Range Mgmt. & Agroforestry 34 (2) : 201-204, 2013
ISSN 0971-2070

Effect of graded levels of Coriander (*Coriander sativum* L.) straw powder inclusion on Wheat straw fermentation and gas production characteristics *in-vitro*

M. K. Tripathi*, Deepika Chaturvedi, R. C. Jakhmola and S. A. Karim
Central Sheep and Wool Research Institute, Avikanagar 304 501, Rajasthan, India
*Present address: Central Institute for Research on Goats, Makhdoom, Farah 281 122, India
Corresponding author e-mail: mktripathi@gmail.com
Received: 17th July, 2013 Accepted: 20th December, 2013

Abstract
Influence of Coriander straw powder inclusion on wheat straw fermentation and gas production characteristics were studied. It was hypothesized that straw of Coriander may have bioactive metabolites, which can manipulate fermentation under rumen ecosystem. Coriander straw contained CP (7.43%), NDF (73.18%), ADF (56.54%), cellulose (48.0%) and lignin (8.77%) in DM. This bio-resource also had 4.28 g total phenol and 0.131 g condensed tannins in each kg dry matter. The metabolizable energy (ME) content was 6.64 MJ/ kg DM. The inclusion of graded levels of Coriander straw powder (0, 10, 20, 30, 40 and 50 mg/ 200 mg substrate) did not change *in-vitro* fermentation of wheat straw. The production of gas (ml/ 200 mg substrate, m mol/ g DM incubated and mmol/g DM fermented) remained unchanged. Inclusion of Coriander straw linearly (p= 0.077) reduced NDF digestibility coefficient. Therefore, Coriander straw did not contain active secondary metabolites to a level that may affect fermentation potential or microbial fermentability of wheat straw, when added up to 25 % as substrate.

Keywords: Chemical composition, *Coriander* straw, Dry matter, 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; **TDOM**: Truly degradable organic matter

Introduction

Coriander (*Coriander sativum* L.) is herbaceous plant of Apiaceae family grown widely in India as a spice crop. The green stem and leaves are used in daily food preparations for its pleasant aromatic flavour, while seed obtained at maturity are used for flavour and also in traditional and modern medicines due to its active bio-chemical compounds. Coriander has properties of carminative, anti-flatulence, diuretic, stimulant, stomachie, appetiser, refrigerant, tonic, antiblious *etc*. The linalool, Ŭ- and ß- pinene, *p*-cymene, Ŭ-terpene are active compounds and oleoresin content is 0.4 per cent. The essential oil has properties of carminative, antiseptic, bactericidal, fungicidal and muscle relaxant. The seed powder is used for relief from fever, thirst, vomiting, sun stroke, controlling cough, diarrhoea and indigestion. India is producing 22000 metric tonnes coriander seed, and with seed to straw ratio 1:3, approximately 66000 metric tonnes of coriander crop residue are available annually. The coriander crop residues (straw) is not utilised and considered a waste. However, straw contains bioactive chemical constituents similar to seed spice but in low concentration. The straw has fragrance resembling to seed spice. Therefore, it was thought that the straw of coriander may improve digestion, bowel movements and reduce heat stress and the oil present may affect rumen microbial ecology because of antifungal and anti-bactericidal properties. The aim of present experiment was to assess the influence of graded levels of coriander straw powder inclusion on wheat straw fermentation and *in-vitro* fermentation characteristics.

Materials and Methods

The inclusion of Coriander straw powder at 0, 5, 10, 15, 20 and 25 % in replacement of wheat straw as substrate was studied in an *in-vitro* system of fermentation using whole rumen micro-biota as microbial inoculum. The wheat straw and Coriander straw were dried at 50-60ºC till constant weight and ground to pass through 1 mm screen and used for fermentation. The wheat straw was replaced by Coriander straw on W/W basis for the study.

