

## MITIGATION OF ENTERIC METHANE PRODUCTION IN RUMINANTS THROUGH THE INCLUSION OF SEAWEED AS FEED ADDITIVES

### ABSTRACT

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This study was conducted in three stages to explore the potential of seaweed as a dietary additive for reducing enteric methane (CH<sub>4</sub>) emissions in ruminants. The objectives were: (1) to identify the chemical composition—including nutrient profiles and secondary metabolites—and evaluate *in vitro* gas production of single seaweed species; (2) to assess the effect of seaweed inclusion in different basal diets (Napier grass and Total Mixed Ration/TMR) through *in vitro* fermentation; and (3) to evaluate *in vivo* the impact of seaweed supplementation in TMR diets on CH<sub>4</sub> emission and rumen performance in ruminants. Eight seaweed species, naturally collected from Drini and Sepanjang beaches in Gunungkidul, Yogyakarta, Indonesia, were evaluated. These included three green algae (*Chaetomorpha linum* (O.F. Mull.) Kütz, *Enteromorpha compressa*, and *Cladophora* sp.) and five red algae (*Gelidium spinosum* (S.G. Gmelin) P.C. Silva, *Hypnea pannosa*, *Acanthopora muscoides* (L.) Bory, *Gelidium amansii* (J.V. Lamouroux), and *Palisada perforata* (Bory) K.W. Nam). The results showed that *C. linum*, *E. compressa*, *A. muscoides*, and *P. perforata* demonstrated higher levels of soluble components, flavonoids, and tannins, as well as significantly lower *in vitro* CH<sub>4</sub> production, indicating their potential as methane-reducing agents. *In vivo* trials using Kacang goats revealed that inclusion of *P. perforata* at 5.00% organic matter (OM) in a TMR diet (60% Napier grass and 40% concentrate) yielded the most promising results. This treatment led to the greatest reductions in CH<sub>4</sub> emissions and protozoa populations, while improving rumen fermentation characteristics, nutrient intake and digestibility, nitrogen balance, total volatile fatty acids (VFA), propionate proportion, microbial protein synthesis, glucose and iron levels, and red blood cell counts. It also resulted in lower acetate proportion, acetate-to-propionate ratio, predicted CH<sub>4</sub> emissions, and levels of white blood cells, lymphocytes, monocytes, and neutrophils. In conclusion, supplementation of *P. perforata* at 5.00% OM in a TMR composed of 60% Napier grass and 40% concentrate presents a promising strategy to enhance ruminant productivity while mitigating environmental impact through reduced enteric methane emissions.

Keywords: Feed additive, Fermentation characteristic, Methane mitigation, Seaweed.