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Effect of spent coffee grounds from filtered specialty coffee as a by-product of processing on ruminal fermentation *in vitro*

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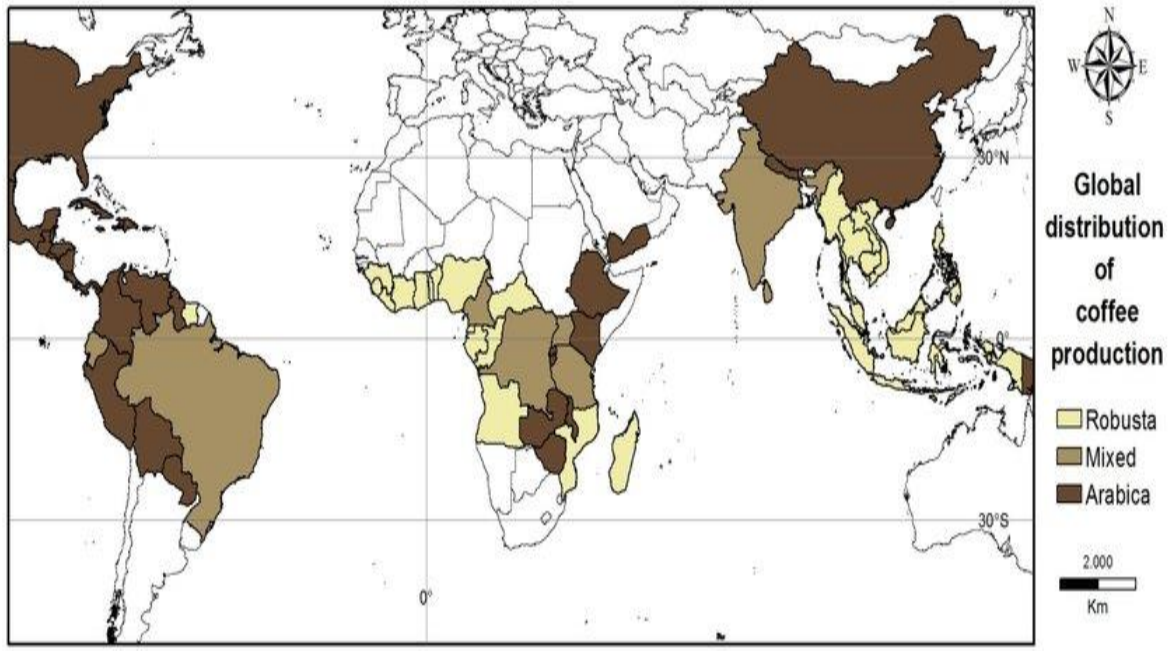
Coffee Plant



Coffea arabica

70% of world production 600 -1800 m.a.s.l.