In-vitro fermentation study

The *in-vitro* gas production procedure of 100 ml glass syringe was used for *in-vitro* fermentation. In brief, the straw samples were ground to pass 1 mm screen and a 200 mg homogenised sample was placed in the bottom of glass syringe, mixed with 30 ml microbial inoculum and incubated at 39°C for 24 hrs. The carbon dioxide was fluxed appropriately at several stages to maintain anaerobic conditions during the *in-vitro* fermentation. 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 laboratory. After 24 hrs, the syringe contents were transferred in 100 ml 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 recommended (Menke and Steingass, 1988; Mould *et al*., 2005) microbial inoculum contained distilled water 365 ml, buffer 183 ml (NH_4HCO_3, 4.0 g; $NaHCO_3$, 35.0 g; dissolved in 1000 ml water), macro-mineral solution 183 ml (Na_2HPO_4, 5.70 g; KH_2PO_4, 6.20 g, $MgSO_4.7H_2O$, 0.60 g; dissolved in 1000 ml water), micro-mineral solution 100 µl ($CaCl_2.2H_2O$, 13.2 g; $MnCl_2.4H_2O$, 10.0 g; $CoCl_2.6H_2O$, 1.0 g; $FeCl_3.6H_2O$, 8.0 g; dissolved in 100 ml water), strained rumen fluid 330 ml, rezasurie 0.01 mg and reducing solution 38.8 ml (1N NaOH, 2.0 ml; $Na_2S.9H_2O$, 285 mg and water 47.5 ml). The microbial inoculum donor animals were maintained on diets at maintenance involving wheat straw and concentrate supplementation.

Chemical analysis

The DM of straw was analyzed by drying at 100^{0}C for 24 h or to constant weight. The AOAC (1995) analytical procedures were used for the OM determination by ashing at 550^{0}C for 4 h and N estimation by a Kjeldahl technique. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined by a sequential procedure using the same sample. For NDF determination, the procedure of Van Soest *et al*. (1991) was used without sodium sulfite or α-amylase, whereas the procedure described by Robertson and Van Soest (1981) was used for ADF and lignin determination. The NDF and ADF are expressed with residual ash. Lignin was estimated using sulphuric acid procedure. The total phenols and condensed tannins were estimated following the procedure of FAO/IAEA (2000).

Table 1. Influence of graded levels of Coriander straw powder on *in-vitro* fermentation (24 h) characteristics of wheat straw

	Levels of Coriander spice (mg/ 200 mg)						SEM	Significance		
	0	10	20	30	40	50		Level	Lin*	Quad**
Gas ml/ 200 mg DM	20.43	21.04	21.47	20.45	21.03	18.16	0.837	0.913	0.502	0.435
mmol gas/ g DM incubated	4.56	4.70	4.79	4.57	4.69	4.05	0.187	0.913	0.502	0.435
mmol gas/ g DM fermented	12.35	12.43	13.77	14.10	16.55	11.95	0.564	0.120	0.296	0.118
Fermentation efficiency(ml gas/mg DM digested)	4.59	4.44	3.93	3.97	3.54	4.63	0.156	0.218	0.413	0.067
TDDM (g/kg)	475.69	477.32	441.79	422.63	386.57	432.70	11.753	0.164	0.029	0.382
TDOM (g/kg)	444.58	452.29	418.43	385.83	343.17	401.53	12.109	0.050	0.011	0.357
ME (MJ/ kg DM)	5.00	5.08	5.14	5.00	5.08	4.69	0.114	0.914	0.507	0.435
MBP (mg/ 200 mg DM)	28.57	28.87	22.60	19.53	11.44	27.70	2.062	0.052	0.098	0.084
PF (TDOM mg / ml gas)	3.74	3.68	3.27	3.19	2.78	3.81	0.135	0.143	0.321	0.068
NDF Digestibility Coefficient.	0.347	0.348	0.303	0.278	0.233	0.290	0.015	0.147	0.025	0.383

*Linear effect, ** Quadratic effect

Mathematical calculations and statistical analysis

The metabolizable energy (ME), microbial biomass production (MBP) and fermentation efficiency were calculated following the procedure (Blummel *et al.,* 1997) using total gas production as: ME (MJ/ kg DM) = 2.2 + (0.136 × actual gas, ml/ 200 mg DM) + (0.0057 × % CP); MBP (mg/ 200 DM) = [Truly degradable OM/ 200 mg DM ï (2.2 × actual gas, ml/ 200 mg DM)]; Fermentation efficiency = (mg DM digested/ ml gas produced). Results were subjected to analysis of variance for statistical significance test using general linear mathematical model as: $Y_{ijk} = \mu + T_i + e_{ij;}$ where: Y_{ijk}= Observation mean; μ = 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

