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Influence of *Dill* (*Anethum sowa* roxb.) straw powder inclusion on *in-vitro* gas production and wheat straw fermentation by mixed rumen micro-organism

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Abstract

Present experiment assessed the effect of *Dill* (A*nethum sowa* roxb.) straw inclusion on the fermentation of wheat straw in *in-vitro* gas production. *Dill* straw contained 95.4, 3.1, 74.1, 53.3, 47.5 and 8.5% of OM, CP, NDF, ADF, cellulose and lignin, respectively with 9.95% total phenol and 0.27 g/kg condensed tannins. The metabolizable energy (ME) content was 5.65 MJ/ kg DM. The inclusion of graded levels of *Dill* straw powder (0, 5, 10, 15, 20 and 25%) significantly improved *in-vitro* fermentation gas production (P=0.003). Gas production (mmol gas/ g DM) shown a linear increasing trend (P=0.103) with increasing levels of *Dill* straw. Though gas production increased still fermentation efficiency shown a decline trend (P=0.144). A linear improvement in truly degradable DM and OM (g/ kg; P= <0.001) and ME content (P = 0.003) was with increasing levels of *Dill* straw. Microbial biomass production, partitioning factor and NDF degradability coefficient were not affected by *Dill* straw inclusion levels. The gas production (mmol/g DM) increased by 1.54 mmol accounting 10.6 % increase, with an improvement of 41.31 g/kg accounting to 8.9% of truly degradable OM (TDOM) with 25 % *Dill* straw. The increase in gas production corresponded with improved TDOM resulted in increased ME of substrate by 11.4%. Inclusion of 25% *Dill* straw powder seems promising to manipulate rumen fermentation favourably upon poor quality feeding.

Keywords: Chemical composition, *Dill* straw, Fermentation, Gas production, Utilisation

Abbreviations: ADF: Acid detergent fibre; **CP**: Crude protein; **DM**: Dry matter; **MBP**, Microbial biomass production; **ME**: Metabolizable energy; **MJ**: Mega Joule; **NDF**: Neutral detergent fibre; **OM**: Organic matter; **PF**: Partitioning factor; **TDDM**: Truly degradable dry matter; and **TDOM**: Truly degradable organic matter

Introduction

Dill (*Anethum sowa* Roxb.) is a traditional seed spice commonly known as ÔSowaÕand the herb is grown for its seed and seed oil. The seed contains 18% total lipids and essential oil content, which varies from 2.5 to 5.0% of seed (Malhotra and Vashishtha, 2008a). The Indian *Dill* oil contains Carvone (<20%) and dillapiole (15 to 35%). The oleoresin is obtained by solvent extraction. The seed is used as carminative, pain killer, antipyretic, stomachic, anti-flatulence and treats heat burns. It is very useful during indigestion, vomiting and promotes milk delivery in females. The seed production varies from 10 to 15 quintals/ hectare and straw approximately 20 to 30 quintals/ hectare. The seed residues obtained after oil extraction is a good source of protein, fat and fibre as cattle feed (Malhotra and Vashishtha, 2008b). The crop residue obtained after successful crop production is not utilised thus goes waste, either left in the field for natural decomposition or burned in the field, which adds carbon dioxide to the environment. The crop residues obtained after seed harvesting have similar flavour as of its seeds, which is used in traditional food preparations to add flavour and promote digestion. The plant secondary metabolites are being exploited to modify rumen fermentation in a way that promote rumen energetic efficiency through stimulated microbial growth, fibre fermentation and reduced green house gas emissions from rumen ecosystem due to enteric fermentation (Ramirez-Restrepo and Barry, 2005). It was hypothesized that traces bioactive secondary metabolites present in dill straw could manipulate rumen fermentation to a certain extent and may add to the dry matter availability for ruminants feeding in India. Therefore, the aim of present study was to assess the quality of *Dill* straw as feed and its influence (included as straw powder) on *in-vitro* gas production and fermentation characteristics of wheat straw by mixed rumen microbes.

Materials and Methods

The inclusion of *Dill* straw powder at 0, 10, 15, 20 and 25% in replacement of wheat straw as substrate was studied in an *in-vitro* system of fermentation using whole rumen fluid as microbial inoculums. The wheat straw and *Dill* straw were dried between 50 to 60 ºC till constant weight, grinded to pass through 1 mm screen and used for fermentation. The wheat straw was replaced by *Dill* straw on weight/weight basis for the study. For in-*vitro* gas production procedure of Menke and Steingass (1988) and for buffer preparation procedure of Mould *et al*. (2005) were followed. Total gas production was measured by piston displacement method for 24 h; volume of gas was converted to mmol assuming 1 mol of gas is equivalent to 22.4 litre of gas under the atmospheric pressure and temperature conditions of gas measurement in our institute laboratory. After the 24 hrs, the syringe contents were transferred in spout less beaker with repeated washing of neutral detergent solution and neutral detergent fibre (NDF) was estimated to assess truly degradable dry matter (TDDM). From these samples truly degradable organic (TDOM) was also estimated by ashing at 450°C for 4 hrs. The microbial inoculum donor animals were kept on diets at maintenance involving wheat straw and concentrate supplementation. AOAC (1995) analytical procedures were followed for the OM determination by ashing at 550^0C for 4 h and N estimation by a Kjeldahl technique. For NDF determination, the procedure of Van Soest *et al*. (1991) was followed without sodium sulfite or a-amylase, whereas the procedure described by Robertson and Van Soest (1981) was followed for ADF and lignin determination. The total phenols and condensed tannins were estimated using FAO/IAEA (2000) procedure. Metabolizable energy (ME), microbial biomass production (MBP) and fermentation efficiency were calculated following the procedure of Blummel *et al.* (1997). Results were subjected to analysis of variance for statistical significance test using general linear mathematical model as: Y_{ijk} = m + T_i + $e_{ij;}$ where: Y_{ijk}= Observation mean; m = General mean, T_i = Effect of i^{th} inclusion level (i = 1, 3), e_{ij}= Random error. The model also tested significance in term of linear and quadratic effects of inclusion levels (SPSS Base 14.0, 2005).

