In Vitro Effect of Peppermint (*Mentha Piperita*) Essential Oil on Gas Production Parameters of Wheat Straw Supplemented by Various Water Soluble Sugars or Starch

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ABSTRACT

The aim of the present study was to evaluate the effect of peppermint (*Mentha piperita*) essential oil (PE, 40 or 80 µl/g DM) on in vitro gas production potential of wheat straw (WS) supplemented with glucose (GLU), fructose (FRU), sucrose (SUC) or starch (STA) as 0.0, 30, 60 and 90 mg/g DM. Supplementation of WS with FRU, GLU (60 mg/g DM), STA and SUC (60 and 90 mg/g DM) caused a significant increase in the volume of gas produced (*b*). However, PE caused to reduce the *b* fraction of the samples evaluated ($p<0.05$). The fractional rate constant of gas production (*c*) was significantly ($p<0.05$) increased when FRU, SUC and PE was added to WS. In addition, *c* was significantly increased when PE as 40 µl/g DM was added to WS samples supplemented with both SUC and STA. However, there was no significant effect of PE when applied as 80 µl/g DM on *c* parameter of those treatments (except for WS supplemented with SUC at 90 mg/g DM).

Key Words: Essential oil, NFC, Gas production, Wheat straw

INTRODUCTION

Non-fibre carbohydrates (NFC) are an important source of energy in the rations of high producing ruminants, however, they vary in their effects on performance. It has been suggested that microbial growth is directly proportional to the rate of carbohydrate degradation (Russell et al., 1992). Differences among NFC components regarding microbial fermentation may also imply that the complement of NFCs in a particular feedstuff is important when predicting animal response. In ruminants, ionophores have been used to enhance ruminal fermentation. However, because of human health concerns, plant extracts and essential oils (EO) are used as alternative natural feed additives in replacement of ionophores (Garcia-Gonzalez et al., 2008). Earlier research with EO as modifiers of ruminal fermentation date to several decades ago but interest in these compounds was resurrected. Nevertheless, fewer studies have systematically investigated individual EO for ruminal effects. Several methods such as in vivo, in situ and in vitro techniques have been used in order to evaluate the nutritive value of feedstuffs. The in vitro gas production technique has proved to be a potentially useful technique for feed evaluation (Menke and Steingass, 1988; Getachew et al., 2004) as it is capable of measuring rate and extent of nutrient degradation (Cone et al., 2002). In addition, in vitro gas production technique provide less expensive, easily to determine (Getachew et al., 2004) and suitable for use in developing countries (Chumpawadee et al., 2005). The objective of this study was to evaluate the effect of various non-fiber carbohydrates and peppermint essential oil (PE) on the fermentation potential of wheat straw (WS).

MATERIAL AND METHODS

Samples of WS were ground through a 1 mm screen and dried in an oven at 66ºC for 48 h. PE is produced by heating peppermint leaves and stems to 100˚C for 6 h and collecting the vapour as a distillate. Treatments were WS, WS plus NFC including glucose (GLU), fructose (FRU), sucrose (SUC) and starch (STA) in 3 levels (30, 60 and 90 mg/g DM), WS plus PE (40 and 80 µl/g DM), WS with SUC and STA at 60 and 90 mg/g DM plus PE (40 and 80 µl/g DM). In vitro gas production parameters of the samples were determined using the Menke and Steingass (1988) procedure. Rumen fluid was obtained from two rumen cannulated sheep (45.5 ± 2 kg, body weight) before the morning feed and immediately strained through four layers of cheesecloth. Animals were fed once daily at the maintenance level with 1.5 kg DM lucerne hay and 0.4 kg DM concentrates (165 g CP/ kg DM) per head per day. Approximately 0.3 g of sample (four replicate for each treatment) was placed in a 100 ml glass syringe. The syringes were prewarmed at 39ºC before the injection of 40 ml of buffered rumen fluid (ratio of buffer to rumen fluid was 2: 1) into each syringe followed by incubation in a water bath at 39ºC. The volume of gas produced was recorded at 2, 4, 8, 12, 24, 36, 48, 72 and 96 h after incubation. Total gas values were corrected for blank incubation. Cumulative gas production data were fitted to an exponential equation of $P = b\ (1 - e^{-ct})$, where b is the volume of gas produced, c is the fractional rate constant of gas production (/h), t is the incubation time (h) and P is the volume of gas produced at time t. All of the data were analysed by using software of SAS (1999) and the gas production parameters of the supplemented samples were compared with WS as control using dunnet's test at $p<0.05$.