Coffea canephora

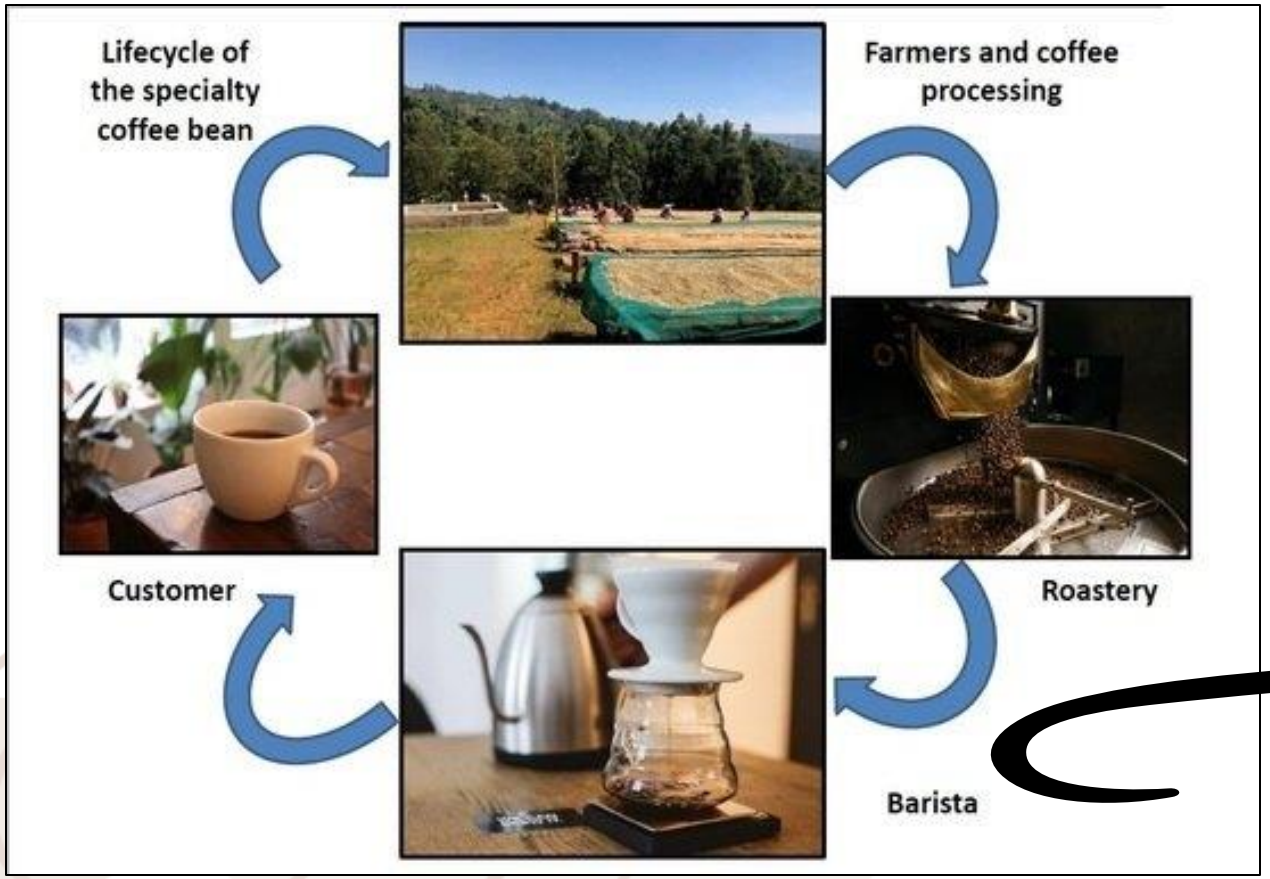
30% of world production 0 – 800 m.a.s.l.

Specialty Coffee

According to the **Specialty Coffee Association of America**, specialty coffee accounts for 5% of total coffee production, has a precisely defined birth certificate (origin), and earns a minimum of 85 out of 100 points on the international rating scale

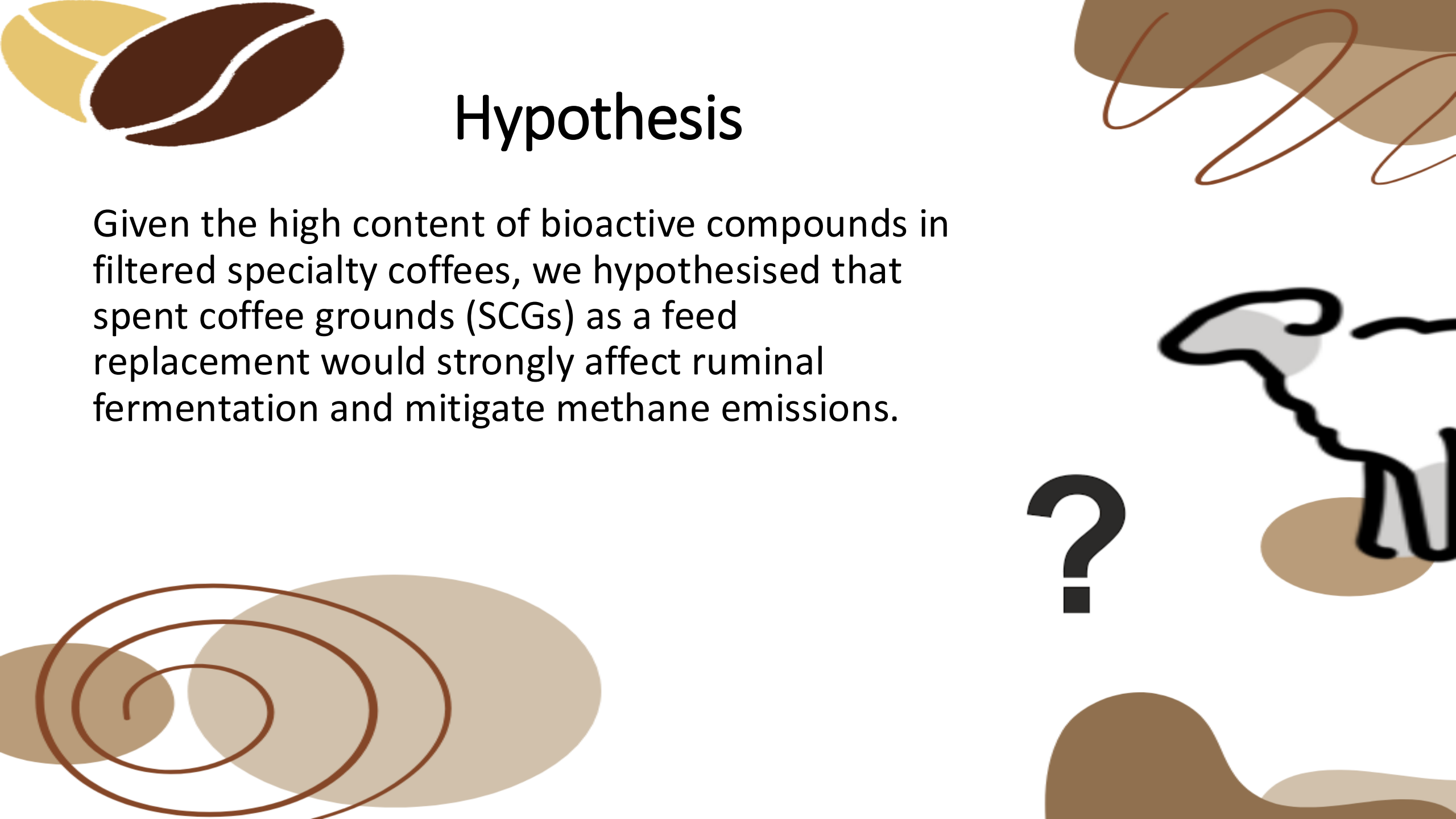
- High-quality beans with known geographical origin
- Specific postharvest processing methods
- Higher polyphenol content compared to conventional coffee