The coriander straw at 94.2 per cent dry matter had organic matter (92.8%), crude protein (07.4%), neutral detergent fibre (73.2%), acid detergent fibre (56.5%), hemicelluloses (16.6%), cellulose (48.8%) and lignin (8.8 percent). The total phenolic contents were 4.28, while condensed tannin content was 0.131 g/ kg DM. Inclusion of coriander straw powder from 0 to 25 per cent in wheat straw did not affect total gas production (ml/ 200 mg substrate), mmol/ g DM incubated and mmol/g DM fermented, which ranged from 18.16 to 21.47 ml, 4.56 to 4.79 and 11.95 and 14.10 mmol respectively. Fermentation efficiency varied from 3.54 to 4.63 and was similar among different inclusion levels. Inclusion of powder reduced dry matter degradation linearly (p=0.029) and was the lowest at 20 per cent inclusion level having 8.91 per cent reduction, while organic matter fermentation reduced by 10.1 per cent at 20 per cent inclusion and OM digestibility reduced linearly (p=0.011). The ME (MJ/kg substrate DM) content was not different among various inclusion levels and ranged from 4.69 to 5.14 MJ. Inclusion of coriander straw powder reduced (p=0.052) microbial biomass production (MBP) and had a linear (p=0.098) and quadratic (p=0.084) reduction trend. The quadratic reduction trend in MBP was at 20 percent inclusion level, which was reduced by 17.13 mg/ 200 mg substrate DM (Table 1). The MBP production ranged from 11.44 to 28.87 mg at different inclusion levels. Coriander straw powder inclusion also had reducing trend (p=0.143) for partitioning factor and NDF digestibility coefficient (p=0.147). At 20 per cent inclusion quadratic decrease (p=0.068) in partitioning factor was observed while NDF digestibility had a linear (p=0.025) decreasing pattern (Fig 1). This straw shown a typical characteristic of poor quality feed resources/ crop residues having low

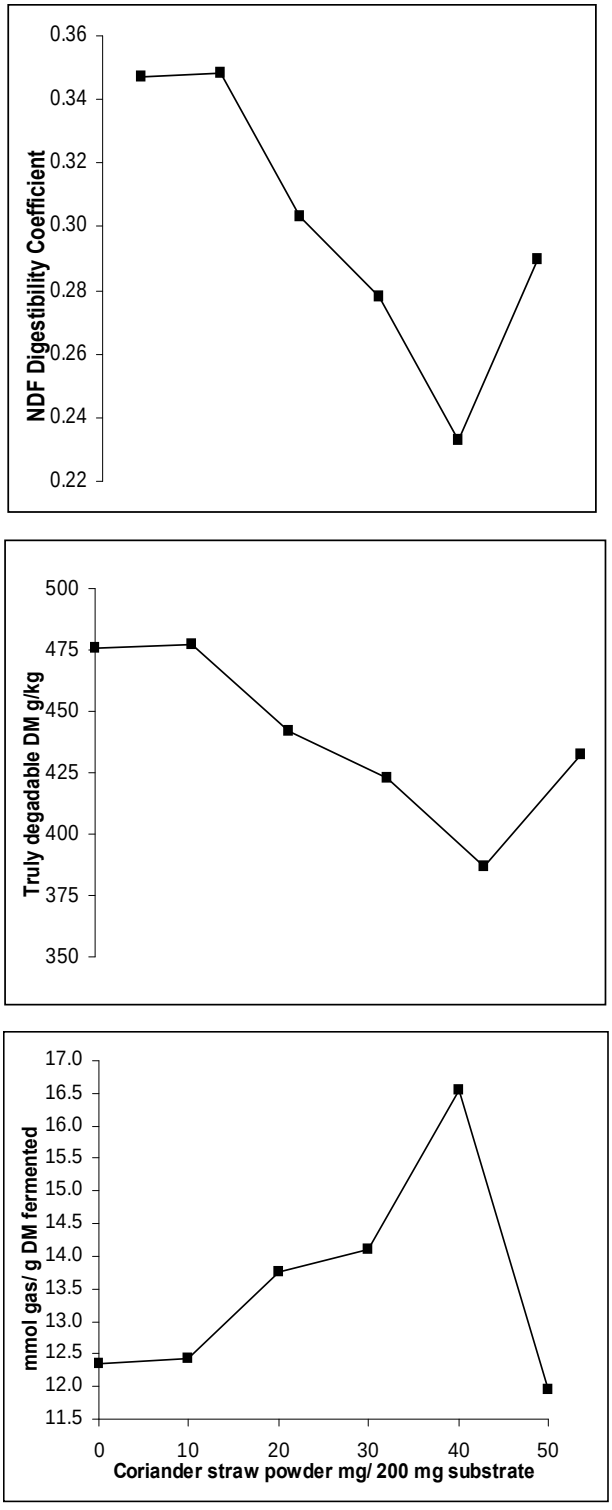

Fig. 1. Gas production, dry matter degradation and NDF digestibility coefficient as affected by graded levels of Coriander straw powder inclusion

