 0.25; 0.29; and 0.29 g/kg. In addition, the Fe content in the cow booster mineral was 12.5 g/kg higher than the Fe in *Sargassum* sp. ie 1.0 g/kg. Fe intake in experimental sheep has met the needs of livestock. Fujihara *et al.* (1995) stated that Fe intake in sheep ranged from 0.03 to 0.05 g/head/d with a tolerance of 0.5 g/head/d.

Zinc intake was highest in treatment T2 compared to treatment T4 but did not differ from

Table 3. Effect of *Sargassum* sp. in the ration on mineral intake in thin-tailed weaning ram

Variable	Treatment[1]			
	T1	T2	T3	T4
Macro mineral (g/kg)				
Ca	8.10 ± 1.11[a]	53.61 ± 6.57[d]	31.98 ± 3.48[c]	16.53 ± 3.29[b]
Mg	16.33 ± 2.75[a]	31.81 ± 4.02[c]	24.64 ± 2.86[b]	26.45 ± 5.69[bc]
K (%)	6.51 ± 1.03[a]	6.41 ± 0.84[a]	8.51 ± 1.00[ab]	9.26 ± 2.01[b]
Na	2.87 ± 1.91[a]	15.19 ± 1.96[b]	13.82 ± 1.60[b]	20.61 ± 4.31[c]
Micro mineral (g/kg)				
Cu	0.24 ± 0.003[ab]	0.029 ± 0.004[b]	0.022 ± 0.003[a]	0.030 ± 0.008[b]
Fe	1.40 ± 0.24[a]	2.79 ± 0.35[b]	1.91 ± 0.23[a]	1.70 ± 4.40[a]
Zn	0.24 ± 0.04[ab]	0.31 ± 0.05[b]	0.25 ± 0.03[ab]	0.22 ± 0.06[a]

[a,b,c] Mean values within rows without common superscript differ at p<0.05.

[1]T1: forage + concentrate + 0% minerals of concentrate; T2: forage + concentrate + 0.38% cow booster minerals of concentrate; T3: forage + concentrate + 5% *Sargassum* sp. of concentrate; T4: forage + concentrate + 10% *Sargassum* sp. of concentrate.

treatment T1, and T3. T1 treatment was not different from T3 and T4. The high intake of Zn in the T2 treatment is thought to have the highest Zn content in the T2 ration compared to Zn in the T1, T3, and T4 rations. The content of Zn in the T2 ration is 48.67 mg/kg; while Zn in T1, T3, and T4 rations was 43.17; 40.98; 38.36 mg/kg. In addition, the Zn mineral booster content of cows was higher, namely 439 mg/kg compared to Zn in *Sargassum* sp. ie 29.29 mg/kg. Intake of Zn in experimental sheep has met the needs of livestock. Ji *et al.* (2014) stated that the Zn requirement for sheep was 22.1 – 23.8 mg/kg. Fujihara *et al.* (1995) stated that Zn intake in sheep ranged from 0.02 to 0.03 g/head/d with a tolerance of 0.75 g/head/d.

Sheep blood plasma minerals before treatment

Macro minerals

The research data of macro and micro minerals in the blood plasma of pre-treated sheep are presented in Table 4.

The results showed that the plasma minerals of weaned rams before treatment had no effect on Magnesium (Mg) and Sodium (Na) but had a significant effect ($p<0.05$) against Calcium (Ca) and potassium (K). The results showed that Ca T1 was the highest compared to T3 treatment, but did not show any difference with T2 and T4. BBlood plasma of Ca levels in T3 were not different from T2 and T4 treatments. For K levels, the results showed that T3 was the highest compared to T1 and T4 treatments but did not differ from T2 . T2 blood plasma K levels were not different from T1 and T4 treatments.

