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Effect of Supplementation of Brown Seaweeds on Intake, Digestibility of Nutrients and Methane Production in Goats

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Abstract Seaweeds have potentials as alternative feed for ruminants, but there is a limited knowledge on their nutritive value. The present study was conducted to find out the effects of supplementation of brown seaweed on intake and digestibility in goats. Fifteen female goats were randomly divided into three groups. While the goats in control group (T_0) were fed a standard ration with no seaweed supplement. However, the diets of the animals in groups T_1 and T_2 were supplemented with brown seaweed at 4 and 8% respectively. The digestibility of coefficient of CP was significantly higher ($p<0.05$) in treatment group compare to control group. Methane production (1/kg DM) decreased with increased level of seaweed in the diet. It was concluded that inclusion of brown seaweed supplementation improved CP digestibility and decreased methane production without any adverse impact on intake and digestibility of nutrients.

Keywords Brown seaweed, Goats, Digestibility, Methane.

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Introduction

Seaweeds are accumulating in all world coast zones and are considered as an environmental hazard. Their collection and use as a nonconventional source for animal feeding may contribute in resolving the environmental problem (Okab 2007, Oliveira et al. 2009). Worldwide, over 1500—2000 species of brown algae are known. Seaweeds are classified into brown algae (Phaeophyceae), red algae (Rhodophyceae) and green algae (Chlorophyceae) (Chapman and Chapman 1980, El Gamal 2012). They are of many different shapes, sizes, colors and composition and occupy varios habitats. Brown algae live primarily in shallow waters or on shoreline rocks and have very flexible stems that allow them to withstand the constant pounding of the waves (Ghosh et al. 2012). Due to their larger size and ease of harvesting brown seaweeds have been more studied and are more exploited than other algae types for their use in animal feeding. Brown algae are the largest seaweeds, up to 35—45 m in length for some species and extremely variable in shape. The most common genera include Ascophyllum, Laminaria, Saccharina, Macrocystis, Nereocystis and Sargassum (Murty and Banerjee 2012). Algae, both micro and macro have been used in both human and animal nutrition (Abowei and Tawari 2011). They are rich in soluble dietary fibers, proteins, minerals, vitamins, antioxidants, hytochemicals and polyunsaturated fatty acids with low caloric value. Methane emission from enteric fermentation in animals is of concern worldwide due to its contribution to the accumulation of greenhouse gases in the atmosphere and an energy loss for the host animal (Hook et al. 2010). Recent studies suggest that red and brown seaweed species may have bioactive components with anti-methanogenic properties (Kinley et al. 2016). Objective of this study was assess the effect of supplementation of brown seaweed on intake and digestibility of nutrients and methane production in goats.

Materials and Methods

Experimental animals and treatments

The present research work was conducted on the, Nuclear Research Laboratory (NRL) in animal nutrition, Indian Veterinary Research Institute Bareilly. The study was under taken to evaluate the effects of brown seaweed supplementation on intake, digestibility and methane production in goats. Fifteen female goats of similar age were be randomly divided into 3 groups consisting five goats each in a completely randomized block design (RBD). While the goats in control group (T_0) were fed a standard ration with no seaweed supplement. However, the diets of the animals in groups T_1 and T_2 were supplemented with brown seaweed at 4 and 8 %, respectively. All the goats were be fed as per ICAR, 1998 to meet their requirements for maintenance. DCP of concentrate mixture was 13.95% which maintained by inclusion of 40 Kg maize, 40 kg wheat bran, 17 kg soyabean meal, 2 kg mineral, 1kg salt and level of brown seaweed varies in all groups.

Metabolic trial

A metabolism trial of 5 day collection period was conducted, during which proper record of feed consumed, residue, feces voided and urine excreted by each goat was maintained. Body weights of the animals were recorded before and after metabolism trial on two consecutive days. For this, all the animals from each group were shifted to the metabolic cages having facilities for individual feeding and watering and separate urine and feces collection.

