Quantifying methane emissions and animal performance from zero-grazed beef steers supplemented with Ascophyllum nodosum extracts via a water-based delivery system

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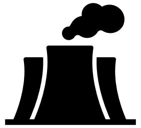
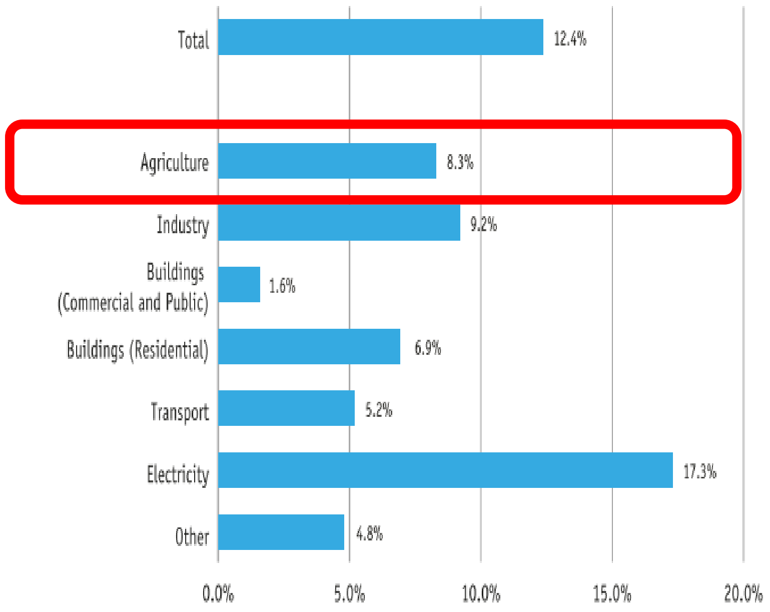
Emissions and Animal Production: The Global

- **The Global Challenge: Increasing Global Population & Demand** 
  - As the global population continues to grow, the demand for dairy and meat products has surged, putting pressure on food systems.
- **Rising Greenhouse Gas Emissions** 
  - This growing demand has led to a significant increase in Greenhouse Gas (GHG) emissions, making the agriculture sector a key contributor to climate change.
- **Balancing Production and Sustainability** 
  - The critical challenge we face is how to sustainably increase animal production to meet this demand while dramatically reducing our carbon footprint.

