Comparing Chemical Composition and Phenolic Compounds of Some Herbals as Potential Feed Additives in Ruminant Nutrition

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Abstract The chemical composition and phenolic compounds of eight herbals (*Alpinia officinarum*, *Artemisia absinthium*, *Cuminumcyminum*, *Dittrichia viscosa*, *Mentha rotundifolia* L., *Nigella sativa*, *Rosmarinus officinalis* L., and *Zingiber officinale*) were evaluated. Feed components were determined by proximate analysis, whereas phenolic and tannin compounds were analyzed by colorimetric procedures. The crude protein content of the herbal samples varied widely, being particularly high for *Nigella sativa* and low for *Alpinia officinarum* and *Rosmarinus officinalis.* The highest contents of total extractable phenols (TEP) and total extractable tannins (TET) were observed in the *Cuminumcyminum* and *Dittrichiaviscose* whereas

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herbals, *Nigella sativa* and *Zingiber officinale* showed lower concentrations. The tannin concentration varied considerably between species, but in general, the plants investigated in this study had low tannin contents (except for *Alpinia officinarum*). Based on the results above, it could be concluded that a large reserve of herbal species in the local flora is available that could be potentially used as additives for livestock feeding. These herbs appear to be promising alternatives to antibiotics in altering rumen fermentation and reducing methane production in ruminants.

Keywords Herbals · Plant secondary compounds · Rumen fermentation · Tannins

1 Introduction

Following the trends in human health care toward herbal medicinal products and plant-derived dietary supplements also in Veterinary medicine and livestock production, increasing use of herbs, essential oils, and plant extracts can be observed. Herbs offer a new perspective on the strategy to achieve lower antibiotic use in the farm, both to contrast antibiotic resistance and to reduce veterinary bills. Animal nutritionists tested the herbs or their extracts to improve the quality of the meat, the oxidative stability in particular, [11], to improve fiber digestibility, and also to reduce CH4 emissions and N excretion [8].

Plant herbs such as garlic, lemongrass, and peppermint are widely used as antibacterial agents and extensively used to maintain the microbial ecosystem of the gastrointestinal tract, especially in tropical regions. Despite their potential as feeds, most herbals contain large amounts of tannins, which have most likely been evolved by plants as a defence mechanism against being consumed by herbivores. The presence of tannins at a high level in plants often limits their utilization as feedstuffs [7]. The anti-nutritive effects of tannins are associated with their ability to combine with dietary proteins, polymers such as cellulose, hemicellulose, and pectin, and minerals thus retarding their digestion [6]. As there is little information regarding these aspects for locally available herbs so the study was conducted to compare the chemical composition and phenolic compounds of the different species of herbs as potential feed additives in ruminants animals.

2 Materials and Methods

Eights herbals were used in this study:

Alpinia officinarum (Rhizome) (*A. officinarum*), *Artemisia absinthium* (aerial part) (*A. absinthium*), *Cuminumcyminum* (seeds) (*C. cyminum*), *Dittrichiaviscosa* (aerial part) (*D. viscosa*), *Mentha rotundifolia* L. (aerial part) (*M. rotundifolia* L.), *Nigella sativa* (seeds) (*N.sativa*), *Rosmarinus officinalis* L. (leaves) (*R.officinalis* L.) and *Zingiber officinale* (Rhizome) (*Z. officinale*).

The freeze-dried samples were ground in a Willey Mill to pass through 1 mm sieve for the determination of chemical composition. Feed samples were analyzed for dry matter (DM) and following the method of AOAC (2000). Nitrogen was determined using the micro-Kjeldahl method (AOAC 2000). Crude Protein (CP) was calculated as N × 6.25. The neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) were analyzed according to Van Soest et al. [12] using the ANKOM Fiber Analyzer (ANKOM Technology, Fairport, NY). Both fiber fractions were expressed including residual ash. Total extractable phenols (TEP) were determined according to the method of Julkunen-Tiitto [3] using the Folin-Ciolateau reagent and tannic acid as standard. Total extractable tannins (TET) were estimated indirectly after adsorption of TEP to insoluble polyvinylpyrrolidone, and measuring the remaining total phenols in the supernatant [4]. Concentration of TET was calculated through subtraction as follows TET = TEP − non-precipitable phenols. Free condensed tannins were measured in the extract using the butanol-HCl assay (Porter et.al., 1986), with the modifications of Makkar [5] and using purified quebracho tannin as standard. All chemical analyses were performed in triplicate.