Spent Coffee Grounds



Hypothesis

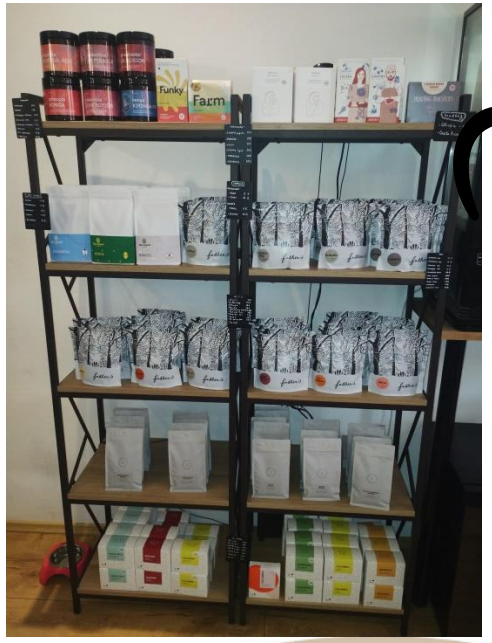
Given the high content of bioactive compounds in filtered specialty coffees, we hypothesised that spent coffee grounds (SCGs) as a feed replacement would strongly affect ruminal fermentation and mitigate methane emissions.



Objective

To quantify the bioactive compounds in Ethiopian specialty coffee (ETH), spent coffee grounds of ETH (SCG-ETH), and spent coffee grounds from blended specialty coffees (SCG-MIX), determine the effect of SCG-ETH on ruminal fermentation and methane emission characteristics in vitro.

Material and Methods



Material and Methods

Chemical analyses

- Nutritional analyses – DM, ADF, NDF, CP, Ash
- Quantitative analyses of bioactive compounds - UHRMS

In Vitro Ruminal Fermentation

- Batch culture fermentation of substrates (MH-BG, MH-SCG-ETH, BG-SCG-ETH, 1:1 w/w), rumen fluid:McDougall´s buffer (1:2), 39 °C, 24 hours, n=3×3
- Measurements:
    - Total Gas, Methane concentration, SCFAs (GC)
    - In vitro dry-matter digestibility (IVDMD)
    - pH
    - Ammonia nitrogen concentration
    - Ruminal Ciliate protozoan

Results

Table 1: Chemical compositions of the dietary substrates (n = 3)

	Dietary substrate				
	BG	**MH**	**ETH**	**SCG-ETH**	**SCG-MIX**
Dry Matter (g/kg)	895	900	962	878	908
Neutral Detergent Fiber (g/kg DM)	169	452	463	602	636
Acid Detergent Fiber (g/kg DM)	75	287	291	374	405
Crude Protein (g/kg DM)	118	124	114	105	109
Ash (g/kg DM)	25.6	96.2	42.5	8.21	11.3

