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Asparagopsis Seaweed for Methane Mitigation

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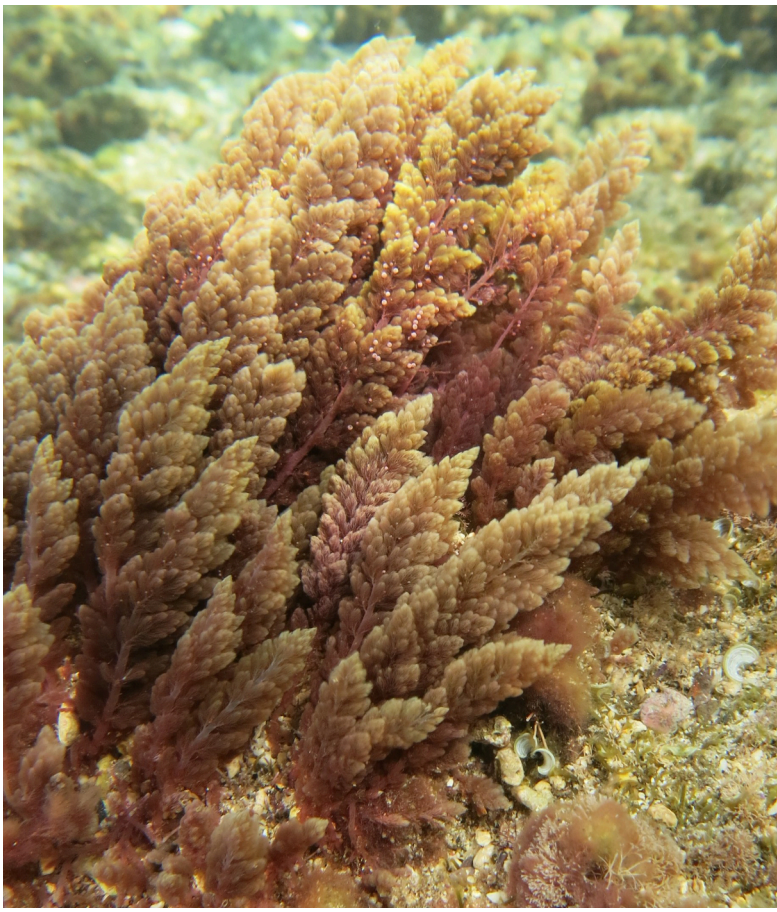
There is tremendous interest in using Asparagopsis as a methane (CH_4) mitigating feed additive because it can be naturally sourced and is "generally recognized as safe" by some regulatory authorities. Asparagopsis is a red seaweed that grows in tropical waters, although it can be grown artificially in tanks. Asparagopsis taxiformis and A. armata are natural sources of halogenated compounds, of which bromoform is the most abundant. These compounds inhibit methyl-coenzyme M reductase that catalyzes the last step of methanogenesis in methanogenic archaea. Inhibition of methyl-H4MPT: Coenzyme M methyltransferase is also possible. Efficacy of Asparagopsis for CH_4 mitigation depends on its concentration of bromoform and other halogenated methane analogues, which are highly variable (Beauchemin et al., 2022).

In laboratory studies, Asparagopsis has been shown to be very effective in decreasing CH_4 production, with nearly complete inhibition occurring in some cases. However, relatively few animal studies have been published to date (as reviewed by Lean et al., 2021). In a short-term study with 12 dairy cows, Roque et al. (2019) observed a 43% reduction in CH_4 yield

(i.e., CH_4 normalized to feed intake) for diets containing 1% A. armata; however, milk yield was negatively affected (-12%). Lowering the feeding rate of A. armata to 0.5% decreased CH_4 yield by 20% compared with the control, without negative impacts on milk yield. Asparagopsis appears to be more effective at decreasing CH_4 production in beef cattle versus dairy cows, and with high concentrate diets compared with high forage diets. In a 21-week study with beef steers fed diets containing 0.25 and 0.5% A. taxiformis (7 animals/treatment), Roque et al. (2021) reported reductions in CH_4 yield of 33% and 52%, respectively, in the first part of the study when the cattle received a high forage diet, and 70% and 80%, respectively, in the finishing stage when a high concentrate diet was fed. No differences were found in average daily gain or carcass quality, but feed conversion efficiency was improved. Kinley et al. (2020) included 0.05%, 0.10%, and 0.20% of *Asparagopsis taxiformis* in a high grain diet fed to beef cattle (10 animals/treatment). Over the 90-day treatment period, CH_4 yield decreased by 9%, 38%, and 98%, for the three levels, respectively, compared to the cattle receiving no seaweed. Growth rate and feed conversion efficiency were enhanced with the mid and high levels of inclusion. While the initial feeding results with Asparagopsis as a CH_4 mitigating feed additive are very encouraging, especially for beef cattle, it is clear that additional studies with greater numbers of animals fed a range of diets and doses of Asparagopsis need to be published to assess CH_4 reduction and animal performance over the long-term. In a unpublished study reported by Meat and Livestock Australia conducted at the University of New South Wales (https://www.mla.com.au/research-and-development/reports/2023/p.psh.1353---effect-of-asparagopsis-extract-in-a-canola-oil-carrier-for-long-fed-wagyu-cattle/) feeding Asparagopsis stabilized in canola oil and 25 mg/kg of dry matter reduced CH_4 yield by 22% (g/kg DMI). Feed intake was reduced (by 7.9%) and liveweight gain reduced by 9.4%, with a trend to reduce carcass weight by 15 kg. There was no effect on trained sensory panel attributes. Consistent with other research, there was no bromoform detectible in meat or offal. Canola oil stabilised bromoform over the duration of use in this study with no volatilisation evident in vegetable oil tanks at the feedlot.

It should be noted that the Commonwealth Scientific and Industrial Research Organisation (CSIRO, Australia) holds a worldwide patent for the use of Asparagopsis in ruminant diets to decrease CH_4 emissions. Additional animal feeding studies are in progress, but these are not yet accessible to the wider scientific community.



Asparagopsis taxiformis

There are numerous barriers that need to be overcome to enable wide scale commercial use of Asparagopsis for CH_4 mitigation (see https://www.abc.net.au/news/2023-07-02/concerns-regarding-asparagopsis-seaweed-health-risk-livestock/102524810). Bromoform levels in Asparagopsis are highly variable and unstable; thus standardised methods for analysis and innovative stabilisation techniques will be needed to ensure product consistency. Safety will need to be addressed, as some regulatory authorities (e.g., the U.S. EPA) classify bromoform as a probable human carcinogen. Whether bromoform is transferred to milk or meat requires further study. The levels of iodine in Asparagopsis are very high and can exceed recommended levels for feeding. Wide scale use of Asparagopsis will depend on the ability to sustainably grow it in aquaculture with consistent concentration of the active compounds, yet growing Asparagopsis in tanks is very challenging, costly, and energy-intense. The CO_2e emissions of growing, harvesting, processing, and transporting Asparagopsis at a large scale will need to be considered. While there is tremendous potential using Asparagopsis as a highly effective feed additive for CH_4 mitigation, production challenges, high cost, lack of long-term animal studies, safety, and regulatory approval currently remain significant barriers to use of Asparagopsis by farmers.

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