Strategies and Policies

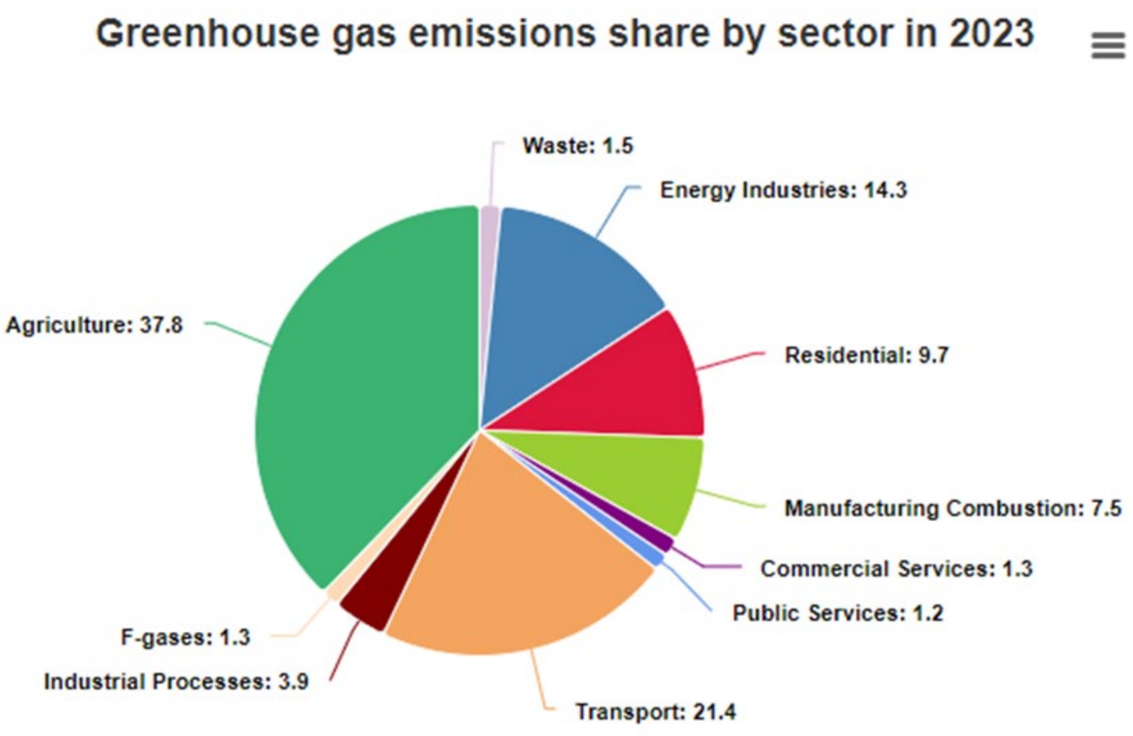
Ireland

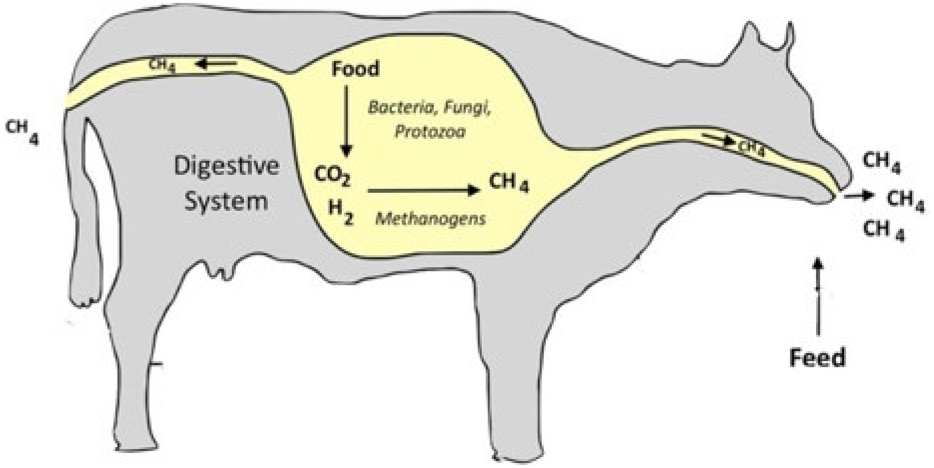
Figure 5: Annual emission reductions required from 2023-2025 to achieve SEC compliance



Irish Greenhouse Gas Emissions

- Emissions arising from methane **(CH_4)** account for 71.2% of agricultural emissions
- Dominated by **enteric fermentation** and manure management from ruminant production systems





Reducing Emissions in Irish Pasture-Based Ruminant Systems

Delivery Methods of Dietary Additives

Total Mixed Ration Diet

Concentrate

Water-based

Seaweed

- **Potential of Seaweed**
  - **Red seaweed (Asparagopsis sp.):** Can reduce CH_4 emissions by up to 98% at 0.5-2% of dry matter intake, due to the presence of Bromoform (Kinley at al., 2020; Machado et al. 2016)
- **Irish Brown Seaweeds as a Sustainable Alternative**
  - Contain natural bioactive compounds such as tannins and polyphenols that can reduce CH_4 emissions, while also supporting local ecosystems and promoting sustainable agricultural practices in Ireland
  - **Ascophyllum nodosum (ASC):** Abundant in phlorotannins, which suppress CH_4 by inhibiting the function of methanogens (Miller at al., 2023)
  - Studies show ASC reduces nitrogen degradability, gas production, and CH_4 emissions in vitro (Belanche et al., 2016; Wang et al., 2008; Kunzel et al., 2022) and CH_4 in vivo (Antaya et al., 2019)

Questions

Can we extract certain bioactive components from brown seaweed to analyse in vivo?

Can brown seaweed extract reduce methane while not impacting animal performance negatively?

Can we deliver a brown seaweed extract through a water-based system?

Can we quantify methane emissions from growing beef steers offered a fresh grass diet?