Results and Discussion

Dill straw contained 95.4, 3.1, 74.1, 53.3, 47.5 and 8.5% of OM, CP, NDF, ADF, cellulose and lignin, respectively. Total phenol was 9.95% and condensed tannin was 0.27 g/kg. The metabolizable energy (ME) content of *Dill* straw was 5.65 MJ/ kg DM. The chemical constituents of *Dill* straw revealed its suitability for feeding in ruminant animals as roughage, as the feed resources/ crop residues contained reasonable quantities of protein, cell wall fibre and lignin, and ME (Leng, 1990). The OM, CP and ME content of *Dill* straw was similar to methi (*Trigonella foenum-graecum*) straw. The *Dill* straw had nutrient contents, which were comparatively higher to straws of Indian cultivars of wheat (Misra *et al.,* 2013) and rice (Tripathi *et al*., 1996). However, crude protein content of *Dill* straw was lower than occurred in coriander straw (Tripathi *et al*., 2013) but it was similar to the range reported in wheat (Misra *et al*., 2013) and rice straw (Tripathi *et al*., 1996). Tannin content of *Dill* straw was low and several factors were reported responsible for polyphenol contents and their effects on digestibility (Bharathidhasan *et al*., 2013). Inclusion of graded levels of *Dill* straw powder at 0.5, 10, 15, 20 and 25% increased total gas production (P=0.006) and had a linear increase (P=0.003). Similarly, gas production as mmol/g of substrate incubated showed also a linear increase. At 25% inclusion gas production increased by 1.04 m mol/ g DM incubated, while this increase was 1.54 m mol/g DM fermented. But gas production per g substrate DM fermented was similar among different inclusion levels, whereas different levels of inclusion had a trend of linear (P=0.103) increase. The fermentation efficiency (ml gas/ mg DM fermented) was the highest at 15% inclusion level, although fermentation efficiency was not different among inclusion levels but had a trend (P=0.103) of increased fermentation efficiency with increasing levels of *Dill* straw. Tripathi *et al*. (2010a, b) also reported an improved fermentation of wheat straw with the inclusion of spices straws of Fenugreek (*Trigonella foenumgraecum* L.) and Fennel (*Foeniculum vulgare* Mill.). Inclusion of *Dill* straw powder improved dry matter fermentation and had a linear (P<0.001) improvement, indeed at 25% level of inclusion an improvement of 5.2% in dry matter fermentation was achieved. Similarly, truly degradable OM improved by 4.1% at 25% level of inclusion and showed linear (P<0.001) improvement trend. The ME of substrate also improved (P=0.061) by 0.65 MJ/kg substrate DM at 25% inclusion and had linear (P=0.003) improvement. Similar to present findings, Singh *et al.* (2011) reported improved rumen fermentation characteristics on tree leaves inclusion in hay based diets, which result better digestibility of nutrients. The microbial biomass production was not influenced and NDF digestibility coefficient remained unaffected by *Dill* straw inclusion at different levels. The partitioning factor (TDOM mg/ml gas) showed reducing (P=0.111) trend and ranged from 3.02 to 3.47 at different inclusion levels.

Table 1. Influence of graded levels of *Dill* (*Anethum sowa* Roxb.) straw powder on *in-vitro* fermentation characteristics of wheat straw

	Levels of *Dill* spice (mg/ 200 mg)						SEM	Significance*		
	0	10	20	30	40	50		Level	Lin	Quad
Gas ml/ 200 mg DM	20.73	21.41	22.20	24.87	25.12	25.39	0.628	0.066	0.003	0.735
mmol gas/ g DM incubated	4.63	4.78	4.96	5.55	5.61	5.67	0.140	0.066	0.003	0.737
mmol gas/ g DM fermented	13.02	13.69	14.21	14.71	14.90	14.56	0.338	0.554	0.103	0.415
Fermentation efficiency (ml gas/mg DM digested)	4.13	3.99	3.94	3.64	3.68	3.77	0.096	0.636	0.144	0.487
TDDM (g/kg)	447.15	444.20	449.27	474.42	481.54	499.42	5.142	0.001	0.000	0.163
TDOM (g/kg)	422.63	414.28	416.19	448.55	446.21	463.94	5.043	0.008	0.000	0.205
ME (MJ/ kg DM)	5.04	5.14	5.25	5.61	5.65	5.69	0.086	0.061	0.003	0.736
MBP (mg/ 200 mg DM)	25.57	22.76	21.33	20.76	19.86	22.16	1.246	0.809	0.332	0.357
PF (TDOM mg / ml gas)	3.47	3.30	3.23	3.05	3.02	3.11	0.082	0.581	0.111	0.457
NDF Digestibility Coeff.	0.311	0.293	0.286	0.305	0.300	0.310	0.004	0.556	0.708	0.152

*Level, inclusion level effect; Lin, linear effect; Quad, Quadratic effect

Conclusion

It was concluded that *Dill* straw has potential to manipulate rumen fermentation for better utilisation of dry roughages/forages in ruminant feeding. Inclusion of *Dill* straw at 25% level was found optimum in ruminant diets as it improved dry matter and organic matter digestibility and also the ME content of wheat straw.

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