There was no significant difference in the Mg and Na content. It is possible that the weaned thin-tailed rams used in this study came from the same area, namely from Temanggung Regency, Central Java Province, Indonesia so they may have consumed the same forage, both grass and legumes. Mineral Mg blood plasma of rams weaned off before treatment was in normal condition. Widiyanto *et al.* (2017) stated that sheep plasma Mg minerals were in a critical status, namely 1-2 mg/100 mL. The feed intake is the same so the minerals in the blood plasma are also no different. Forage minerals are influenced by several factors, namely soil, plant species, maturity stage, results of pasture management and climate (Khan *et al.,* 2008). Significantly ($p<0.05$) on Ca and K content, the possibility of weaning rams used in this study came from areas with different heights and the seeds and feed intake were also different so that the content of Ca and K in blood plasma was also different. Different Brouček *et al.* (2009) stated that the factors that affect the mineral content of sheep blood plasma are different, namely the altitude of the place of rearing, season, seeds and management of maintenance and feed. Khan *et al.* (2008) stated that forage minerals are influenced by several factors, namely soil, plant species, maturity stage, results of pasture management and climate. The Ca content of sheep blood plasma before treatment was still in normal condition. Widiyanto *et al.* (2017) stated that sheep plasma Ca minerals were in a critical status, namely 8 mg/100 mL.

Micro minerals

The results showed that plasma minerals from weaned rams before treatment did not affect copper (Cu), iron (Fe) and zinc (Zn). There was no difference between the treatments for the levels of Cu, Fe and Zn before the treatment, it is possible that the weaning male thin tailed sheep used in the study came from the same area so that they feed intake the same forage, both grass and legumes. Khan *et al.* (2008) stated that forage minerals are influenced by several factors, namely soil, plant species, maturity stage, results of pasture management and climate.

Blood plasma minerals after treatment

The effect of treatment on macro and micro minerals in blood plasma is presented in Table 5.

Macro minerals

The results showed that the addition of the mineral *Sargassum* sp. In weaningthin tails ram, TMR pattern feeding did not affect plasma mineral concentrations of Ca, K and Na, but significantly ($p<0.05$) on Mg mineral concentration. There was no difference in the content of Ca, K and Na, it was assumed that the rations given for both the treatment without minerals (T1) and the mineral treatments T2, T3 and T4 contained almost the same Ca, K and Na content in blood plasma. For the T1 treatment, even without the addition of minerals, the mineral content of the ration was Ca 1354.76 mg/kg; K 1.13%; Na 909.06 mg/kg so the

Table 4. Blood plasma minerals of thin tailed weaning ram before treatment*

Variable	Treatment[1]			
	T1	T2	T3	T4
Macro mineral (mg/kg)				
Ca	87.13 ± 20.19^{b}	68.57 ± 16.62^{ab}	57.16 ± 8.08^{a}	79.86 ± 12.18^{ab}
Mg^{ns}	42.51 ± 6.07	37.02 ± 5.87	38.33 ± 3.59	41.38 ± 5.16
K (%)	682.99 ± 64.76^{a}	938.07 ± 325.45^{ab}	1013.31 ± 145.32^{b}	689.37 ± 35.13^{a}
Na	2079.07 ± 105.70	1901.56 ± 139.16	1975.25 ± 191.47	2128.31 ± 171.15
Micro mineral (mg/kg)				
Cu^{ns}	0.68 ± 0.06	0.99 ± 0.21	1.01 ± 0.50	0.77 ± 0.32
Fe^{ns}	305.96 ± 85.47	355.79 ± 22.03	379.22 ± 85.87	313.37 ± 58.40
Zn^{ns}	3.91 ± 1.02	4.53 ± 0.40	4.25 ± 0.73	3.54 ± 0.95

[a,b,c] Mean values within rows without common superscript differ at $p<0.05$; ns = not significant.

[1]T1: forage + concentrate + 0% minerals of concentrate; T2: forage + concentrate + 0.38% cow booster minerals of concentrate; T3: forage + concentrate + 5% *Sargassum* sp. of concentrate; T4: forage + concentrate + 10% *Sargassum* sp. of concentrate.

*Animal were grouped based on each treatment and analyzed blood plasma minerals before feeding trial period.

