

In Vitro Gas Production, Methanogenesis, Dry Matter Degradability and Rumen Metabolites of Ripe and Abscised Unripe Mango Fruits of Three Varieties

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INTRODUCTION & AIM

- Ruminant Livestock, encompassing cattle, sheep, and goats are fundamental to global food security, serving as efficient converters of fibrous plant biomass into high-quality animal protein and dairy production.
- Enteric methane emission from ruminants represent a substantial contribution to anthropogenic greenhouse gas concentrations, accounting for approximately 15-20% of total global CH₄ emissions.
- Abscission of mango fruits does not only impact negatively on the environment but also contribute losses to the mango farmers (Ibrahim et al., 2025).
- Assessing the nutritional quality of abscised unripe mango fruits using the *in vitro* fermentation techniques will not only reveal its potential value as livestock feed within a short period of time but also help to mitigate the adverse effects of the wastes on the environment.
- The primary objective of this study is to evaluate the fermentation characteristics of abscised unripe mango fruits as a substrate in a simulated ruminant fermentation environment.

MATERIALS & METHOD

- Semi automatic *in vitro* gas production technique using the method of Theodorou (1994).
- The McDougall's buffer solution was prepared according to the procedure of McDougall (1948). The strained rumen fluid was diluted with the buffer solution at a ratio of 1 : 2 (v/v). McDougall's buffer solution was prepared by mixing distilled water with these chemical compounds; Sodium bicarbonate, Sodium chloride, Potassium chloride, Calcium chloride, Sodium phosphate dibasic, and Magnesium sulfate.
- Treatments: Timothy hay and three varieties of riped and unriped mango fruits (Alphonso, Mabrouka, and Zill). Approximately 0.5 g of substrates incubated for 48 hours. Methane measured using CO₂ absorption method.
- All data collected at the end of the experiment were subjected to statistical analysis of variance using general linear models (GLM) procedure of SPSS.
- Significant means were compared using DMRT at P<0.05.

Table 1: Chemical composition and metabolizable energy of Timothy hay (*Phleum pratense*), ripe and abscised unripe mango fruits of Alphonso, Mabrouka and Zill varieties.

Parameters (%)	Timothy hay	Alphonso		Mabrouka		Zill	
		Unripe	Ripe	Unripe	Ripe	Unripe	Ripe
Dry matter	94.59	95.13	96.68	95.27	94.93	96.21	95.43
Crude protein	12.23	7.35	5.76	7.06	6.37	6.99	6.19
Crude fiber	27.16	5.01	4.75	4.93	5.49	5.93	4.96
Ether extract	1.26	8.61	10.91	10.23	11.01	8.91	11.05
Crude ash	11.45	4.54	3.41	4.83	3.37	5.39	2.97
Nitrogen-free extract	47.90	74.49	75.41	72.93	73.76	72.77	75.24
Acid detergent fiber	38.13	10.40	10.26	10.33	9.81	11.60	9.75
Neutral detergent fiber	68.83	24.61	23.06	24.49	24.10	25.78	23.59
Lignin	7.25	2.98	3.22	2.61	3.27	3.22	3.23
ME (Kcal/kg DM)	3489	3583	3744	3650	3717	3534	3766

ME= Metabolizable energy.