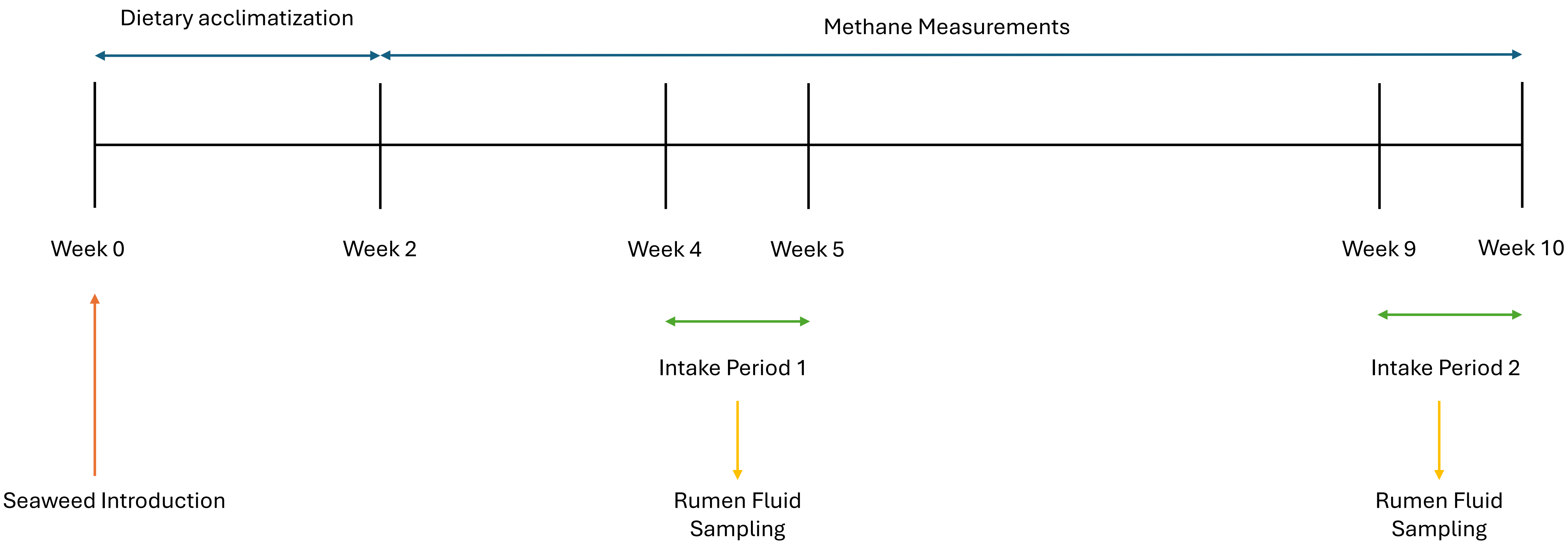
Table 1: Chemical Composition of Seaweed Extracts.

Seaweed composition (g/kg DM)	SW1	SW2
DM(g/kg)	42	370
Ash	16	88
Total tannins	167	18
Total sugars	95	183
Total phenols	761	364
Phlorotannin's	276	246