Table 5. Effect of *Sargassum* sp. in the ration to the blood plasma minerals of weaning thin tailed ram

Variable	Treatment			
	T1	T2	T3	T4
Macro mineral (mg/kg)				
Ca	50.11 ± 21.19	66.53 ± 7.58	61.52 ± 8.65	55.31 ± 11.31
Mg	44.78 ± 6.41^{a}	49.65 ± 4.75^{a}	58.94 ± 5.85^{b}	50.42 ± 4.63^{a}
K (%)	773.78 ± 99.99	1010.19 ± 372.61	925.64 ± 166.81	714.83 ± 46.89
Na	2625.32 ± 67.39	2127.75 ± 413.36	2105.25 ± 521.53	2201.97 ± 363.60
Micro mineral (mg/kg)				
Cu	0.71 ± 0.16^{ab}	0.66 ± 0.12^{ab}	0.80 ± 0.15^{b}	0.54 ± 0.15^{a}
Fe	436.44 ± 23.24^{b}	393.55 ± 29.99^{ab}	330.86 ± 94.80^{a}	319.99 ± 69.58^{a}
Zn	4.83 ± 0.87	5.02 ± 0.52	4.05 ± 0.34	4.13 ± 0.82

^{a,b,c} Mean values within rows without common superscript differ at p<0.05; ns = not significant.

content of Ca, K and Na plasma is almost the same as the mineral treatment. The concentration of mineral Ca in blood plasma as a result of the research T1, T2, T3 and T4 were 50.11; 66.53; 61.52; 55.31 mg/kg lower than the standard mineral Ca in sheep blood, which ranges from 115 – 128 mg/L. Fujihara *et al.* (1995) reported that the low concentration of mineral Ca in blood plasma is thought to have not been optimally absorbed, although the intake of Ca mineral in T1 treatment was 8.10 mg/kg according to the standard requirement, while T2, T3 and T4 exceeded the standard requirement. The need for Ca for sheep is 2,000 – 8,000 mg/L (Fujihara *et al.,* 1995).

The results of the study showed that the concentration of Mg in T3 treatment was higher (P<0.05) than T1, T2 and T4 treatments. The concentration of Mg in T1 treatment was not different from T2 and T4 treatments. The high concentration of Mg in T3 treatment was suspected by the addition of *Sargassum* sp. 5% Mg content in the plasma is increased and is optimal for sheep. The Mg concentrations from this study were T1, T2, T3 and T4 respectively, namely 44.78; 49.65; 58.94; 50.42; mg/kg is almost the same as the results of Fujihara *et al.* (1995) ranged from 30.4 to 67.1 mg/L. and exceeds the standard Mg in sheep blood plasma. Fujihara *et al.* (1995) stated that the standard of Ca in plasma hens was 22-28 mg/L.

Micro minerals

The results showed that the addition of *Sargassum* sp. In weaning male thin tails, TMR pattern feeding did not affect the plasma mineral concentration of Zn, but significantly (p<0.05) on the concentration of Cu and Fe minerals. There was no difference in the concentration of Zn in plasma between treatments. It was assumed that the consumption of Zn was almost the same as T1, T2, T3 and T4 treatments, respectively, namely 242.40; 311.90; 253.89; 216.31 mg/kg. The concentration of Zn in blood plasma as a result of this study were T1, T2, T3 and T4, respectively, namely 4.83; 5.02; 4.05; 4.13 mg/kg higher than the results of research by Fujihara *et al.* (1995) which ranged from 0.2 - 1.6 mg/L and the standard of Zn in sheep blood plasma. Fujihara *et al.* (1995) stated that the standard of Zn in sheep blood plasma was 0.02 – 0.2 mg/L.

The Cu concentration showed that the T3 treatment was higher (p<0.05) then T4 treatment, but did not show any difference with the T1 and T2 treatments. The high concentration of Cu in T3 treatment is thought to have good absorption of Cu in the blood. Cu concentrations in blood plasma for T1, T2, and T3 treatments were in the normal range for sheep. McDowell (2003) reported the normal range of sheep plasma Cu Cu is 0.6 – 1.5 mg/L. The concentration of Fe in the T1 treatment was higher than the T3 and T4 treatments but did not differ from the T2 treatment; The concentration of Fe in T2 treatment was not different from T3 and T4.

