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NUTRITIONAL STUDIES ON THE UTILIZATION OF VETIVER PLANTS (*VETIVERIA ZIZANIOIDES L.*) AS A NON -CONVENTIONAL FEED-STUFF FOR FEEDING SMALL RUMINANTS

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ABSTRACT

The present study was conducted to estimate the nutritive value of vetiver plants (*Vetiveria zizanioides L.*) with different levels of concentrates (30, 50 and 70% of DM) compared to clover hay. In vitro dry matter disappearance (IVDMD) and organic matter disappearance (IVOMD) were determined. Vetiver grass was planted at Middle Sinai research station (El-Maghara) and produced 2.14 ton/feddan. The chemical composition showed that Vetiver grass had 10, 24.6 and 3.2 % as crude protein, crude fiber and lipids contents. Metabolizable energy recorded higher values for vetiver grass compared to clover hay (2.05 vs 1.83 Mcal/kg DM). The IVCPD, and total gas production were significantly increased with increasing the level of concentrates. The results suggested that vetiver grass is a promising feed resource for feeding small ruminants under desert conditions in Sinai. While, in vivo studies are needed to estimate their actual nutritive values and their effects on animal performance.

Key words: vetiver grass , chemical composition, digestibility, gas production.

Introduction

The variety on the natural feed resources sought have motivated nutritionists to use nonconventional fodder plants as a part of the animal feed. Vetiver grass (*V. zizanioides*) is a perennial grass of the family Poaceae, which is originated from Southeastern Asia, India and tropical Africa. In mid-eighties vetiver grass was developed by the World Bank for soil and water conservation in India (Akhzari et al., 2013). At present, there are more than 100 countries cultivating and using vetiver (Chen, 1998). Some studies (Lavanaia, 2003) assessed the potential utilize of vetiver grass as commercially herbage for produce the scented oil that can be distilled from its roots. Other studies emphasized its effectiveness in erosion, sediment control, and to be highly tolerant to extreme soil conditions (Balasankar et al., 2013). Vetiver grass may also be a promising feed resource because it has various advantages such as high quality, fast growth rate and easy adaptation to the environment and can bear repetitive mowing without occupying farming land (Ahmadi Beni et al., 2014). However, there is limited information on their nutritive value and the utilization of this grass as animal feed. Therefore, the present study aimed to estimate the nutritive value of vetiver grass to provide support for future applications for feeding ruminants.

Material and Methods

Experimental grass preparation

The experimental field work was conducted in Middle Sinai research station (El-Maghara), Desert Research Center, Egypt and was divided into two parts. The first part included cultivating vetiver grass while the second part included nutritional evaluation of the cultivated grass with different levels of concentrate feed mixture (30, 50 and 70% of DM) compared to clover hay as traditional forage at in vitro level. Vetiver grass was planted in rows 75 cm apart and spaced 50 cm within the same row. The main source of irrigation was the ground water of which total dissolved salt ranged from 2500 ppm to 3000 ppm. The first cut was taken after a year of planting. The plant reached a height of 103 cm and produced 2.140 ton/ feddan under desert conditions in the middle Sinai station farm. The whole plant except roots were harvested, chopped (3-5 cm) then samples were dried at 50°C for 48 h using a forced air oven to prevent enzymatic degradation of the phenolic compounds present in the plant matter. Once dry, 200 g of plant matter was ground and sieved through a 2-mm screen. The grounded material was mixed well and then 100 g were sub-sampled, reground and passed through a 0.5-mm screen sieve. These finely ground subsamples were used in tannin analysis while the rest of the material was used for in vitro gas production analysis. Samples of concentrate mixture (CM), consisted of 25% cotton seed cake + 30% corn + 35% wheat bran + 3% rice straw + 3% molasses + 1% urea + 2% limestone and 1% common salt, were mixed with vetiver samples at level of 30 (D1), 50 (D2) and 70% (D3) of DM. Representative samples of vetiver grass hay, clover hay, concentrate mixture and the experimental diets (D1 consisted of 30 : 70 CM : vetiver grass, D2 consisted of 50 : 50 CM :vetiver grass and 70 : 30 CM : vetiver grass was taken for analysis.