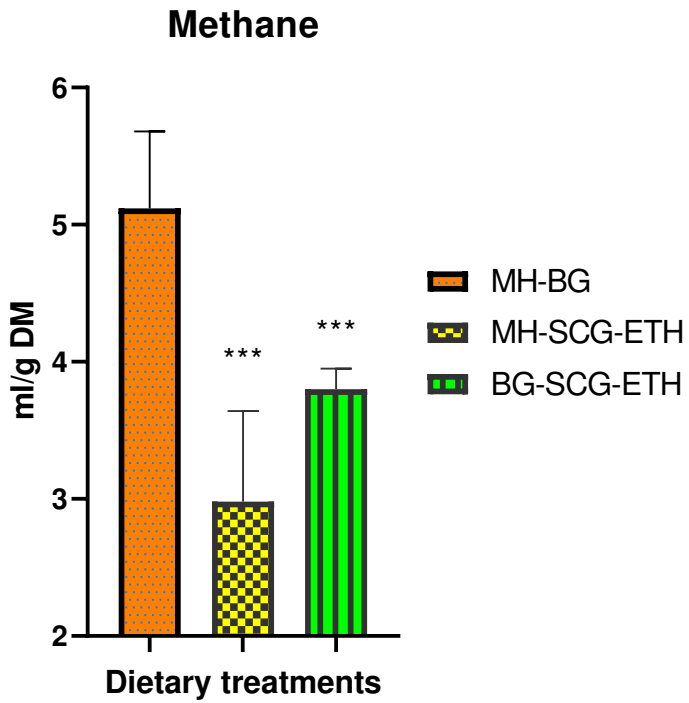
BG = Barley grain; MH = Meadow hay; ETH = Ethiopian coffee; SCG-ETH = Spent coffee grounds from Ethiopian specialty coffees brewed using the filtered method; SCG-MIX = Spent coffee grounds from blended specialty coffees brewed using the filtered method

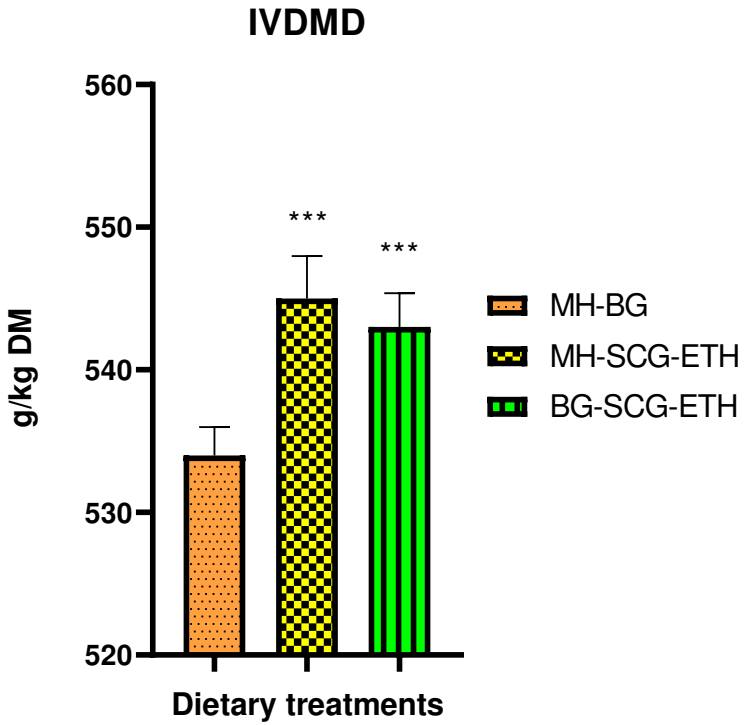
Results

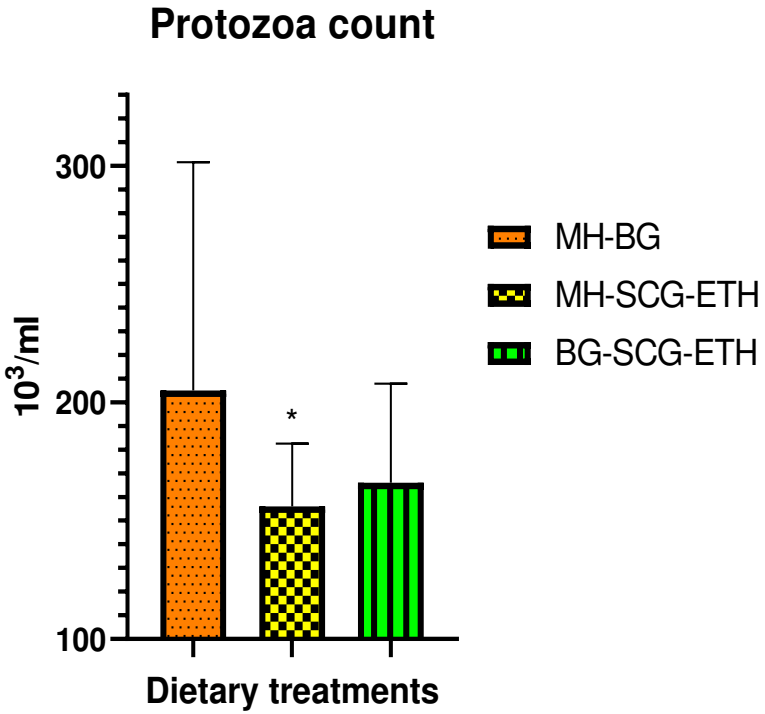
Table 2: Main bioactive compounds (mg/g DM) (n = 3, mean ± SD)