3 Results

The crude protein content of herbals samples varied widely; it ranged between 47 and 351 g kg^{-1} DM, being particularly high for *N. sativa* and low for *A. officinarum* and *R. officinalis*. The lowest NDF and ADF content (199 and 131 g kg^{-1} DM) was found in D. viscose and the highest (517 and 272 g kg^{-1} DM) in *C. cyminum.* The TEP content varied widely from 40.33 g kg^{-1} DM g in *N. sativa* to 124.70 g kg^{-1} DM in *D. viscosa*, whereas the content of TET ranged from 25.06 g kg^{-1} DM in *R. officinalis* to 82.02 g kg^{-1} DM in *C. cyminum*. The highest contents of FCT and TCT were recorded fo r*A. officinarum* whereas *Z. officinale* showed lower concentrations. The FCT and TCT varied widely from 4.48–15.74 g kg^{-1} DM to 41.90–386.34 g kg^{-1} DM, respectively (Table 1).

4 Discussion

The significant variations among herbal samples in the cell wall components may be due to some inherent anatomical or morphological differences related to cell wall rigidity [13] and leaf/twig ratio in the samples used in the chemical analysis. The majority of the herbal species considered in this study contained below 40% NDF on a DM basis and this qualifies them as good quality plants [10].

The concentration of phenolic compounds in the collected herbals showed considerable variation among species. The analysis of specific tannins indicates the presence of some anti-nutritive factors in the samples. Except for some few species (*A. officinarum and A. absinthium*), the plants material investigated in this study had low

Table 1 Chemical composition and Phenolic compounds (g kg^{-1} dry matter) of Herbal plants

Botanical name	CP	NDF	ADF	TEP	TET	FCT	TCT
A. officinarum	47 ± 4.07	440 ± 1.32	252 ± 2.57	60.73 ± 6.08	39.02 ± 5.43	41.90 ± 3.75	386.34 ± 13.28
A. absinthium	228 ± 11.44	266 ± 5.32	189 ± 1.46	80.31 ± 4.68	57.43 ± 5.75	13.22 ± 2.16	87.71 ± 7.78
C. cyminum	209 ± 12.66	517 ± 7.95	272 ± 3.99	107.10 ± 9.47	82.02 ± 10.52	12.89 ± 2.15	24.29 ± 1.66
D. viscosa	147 ± 40.52	199 ± 4.59	131 ± 4.58	124.70 ± 12.86	68.47 ± 14.62	12.02 ± 6.13	52.16 ± 7.75
M. rotundifolia L.	233 ± 20.92	248 ± 8.24	145 ± 2.71	67.10 ± 5.48	41.82 ± 7.17	10.60 ± 1.63	69.87 ± 9.78
N. sativa	351 ± 10.43	293 ± 36.1	121 ± 8.75	40.33 ± 5.48	30.08 ± 0.82	6.93 ± 2.66	17.87 ± 4.45
R. officinalis L.	80 ± 20.62	329 ± 14.79	256 ± 5.84	76.47 ± 1.5	25.06 ± 5.66	5.81 ± 1.33	41.66 ± 3.25
Z. officinale	95 ± 2.55	347 ± 60.52	75 ± 0.89	41.65 ± 2.18	26.79 ± 2.51	4.48 ± 1.75	15.74 ± 1.93

CP: Crude protein; NDF: Neutral detergent fiber; ADF: Acid detergent fiber; ADL: Acid detergent lignin; TEP: Total extractable phenols; TET: Total extractable tannins; FCT: Free condensed tannins; TCT: Total condensed tannins

tannin contents, particularly in *Z. officinale,* which would be of little significance in their effects on digestion of nutrients by ruminants, consistently with result pointed out in the literature [2] with woody leguminous shrubs.

Several studies showed the strong antimicrobial activity of certain plant extracts against Gram − and Gram + bacteria. Plants readily synthesize substances for their defence against insects, herbivores, and microorganisms. The secondary plant metabolites such as flavonoids and tannins have been found to reduce methane production and meat' lipid oxidation and increase its alpha-tocopherol content [15], moreover, tannins prevent bloat of the rumen and possess anthelmintic properties [14].

5 Conclusions

Based on the results above, it could be concluded that a large reserve of herbal species in the local flora is available and could be potentially used for livestock feeding. These herbs appear to be promising alternatives to antibiotics in altering rumen fermentation and reducing methane production in ruminants.

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