protein, high fiber and lignin, and low ME (Leng, 1990). The OM and ME content of present coriander straw was similar to that reported by Tripathi *et al*. (2010 a & b) in Fennel and Coriander straw but crude protein content was lower in present study which may be attributed to the different agronomic practices. The coriander straw has nutrient content similar to straws of Indian cultivars of wheat (Misra *et al*., 2013) and rice (Tripathi *et al*., 1996), except of crude protein, which was higher by 2.5 to 3 % units. Although coriander straw had adequate crude protein to support microbial growth under rumen ecosystem, however, reduced dry matter, organic matter and NDF digestibility coefficient warrant its suitability as feed for ruminants to manipulate microbial ecosystem. Because *Coriander* straw did not contain active secondary metabolites to a level that affect fermentation potential or microbial fermentability of wheat straw, when added upto 25 % as substrate. Further studies require exploring suitability of coriander crop by-products as source of secondary plant metabolites.

References

AOAC. 1995. *Official methods of analysis*. 16th ed., Association of Official Analytical Chemists Washington, DC, USA.

Blummel, M., H. P. S. Makkar and K. Becker. 1997. In-vitro gas production: a technique revisited. *J. Anim. Physiol. Anim. Nutri*. 77:24-34.

FAO/IAEA. 2000. *Quantification of tannins in tree foliage*. A laboratory manual for the FAO/IAEA Co-ordinated Research project on '*Use of Nuclear and Related Techniques to Develop Simple Tannin Assay for Predicting and Improving the Ssafety and Efficiency of Feeding Ruminants on Tanniniferous Tree Foliage'*. Joint FAO/IAEA Division on nuclear techniques in food and agriculture, IAEA, Vienna. pp 4-6.

Leng, R. A. 1990. Factors affecting the utilization of poor quality forage by ruminants particularly under tropical conditions. *Nutri. Res. Rev*. 3:1-26.

Menke, K. H. and H. Steingass. 1988. Estimation of the energetic feed value from chemical analysis and *in vitro* gas production using rumen fluid. *Anim. Res. Dev.* 28:7-55.

Misra, A. K., K. K., Singh, T. A. Khan and G. H. Pailan. 2013. Estimation of wheat straw availability and variation in straw quality. *Range Mgmt. & Agroforestry* 34: 112-118.

Mould, F. L., R. Morgan, K. E. Kleim and E. Krystallidou. 2005. A review and simplification of the *in-vitro* incubation medium. *Anim. Feed Sci. Technol*. 123-124:155-172.

Robertson, J. B. and P. J. Van Soest. 1981. *The detergent system of analysis and its application to human foods*. Cornell University, Ithaca, New York, NY, USA.

Tripathi, M. K., M. Singh, C. Avinash, and A. S. Mishra. 1996. Rumen nutrient degradation pattern and their correlation in two varieties of rice straw. *Indian J. Anim. Sci.* 66:79-84.

Tripathi, M. K., Deepika Chaturvedi, R. C. Jakhmola and S. A. Karim. 2010a. Influence of Fennel (*Foeniculum vulgare* Mill.) straw powder inclusion on *in-vitro* gas production and wheat straw fermentability by mixed rumen micro-organism. *Range Mgmt. Agroforestry Symposium Issue* (B): 208-209.

Tripathi, M. K., Deepika Chaturvedi, R. C. Jakhmola and S. A. Karim. 2010b. Effect of graded levels of Fenugreek (*Trigonella foenumgraecum* L.) straw powder inclusion on wheat straw fermentation and gas production characteristics *in-vitro*. *Range Mgmt. Agroforestry Symposium Issue* (A): 44-46.

Van Soest, P. J., J. B. Robertson and B. A. Lewis. 1991. Methods for dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. Symposium: Carbohydrate methodology, metabolism and nutritional implications in dairy cattle. *J. Dairy Sci*. 74:3583-3597.