RESULTS & DISCUSSION

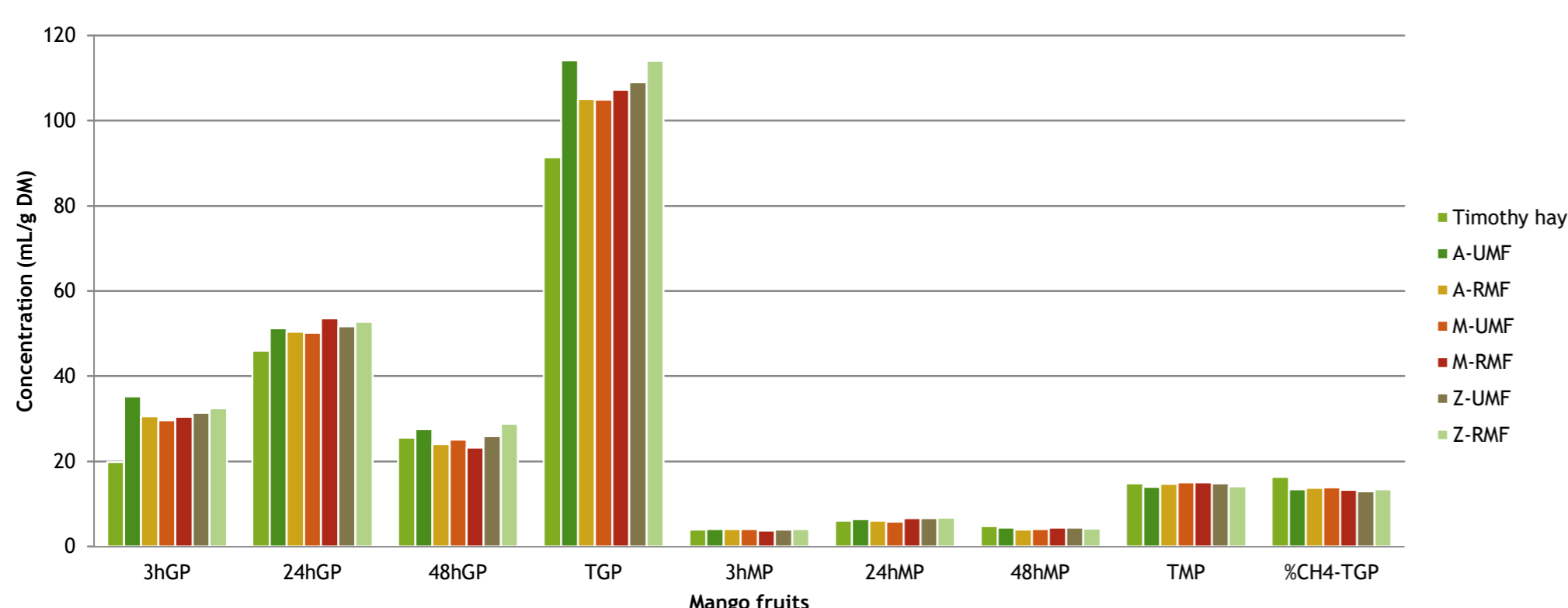


Figure 1: 3, 24 and 48 Hours Readings of Ruminal Gas and Methane Production of Ripe and Abscised Unripe Mango Fruits of Alphonso, Mabrouka and Zill Varieties.

Table 2. Ruminal Gas Production, Methanogenesis and *In vitro* Degradability of Ripe and Abscised Unripe Mango Fruits of Three Varieties.

Parameter	Alphonso		Mabrouka		Zill		SEM	P value	
	Timothy hay	Unripe	Ripe	Unripe	Ripe	Unripe			Ripe
TGP (mL/g DM)	91.42 ^b	104.9 ^a	107.2 ^a	108.9 ^a	114.0 ^a	114.1 ^a	105.1 ^a	4.52	0.001
Total CH ₄ (mL/g DM)	14.87	14.06	14.70	15.09	15.06	14.80	14.10	0.56	0.113
%CH ₄ -TGP	16.29 ^a	13.46 ^b	13.77 ^b	13.89 ^b	13.28 ^b	12.99 ^b	13.46 ^b	0.70	0.001
IVDMD (g/kg DM)	556.0 ^c	861.8 ^{ab}	923.5 ^a	845.0 ^{ab}	900.8 ^{ab}	895.8 ^{ab}	827.3 ^b	44.6	0.001
CH ₄ /IVDMD (mL/kg DM)	26.17 ^a	19.69 ^b	18.92 ^b	18.86 ^b	17.97 ^b	17.86 ^b	18.93 ^b	2.41	0.032

^{abc} = means with different superscripts differ significantly at p < 0.05 across rows, SEM=Standard error of mean, P=probability, TGP=total gas production, IVDMD=*in vitro* dry matter degradability.

