Harnessing Macroalgae from South Sulawesi: An In Vitro Approach to Enhancing Ruminant Efficiency and Methane Mitigation

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Abstract:

The livestock sector faces a dual challenge: enhancing ruminant productivity while mitigating methane (CH_4) emissions, a key contributor to climate change. This in vitro study evaluates the potential of seven macroalgae species from South Sulawesi, Indonesia, as feed additives to improve microbial efficiency and reduce CH_4 production in ruminants. The species assessed include four cultivated macroalgae (*Eucheuma cottonii, Eucheuma denticulatum, Caulerpa sp., Gracilaria sp.*) and three non-cultivated species (*Halimynea sp., Caulerpa sp., Sargassum sp.*), tested at inclusion levels of 0%, 5%, 10%, and 15%. A significant interaction between macroalgae type and inclusion level was observed, affecting microbial protein synthesis, bacterial and protozoal populations, and CH_4 emissions ($p < 0.05$). Saponin-rich species, particularly *Caulerpa sp.* (cultivated and non-cultivated) and *Eucheuma denticulatum*, demonstrated the greatest efficacy, enhancing microbial protein synthesis and bacterial populations while reducing protozoal activity and CH_4 emissions at 10%–15% inclusion levels. In contrast, tannin-rich species such as *Sargassum sp.* showed limited impact on CH_4 mitigation, underscoring the complex role of bioactive compounds in modulating rumen microbial dynamics. These findings highlight the promise of South Sulawesi's macroalgae as a sustainable strategy for improving livestock productivity and minimizing environmental impacts. Future research should focus on optimizing the use of saponin-rich macroalgae and exploring synergistic effects among species to support global sustainability goals.

Keywords:

Macroalgae, Feed Additives, Methane Mitigation, South Sulawesi, Saponins and tannis, In Vitro.