Conclusion

The use of 10% *Sargassum* sp. powder of the total concentrate by sun-drying can increase the intake of macro and micro minerals as well as minerals Mg, Cu and Fe in the blood plasma of weaned thin-tailed rams.

Conflict of interest

The authors declare that they have no conflict of interest.

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Author's contribution

The contribution of each author is to provide corrections to the contents of the journal.

Ethics Approval

This research has met the ethical requirements of the Research Ethics Commission of the Faculty of Veterinary Medicine,Universitas Gadjah Mada, Statement of Ethical Clearance Number: 0145/EC-FKH/Eks/2019.

References

Adiwinarta, R., Kustantinah, I. G. S. Budisatria, Rusman, and E. Indarto. 2018. Profile of rumen fermentation and blood urea nitrogen concentration of kacang goat fed total mixed ration Vs roughage. IOP Conf.Ser.: Earth Environ. Sci. 119: 1-5. https://doi:10.1088/1755-1315/119/1/012049.

Adawiah, T. Sutardi, T. Toharmat, W. Manalu, Nahrowi, and U.H. Tanuwiria. 2006. Suplementasi sabun mineral dan mineral organik serta kacang kedelai sangrai pada domba. Media Peternakan 29: 27-34.

AOAC. 1984. Association of Official Analytical Chemists. Official methods of analysis 14 edition. the Arlington, VA.

Brouček, J., M. Šoch, and P. Šrejberová. 2009. Effect of different environmental factors on selected blood minerals in sheep. Slovak J. Anim. Sci. 42: 145 - 150.

Costa, R., J. Silva, A. Medeiros, F. Carvalho, M. Andrade, G. Cruz, T. P. D. Silva, and L. Bezera. 2021. Mineral requirements for weight gain in growing male santa inês and morada nova hair sheep. J. Anim. Sci. 92. https://doi.org/10.1111/asj.13583.

El-Waziry, A., A. Al-Haidary, A. Okab, E. Samara, and K. Abdoun. 2015. Effect of dietary seaweed (U*lva lactuca*) supplementation on growth performance of sheep and on in vitro gas production kinetics. Turk. J. Vet. Anim. Sci. 39: 81–86 http://doi:10.3906/vet-1403-82.

Fujihara, C., Hosoda, and T. Matsui. 1995. Mineral status of grazing sheep in the dry area of midland china. Ajas 8: 179 -186.

Ji, S. K., G. S. Xu, Q. Y. Diao, C. G. Jiang, K. D. Deng, Y. Tu, and N. F. Zhang. 2014. Net zinc requirements of dorper â thin-tailed han crossbred lambs. Asian-Australas. J. Anim. Sci. 26: 1282-1288. http://doi.org/10.1016/j.livsci.2014.06.021.

Khan, Z. I., M. Ashraf, K. Ahmad, I. Javed, and E. E. Valeem. 2008. A comparative study mineral status of blood plasma of small ruminants and pastures in punjab. Pak. J. Bot. 40: 1143-1151.

Ktita, S. R., A. Chermiti, C. Valdés, and S. López. 2019. Digestibility, nitrogen balance and weight gain in sheep fed with diets supplemented with different seaweeds 31: 3255–3263. https://doi.org/10.1007/s10811-019-01789-7.

Kumar, S., D. Sahoo, and I. Levine. 2015. Asessment of nutritional value in a brown seaweed sargassum wightii and their seasonal variations. Algallgal Res. 9: 117–25. http://doi.org/10.1016/j.algal.2015.02.024.

Makkar, H. P. S., G. Tran, V. Heuze, S. G. Reverdin, M. Lessire, F. Lebas, and P. Ankers. 2016. Seaweed for livestock diets: A. review. J. Anim. Feed Sci. Technol. 212: 1-17.

McDowell, L. R. 2003. Minerals In Animal and Human Nutrition No.Ed.2 pp.xvi + 644 pp. ISBN: 0444513671. Publisher : Elsevier Science B.V.