Compound	ETH	SCG-ETH	SCG-MIX	*P*
trans 3-O-Caffeoylquinic acid	1.71 ± 0.31^{a}	2.66 ± 0.21^{b}	2.45 ± 0.41^{ab}	0.025
cis 5-O-Caffeoylquinic acid	3.60 ± 0.71^{a}	7.35 ± 1.02^{b}	5.44 ± 0.52^{ab}	0.003
trans 5-O-Caffeoylquinic acid	9.04 ± 1.05	13.1 ± 4.01	10.5 ± 3.01	0.306
epimer 3-caffeoylquinic acid-1,5-lactone	0.85 ± 0.11^{a}	2.33 ± 0.32^{b}	2.62 ± 0.71^{b}	0.007
3-caffeoylquinic acid-1,5-lactone	2.13 ± 0.23	1.68 ± 0.41	1.64 ± 0.02	0.124
epimer 4-Caffeoylquinic acid-1,5-lactone	0.76 ± 0.01^{b}	0.41 ± 0.03^{a}	0.45 ± 0.02^{a}	< 0.001
3,4-Dicaffeoylquinic acid	0.41 ± 0.01^{a}	1.10 ± 0.03^{b}	1.20 ± 0.47^{b}	0.023
Total content	**20.9 ± 0.09^{a}**	**35.2 ± 0.24^{c}**	**31.2 ± 0.19^{b}**	**< 0.001**

Results


Methane
ml/g DM
6
5
4
3
2
***
***
MH-BG
MH-SCG-ETH
BG-SCG-ETH
Dietary treatments


IVDMD
g/kg DM
560
550
540
530
520
***
***
MH-BG
MH-SCG-ETH
BG-SCG-ETH
Dietary treatments


Protozoa count
10^3/ml
300
200
100
*
MH-BG
MH-SCG-ETH
BG-SCG-ETH
Dietary treatments

Results

Table 3: Effect of dietary substrates on fermentation parameters (n = 9, mean ± SD)

	Dietary treatments			
	MH-BG	**MH-SCG-ETH**	**BG-SCG-ETH**	***P***
Total SCFA (mM)	44.6 ± 3.06	47.6 ± 6.19	47.5 ± 2.14	0.233
Acetate (mol%)	60.9 ± 2.03	60.4 ± 2.25	59.6 ± 2.18	0.425
Propionate (mol%)	16.8 ± 0.37^{a}	18.3 ± 0.81^{b}	16.8 ± 0.75^{a}	< 0.001
n-Butyrate (mol%)	15.6 ± 1.22^{b}	13.2 ± 1.32^{a}	16.1 ± 1.61^{b}	0.005
iso-Butyrate (mol%)	1.75 ± 0.208^{a}	2.29 ± 0.18^{b}	2.19 ± 0.29^{b}	< 0.001
n-Valerate (mol%)	2.73 ± 0.698	2.98 ± 0.84	2.61 ± 1.42	0.742
iso-Valerate (mol%)	2.26 ± 0.380	2.83 ± 0.71	2.80 ± 0.72	0.115

BG = Barley grain; MH = Meadow hay; ETH = Ethiopian coffee; SCG-ETH = Spent coffee grounds from Ethiopian specialty coffees brewed using the filtered method; SCG-MIX = Spent coffee grounds from blended specialty coffees brewed using the filtered method. (1:1 w/w).

Conclusion

- Our research has highlighted the potential of spent coffee grounds from filter-brewed specialty coffees as a feed substitute for ruminants.

- Due to their bioactive compounds and relatively low cost, they could be used as alternative sources of feed with the potential to modulate ruminal fermentation, reduce methane emissions, and increase the digestibility of dietary substrates.

Thank You for Your Attention!