RESULTS AND DISCUSSION

The effect of NFC on in vitro gas production parameters (b and c) of wheat straw are shown in Table 1. Among NFC sources used, three levels of fructose, GLU as 60 mg/g DM, STA and SUC as 60 and 90 mg/g DM significantly increased the volume of gas produced (*b*) from WS. Also, the fractional rate constant of gas production (*c*) was significantly increased when FRU as 60 and 90 mg/g DM and SUC as 60 mg/g DM was added to the medium ($p<0.05$). These data indicate that the fermentability of WS was altered by FRU and SUC supplementation. It might be concluded that each source of NFC evaluated in the present study caused unique pattern of fermentation when added to WS as a fibrous feed.

Table 1 Gas production parameters of wheat straw as non supplemented or supplemented with non-fibre carbohydrates

Treatments	Level of NFC (mg/g DM)	Gas Production Parameters	
		b	*c*
WS	0	86.74 [a]	0.024 [a]
WS FRU	30	97.41 [b]	0.028 [a]
	60	99.65 [b]	0.030 [b]
	90	106.59 [b]	0.031 [b]
WS GLU	30	90.86 [a]	0.020 [a]
	60	92.97 [b]	0.023 [a]
	90	91.19 [a]	0.025 [a]
WS STA	30	86.49 [a]	0.021 [a]
	60	94.35 [b]	0.021 [a]
	90	100.82 [b]	0.023 [a]
WS SUC	30	89.62 [a]	0.027 [a]
	60	107.3 [b]	0.029 [b]
	90	102.81 [b]	0.029 [a]
s.e.m		3.29	0.001

[a, b]Means within each feed sample with a different letters in each column are significant

The effect of PE on in vitro gas production parameters of WS are shown in Table 2. Supplementation of WS with PE at both levels significantly reduced the volume of gas produced but increased the fractional rate constant of gas production. The results indicate that PE particularly as 80 µl/g DM had a potential to reduce the fermentability of WS.

Table 2 Effect of peppermint (*Mentha piperita*) essential oil on gas production parameters of wheat straw

Gas Production Parameters	Wheat straw			SEM	p-value
	PE(µl/g DM)				
	0.0	40	80		
b	86.74 [a]	9.51 [b]	5.06 [b]	1.06	< 0.05
c	0.024 [a]	0.16 [b]	0.049 [b]	0.007	< 0.05

[a, b]Means within each feed sample with a different letters in each row are significant

The effect of NFC and PE on in vitro gas production parameters of WS are shown in Table 3. PE reduced significantly b parameter of WS samples supplemented with both SUC and STA. In addition, *c* was significantly increased when PE as 40 µl/g DM was added to WS samples supplemented with both SUC and STA. However, there was no significant effect of PE as 80 µl/g DM on c parameter of those treatments (except for WS supplemented with SUC at 90 mg/g DM). The results indicate that PE particularly as 40 µl/g DM had a potential to alter the fermentability of WS supplemented with NFC sources. It might be concluded that there are interaction effects between each source of NFC and EO evaluated in the present study.

Table 3 Effect of non-fibre carbohydrates and peppermint (*Mentha piperita*) essential oil on gas production parameters of wheat straw

Gas Production parameters		Wheat straw									
		STA				SUC					
		60mg/g DM		90mg/g DM		60mg/g DM		90mg/g DM			
		PE(µl/g DM)		PE(µl/g DM)		PE(µl/g DM)		PE(µl/g DM)			
	ws	40	80	40	80	40	80	40	80	SEM	p-value
b	86.74 [a]	20.1 [b]	9.96[b]	23.33 [b]	15.65[b]	19.04 [b]	13.71[b]	22.9 [b]	16.22 [b]	0.88	< 0.05
c	0.024 [a]	0.063 [b]	0.02 [a]	0.06 [b]	0.020[a]	0.115[b]	0.022[a]	0.132[b]	0.035[b]	0.004	< 0.05

[a, b:] Means within each feed sample with a different letters in each row are significant.

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