Michael, S. A. 2014. Drives and limits to feed intake in ruminants. Anim. Prod. Sci. 54: 1513-1524. http://doi.org/10.1071/AN 14478.

Mokoboki, H. K., L. R. Ndlovu, and M. M. Malatje. 2011. Intake and relative palatability indices of acacia species fed to sheep and goats. Agroforest. Syst. 81: 31–35. http://doi.org. 10.1007/s10457-010-9352-5.

MOOPAM. 1989. Manual of oceanographic and pollutant analysis methods. 2nd ed. The Regional Organization for the Protection of the Marine Environment (ROPME), Kuwait, 458 https://doi.org/10.1016/0269-7491(93)90074-X

Muwel, N., A. Das, K. Raje, R. Yengkhom, V. K. Munde, and S. Choudhary. 2018. Effect of supplementation of brown seaweeds on intake, digestibility of nutrients and methane production in goats. Environment and Ecology 36: 1021-1024. http://www.environ mentandecology.com.

Suttle, N. F. 2010. Mineral Nutrition of Livestock. 4th ed. Honorary Research Fellow Moredun Foundation Pentland Science Park Bush Loan Penicuik Midlothian EH26 OPZ UK.

Owens, F. N., P. Dubeski, and C. F. Hanson. 2014. Factors that alter the growth and development of ruminants. J. Anim Sci. 1993: 3138-3150. https://doi.org/10.2527/1993.71113138x

Paga, A., A. Agus, Kustantinah, and I. G. S. Budisatria. 2021. Effect of different drying methods on the mineral content of seaweed *Sargassum* sp. http://www.lrrd.org/lrrd 33/3.

Pal, D. T., N. K. S. Gowda, C. S. Prasad, R. Amarnath, U. Bharadwaj, G. S. Babu, and K. T. Sampath. 2010. Effect of copper- and zinc-methionine supplementation on bioavailability mineral status and tissue concentrations of copper and zinc in ewes. J. Trace Elements in Medicine and Biology 24: 89-94. http://doi.10.1016/j.jtemb.2009.11.007.

Ruperez, P. 2002. Mineral content of edible marine seaweeds. Food Chemistry 79: 23-26. https://doi.org/10.1016/S0308-8146(02)00171-1

Salido, W. L., J. Achmadi, and A. Purnimoadi. 2016. Komposisi tubuh domba ekor tipis yang diberikan pakan bungkil kedelai terproteksi tanin dengan kadar berbeda. J. Vet. 17: 133-142.

Shumye, M. 2021. Growth curve analysis of body weight in crossbred dairy cattle in central ethiopia. 33 (7). Retrieved November 15, from http://www.lrrd.org/lrrd 33/7.

Singh, B. K., R. C. Chopra, S. N. Rai, M. P. Verma, and R. K. Mohanta. 2017. Nutritional evaluation of seaweed on nutrient digestibility, nitrogen balance, milk production and composition in sahiwal cows. Proceedings of the National Academy of Sciences, India Section B: Bio. Sci. 87: 437-443.

Steel, R. G. D., J. H. Torrie, and D. A. Dickey. 1997. Principles and Procedures of Statistics a Biometrical Approach. 3rd edn. McGraw-Hill, Inc., New York, p. 666. ISBN: 0070610282.

Van denHoek, L. S. and E. K. Bayoumi. 2018. Evaluating seaweed as a source of protein in the future of food production worldwide 1.IOSR. J. Pharm. Bio. Sci. j (IOSR-JPBS) 13: 30-37. www.iosrjournals.org.

Widiyanto, E., K.M. Suramanto, and V. D. Y. B. Ismadi. 2017. Mineral status of java thin-tailed sheep grazed in Mijen agriculture area, Semarang, Indonesia. http://doi 10.14710/jitaa.42.2.120-127.

Ziehank, E. H., M. Ganter, I. H. Pauka, and A. Binder. 2008. Trace mineral status and liver and blood parameters in sheep without mineral supply compared to local roe deer (*Capreolus Capreolus*) Populations. 75: 185–191 http:// doi:10.1016/j.smallrumres. 2007.10.006.