Respiration calorimeter study

All goats were weighted and kept in open circuit respiration chamber for two days for acclimatization and then recording of the respiration data for hourly interval for two consecutive days. The animal was provided sufficient amount of clean drinking water, feeding manger was attached to metabolic crate, kept inside the respiration chamber. After offring the feed, the chamber was air tightened by closing the door. Recording of temperature of dry and wet bulb, follow rate, air volume, atmospheric pressure was done manually at hourly interval. Methane (CH^4), carbon dioxide (CO_2) and oxygen (O_2) content of sample of the outgoing and incoming air from the respiration chamber were determined by the infrared analyzer attached with the chamber. The chamber was opened after 24 h. Oxygen utilization, production of carbon dioxide, methane was calculated as per the following formulas :

Oxygen consumed : The total volume of oxygen inspired is computed as per the following formula :

O_2 (1) $=V_{STP}X$ (Difference in the concentration of oxygen between ingoing and outcoming air of the chamber)

$$VSTP=V273/(273+t)\ X\ (P-VP)/760$$

Where, V=Volume at room temperature and pressure, t = Dry bulb temperture (^oC), P=Barometric pressure in mm Hg, VP=Vapor pressure, V_{STP}=Volume at standard temperature and pressure.

Carbon dioxide : Total volume of Carbon dioxide expired is calculated as per the following formula :

$$CO_2\ (1) = V_{STP}\ (C_1 - C_1)/100$$

Where, C_t = Average carbon dioxide percentage in outcoming air, C_i = Average carbon dioxide percentage in incoming air. Methane production : Total volume of methane produced calculated by the following equation :

$$CH_4\ (1) = V_{STP}\ (M_t - M_i)/100$$

Where, M_f = Average percentage of methane in outgoing air, M_i = Average percentage of methane in incoming air.

Analytical methods

The samples of feed offered, residue and feces were analyzed for proximate principles as per standard procedures of Association of Official Analytical Chemists (AOAC 1995) and methane production was calculated above mentioned formula.

Results and Discussion

In the present study, the daily intake of DM, OM, EE, NDF and ADF of concentrate, wheat straw and green oat g/d% BW did not differ significantly ($p>0.05$) among treatment group. The digestibility coefficient of DM, OM, EE, NDF, ADF did not differ significantly among treatment group. The intake of DM by goat was within normal range and this clearly indicated that all the experimental diet were palatable. The digestibility of coefficient of CP was significantly higher ($p<0.05$) in treatment group compare to control group (Table 1). These finding

Table 1. Effect of brown seaweed supplements on nutrient digestibility (%) in goat. [a,b] Means with different superscripts within a row differ significantly ($p< 0.05$).

Attributes	T_0	T_1	T_2	SEm	p values
DM	67.30±0.93	69.55±1.54	71.35± 1.75	0.90	0.184
OM	69.80±1.09	71.99±1.64	73.54±1.78	0.93	0.265
CP	73.29^{a}±1.03	75.18^{ab}±0.91	78.87^{b}±1.85	1.03	0.016
EE	55.84±2.22	60.69±1.46	60.99±2.10	1.20	0.195
NDF	58.62±1.88	63.54±1.8	63.64±1.85	1.22	0.088
ADF	43.57±2.84	48.01±4.16	51.62±2.78	1.99	0.268

Table 2. Effect of brown seaweed supplements on methane production (1/kg DMI) in goat. [a,b]Means with different superscripts within a row differ significantly ($p<0.05$).

Attributes	T_0	T_1	T_2	SEm	P values
Methane production (1/kg DMI)	14.67 ± 1.13^{a}	11.04 ± 0.62^{b}	10.94 ± 0.70^{b}	0.68	0.05

agreement with the results of Hansen et al. (2003). As we know brown seaweeds are rich in minerals (14—35% DM) and contain low to moderate amounts of crude protein (5—13%). Crude protein of brown seaweeds was found to be rumen-undegradable *in situ*, but the *in vitro* trypsin digestibility of their proteins was high, which could make brown algae a good source of protein for ruminants despite their low protein content (Gojon-Baez et al. 1998).

Many studies have investigated the effects of including seaweeds in the diet of ruminants on methane emissions, but results have been contradictory. Present study revealed that methane production (1/kg DMI) decreased with increased level of seaweed in the diet (Table 2). Overall mean of methane production varied significantly ($p<0.05$) between the groups. In contrast Belanche et al. (2016) observed no changes in methane production in Rusitec fermenters by including either one of the brown seaweed *Laminaria digitata* or *Ascophyllum nodosum* at 50 g/kg in the diet (DM basis). Methane production was lower because brown seaweed species have bioactive components with anti-methanogenic properties.

Conclusion

It was concluded that inclusion of brown seaweed supplementation improved CP digestibility and decreased methane production without any adverse impact on intake and digestibility of nutrients. The study suggests that these seaweeds have the potential to be used as an alternative feed source for small ruminants under some conditions.

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