- The total gas production (TGP) and *in vitro* dry matter degradability (IVDMD) of ripe and abscised unripe mango fruits of Alphonso, Mabrouka and Zill varieties were statistically similar and significantly higher (P<0.05) than the Timothy hay.
- Although, no significant difference (P>0.05) was observed in total enteric CH₄ production (mL/g DM) among the Timothy hay and the mango fruits of the three varieties, the percentage of CH₄ to gas production, TGP/IVDMD and CH₄/IVDMD were higher (P<0.05) in the Timothy hay than the ripe and abscised unripe mango fruits of Alphonso, Mabrouka and Zill varieties.

Table 3. Rumen Indices of Timothy hay (*Phleum pratense*), Ripe and Abscised Unripe Mango Fruits of Alphonso, Mabrouka and Zill varieties.

Rumen indices	Timothy hay	Alphonso		Mabrouka		Zill		SEM	P value
		Unripe	Ripe	Unripe	Ripe	Unripe	Ripe		
pH	6.77 ^a	6.56 ^b	6.64 ^b	6.66 ^{ab}	6.56 ^b	6.58 ^b	6.55 ^b	0.06	0.001
NH ₃ -N (mg/dL)	16.69	13.32	16.67	16.00	16.64	13.33	13.45	2.00	0.159
VFAs (mmol/L)	110.0 ^b	130.1 ^{ab}	140.1 ^{ab}	130.0 ^{ab}	123.3 ^{ab}	133.3 ^{ab}	150.0 ^a	12.58	0.014
Expressed as % of VFAs									
Acetic acid	63.39 ^a	57.89 ^{ab}	59.17 ^{ab}	60.83 ^{ab}	58.33 ^{ab}	54.51 ^{ab}	52.78 ^b	4.31	0.029
Propionic acid	19.94 ^b	24.81 ^{ab}	21.63 ^{ab}	21.03 ^{ab}	24.14 ^{ab}	24.36 ^{ab}	29.17 ^a	3.69	0.048
Butyric acid	9.75	10.20	8.70	11.38	11.84	11.02	10.32	2.29	0.331
Iso-butyric acid	3.89	4.10	5.49	3.76	5.69	5.12	4.72	1.23	0.196
A:P	2.73 ^a	2.04 ^b	2.19 ^b	2.15 ^b	2.03 ^b	2.12 ^b	1.81 ^b	0.26	0.043

^{ab} = means with different superscripts differ significantly at p < 0.05 across rows, SEM=Standard error of mean, P=probability, VFAs=volatile fatty acids, A:P= acetate to propionate ratio.

- The ripe mango fruit of Zill variety had significantly higher (P<0.05) volatile fatty acids (mmol/L) and propionic acids but lower acetic acids production than the forage while other tested mango fruits showed higher but non-significant volatile fatty acids (VFAs) and propionic acids production compared to the forage.
- The ratios of acetate to propionate were lower (P<0.05) in mango fruits compared to the Timothy hay.
- There was no difference (P>0.05) observed in the ruminal NH₃-N (mg/dL), butyric acids and iso-butyric acids production among the forage and the mango fruits of the three varieties.

CONCLUSION

- It can be concluded that abscised unripe mango fruits of Alphonso, Mabrouka and Zill varieties possess competitive nutritional quality as the ripe mango fruits; outperforming the Timothy hay as both livestock and climate-smart dietary ingredients.
- Also, it was observed that variety had no effect on the *in vitro* gas production, dry matter degradability and methanogenesis of mangos for both the ripe and abscised unripe fruits.

FUTURE WORK / REFERENCES

- These findings underscore abscised unripe mango fruits of Alphonso, Mabrouka and Zill varieties as alternative feeds for ruminants and other classes of livestock, warranting further investigation through *in vivo* studies to fully realize their potential in animal production systems.