Experimental Design

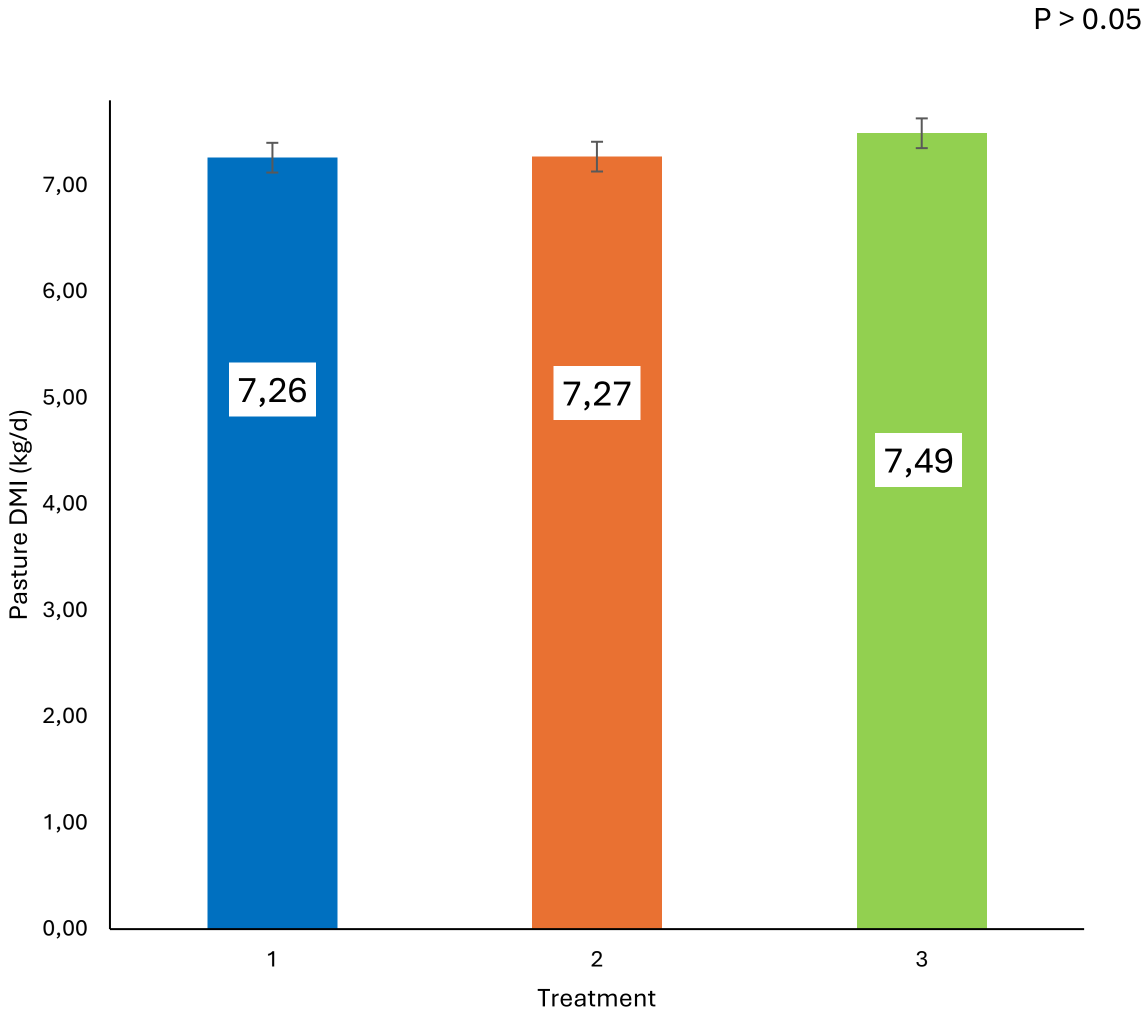
- 45 beef steers used in a complete randomized design over a 70-d period
- Balanced for age, body weight, breed and farm of origin
- Offered a basal diet of zero-grazed grass and concentrate
- Randomly allocated to one of three dietary treatments:
    - **CTR** (0% ASC extract)
    - **SW1** (1% of ASC extract 1)
    - **SW2** (4% of ASC extract 2)
- CH_4 measured using three GreenFeed units

Timeline


Dietary acclimatization
Methane Measurements
Week 0
Week 2
Week 4
Week 5
Week 9
Week 10
Intake Period 1
Intake Period 2
Seaweed Introduction
Rumen Fluid Sampling
Rumen Fluid Sampling

Results

Figures 1 and 2: The effect of treatment on the intakes of dry matter and water



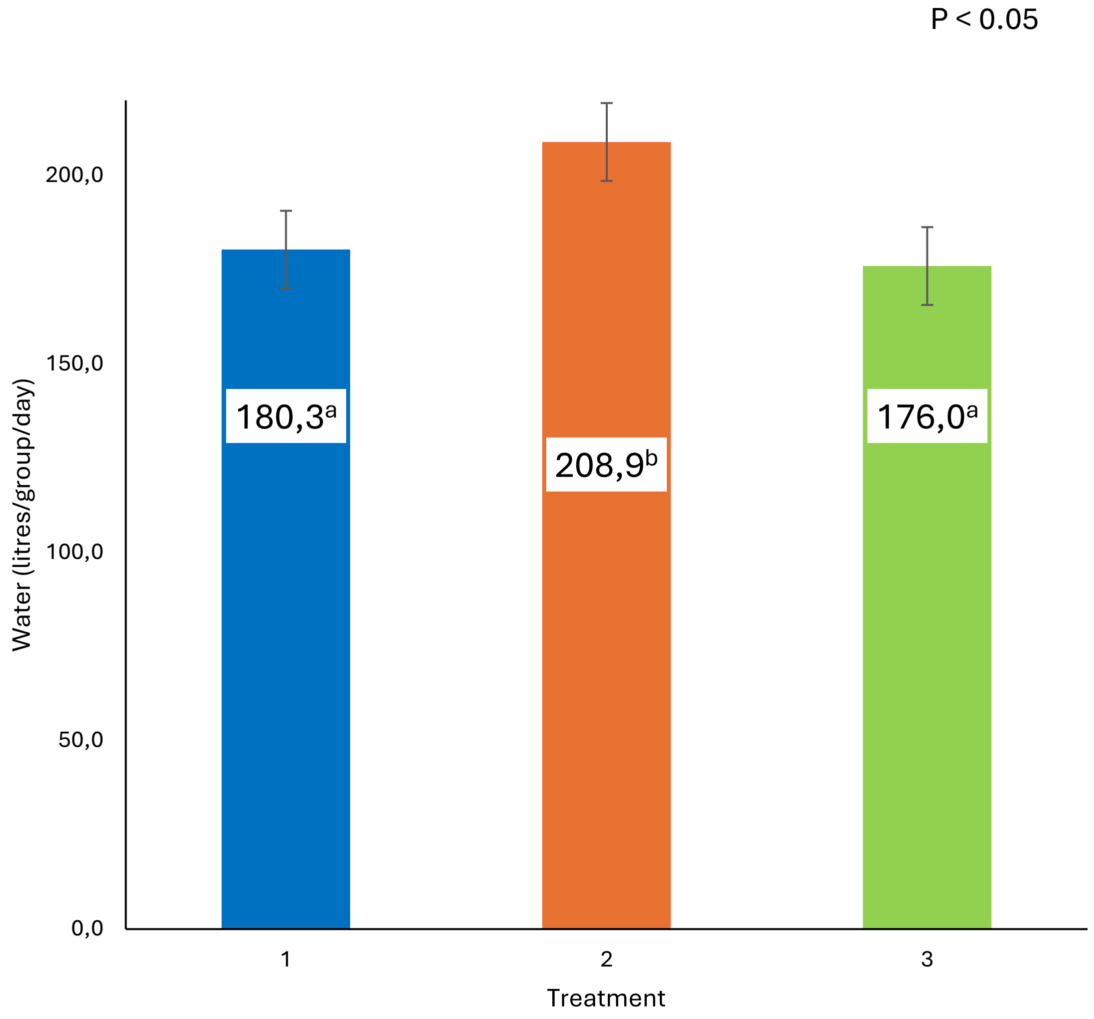


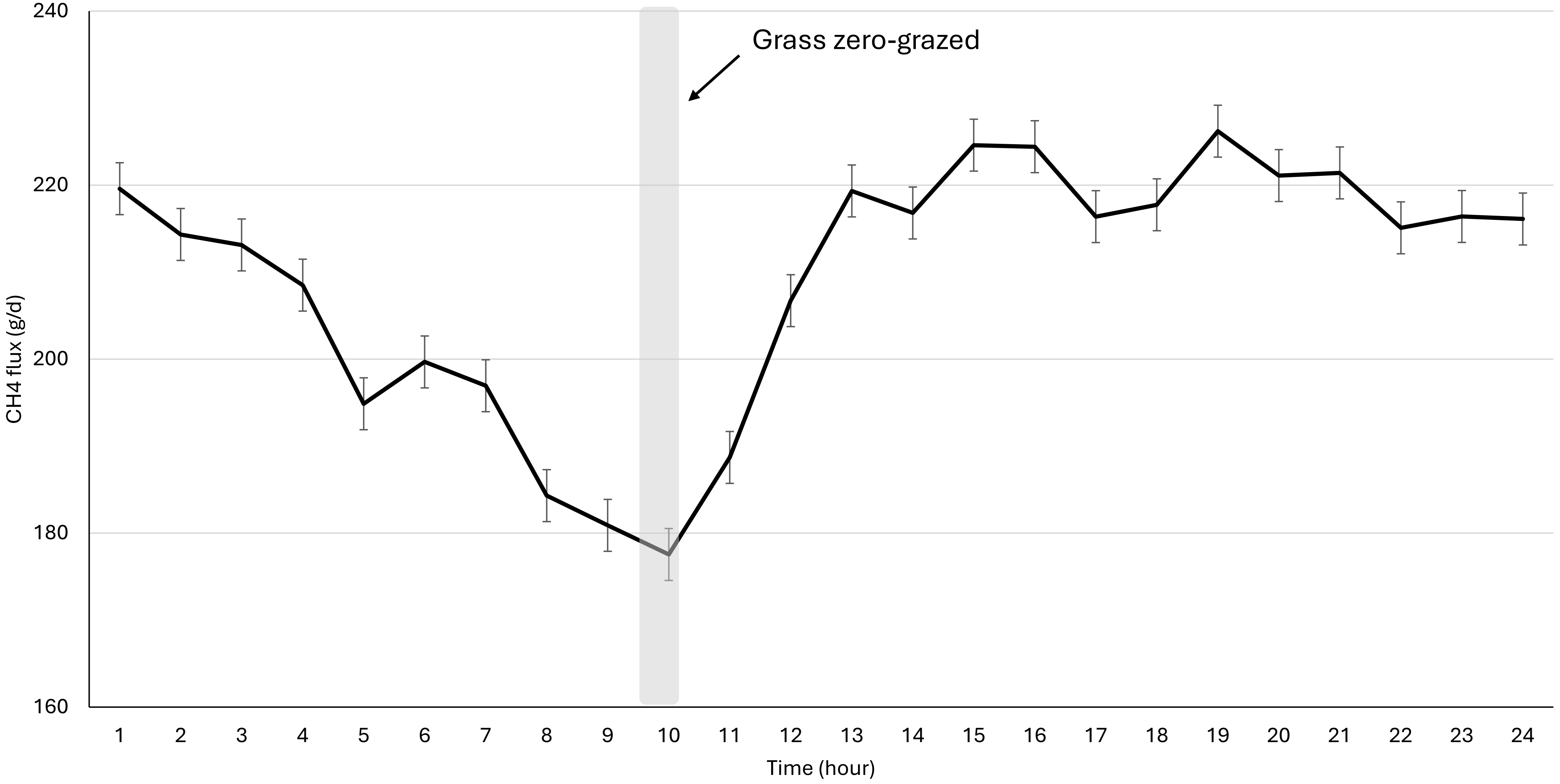
Table 2: The effect of treatment on animal performance parameters

	Diet				
	CTR	SW1	SW2	SEM	*P*-value
Initial BW (kg)	321.9	324.5	321.5	8.01	0.96
Final BW (kg)	425.7	420.2	429.7	5.09	0.43
Total weight gain (kg)	103.1	97.6	107.1	5.09	0.43
ADG (kg/d)	1.47	1.40	1.53	0.072	0.43

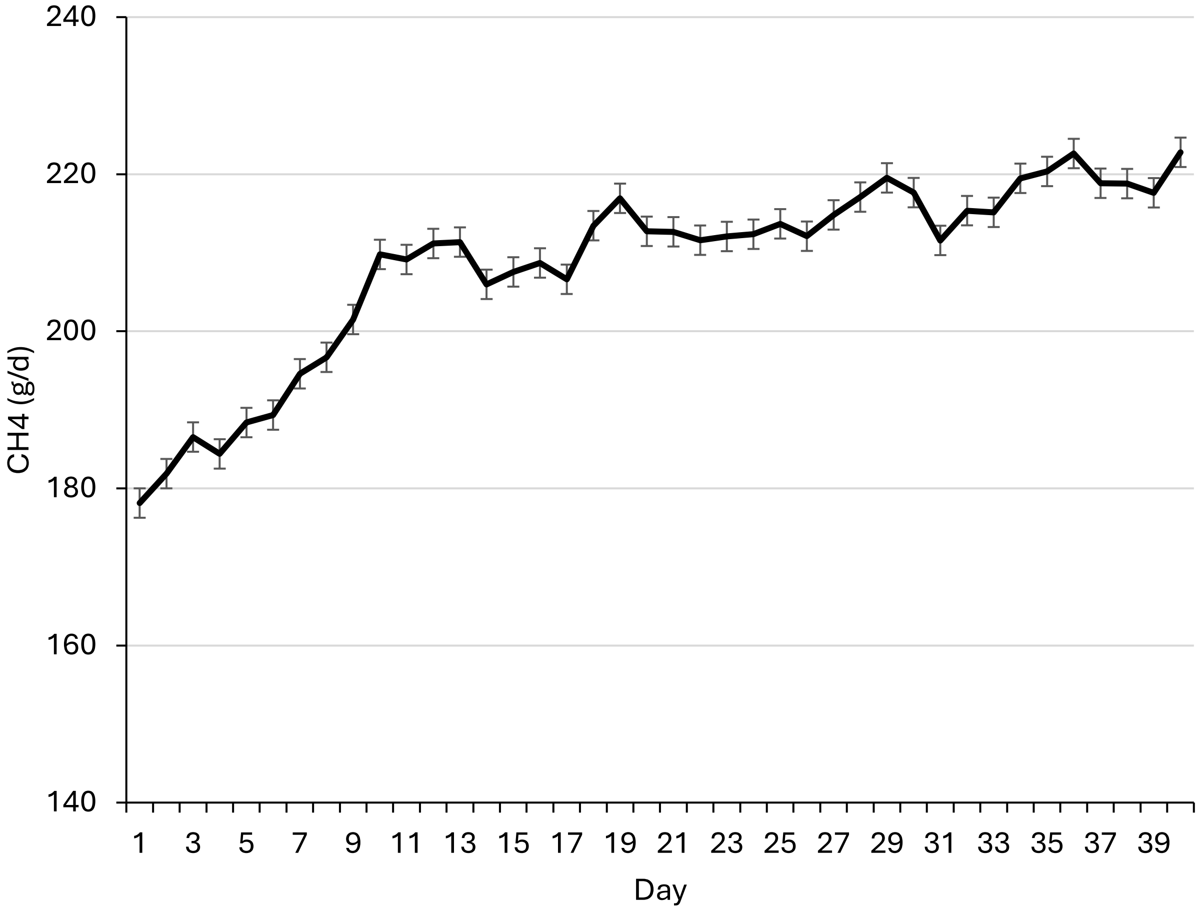
Table 3: The effect of treatment on gaseous emissions

	Diet				*P*-value		
	CTR	SW1	SW2	SEM	Trt	Period	Trt*Period
CH_4 (g/d)	206.9	210.5	205.3	4.34	0.69	-	-
CH_4 (g/kg BW)	0.57	0.57	0.55	0.008	0.19	-	-
CH_4 (g/kg ADG)	148.4	146.8	142.8	2.26	0.21	-	-
CO_2 (g/d)	7952	7991	8042	128.1	0.88	-	-
H_2 (g/d)	1.46	1.39	1.41	0.044	0.55	-	-
CH_4 during intake periods (g/d)	213.3	216.5	214.6	3.55	0.83	0.02	0.27
CH_4 (g/kg DMI)	25.0	25.4	24.5	0.45	0.45	0.20	0.62

Figure 3: Diurnal Pattern of CH_4 emissions



Figures 4 and 5: Relationship Between CH_4 and Body Weight



CH_4 expressed over the duration of the measurement period

Conclusions

- ASC extracts were effectively delivered to beef steers through a water-based system over a 70-d period and did not negatively affect water intakes
- No adverse effects on animal performance were observed, with consistent average daily gain and feed intake across all groups

Thank you

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