Fig 1. Growing vetiver grass in May



Fig 2. Growing vetiver grass in November

Chemical analysis

Proximate analysis (DM%, CP%, CF%, EE% and Ash %) of vetiver hay, clover hay, concentrate mixture and the experimental diets (D1, D2 and D3) were conducted according to A.O.A.C. (1990). Fiber fractions [neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined according to Goering and Van Soest (1991). The NFC (non-fiber carbohydrate) was calculated as: $NFC = 100 - (CP + NDF + EE + Ash)$ and TDN (total digestible nutrient) was calculated as follow:

$TDN = 0.479 NDF + 0.704 NFC + 1.594 EE + 0.714 CP$ for forage (Jayanegara et al., 2019)

$TDN = 0.323 NDF + 0.883 NFC + 1.829 EE + 0.885 CP$ for concentrate (Jayanegara et al., 2019)

While metabolizable energy (ME) was calculated as follow: $ME (M \text{ cal/ kg DM}) = (TDN \times 3.6) / 100$ (Church and Pond, 1982).

Determine of saponins was according to the method of Segal et al. (1966). Total tannins (TT) were determined gravimetrically with copper acetate method according to Balbaa et al. (1986). Sodium (Na) and potassium (K) were determined by using the standard

flame photometry (Jackson, 1958). While calcium was determined by spectrophotometer (Gindler and King, 1972). Inorganic phosphorus was determined by atomic absorption spectrophotometer according to Chapman and Pratt (1961).

In vitro gas procedure

Three adult rams (mean weight 50 ± 0.8 kg) were used as a source of rumen liquor which was collected before feeding in pre-warmed insulated bottles then mixed and squeezed through 3-layers cheesecloth under continuous flushing with CO₂ and immediately transported to laboratory at 39°C for in vitro gas production procedure according to Menke and Steingass (1988). Each treatment was tested in 6 replicates accompanied by blank vessels (no substrate). 400 mg of milled substrate was added to the incubation vessels of 100mL capacity. Each vessel was filled with 40 mL of the incubation medium consisted of 292 mg K₂HPO₄, 240 mg KH₂PO₄, 480 mg (NH₄)₂SO₄, 480 mg NaCl, 100 mg MgSO₄·7H₂O, 64 mg CaCl₂·2H₂O, 4 mg Na₂CO₃ and 600 mg cysteine hydrochloride per 1 liter of distilled water and dispensed anaerobically in the 1:4 (v/v) ratio. Then the treatments were incubated at 39°C for 48h.

The average of the volume of gas produced from the blanks was deducted from the volume of gas produced per sample. After 48 h digestion, the samples were transferred into test tubes and centrifuge for 1h in order to obtain the residues which was then filtered using Whatman No 4 filter paper temperature ranges between 30°C and 42°C being the by gravity and the residues placed in for drying at 65°C for 24 h. The dry residues were weighed and digestibility calculated using the equation as follows:

$$\text{IVDMD (\%)} = [(\text{initial DM input} - \text{DM residue} - \text{Blank}) / \text{initial DM input}] * 100$$

Substrate residues after 48 h of incubation were dried and analyzed for proximate analysis.

Statistical analysis

Data obtained from each diet were analyzed for variance using an ANOVA procedure according to SAS (2000) using the following model: $Y_{ij} = \mu + a_i + \epsilon_{ij}$

where Y_{ij} is observation, μ is overall mean, a_i is the level of plant inclusion ($i = 1$ to 3), and ϵ_{ij} is error. Tukey's test was used for the multiple comparisons among mean values for the four plants and the significance level was set at $p < 0.05$.

Result and discussion

Chemical composition, minerals content and nutritive value of the experimental plants

Proximate analysis of clover hay, vetiver grass and concentrate mixture (CM) as energy feed supplements are shown in table (1). The results showed that clover hay and vetiver grass had comparable values of CP content (126 and 100 g/kg DM, respectively). The values obtained can meet the daily protein requirement of 70 g/kg DMI 100 for grazing animals (Okaraonye and Ikewuchi, 2009). As vetiver grass contained higher concentrations of lipids (EE) and non-fiber carbohydrate (NFC). Therefore, the nutritive value as total digestible nutrient (TDN) of vetiver grass surpassed their mates of clover hay (50.7 vs 57, respectively). The same trend of TDN was observed for metabolizable energy

(ME) as well. Metabolizable energy pattern could be attributed to TDN % of each feedstuff. These results suggested that vetiver grass has suitable crude protein and energy contents that could be considered high quality forage for animal feeding system.

On the other hand, the levels of total tannins and saponin in vetiver (61 and 63 g/kg DM, respectively) were higher than their values in clover hay (19 and 44 g/kg DM, respectively). From the level obtained in the present study, it is not likely that the saponin content of vetiver will affect its nutritional potentials to any significant extent (Falola *et al.* 2013). While the level of total tannins in vetiver grass could have adversely affect digestibility in sheep and cattle as reported by Diagayette and Huss (1981). Goat is known to tolerate about 90 g/kg DM dietary tannin (Natis and Malachek, 1981).

Data in table 2. showed that clover hay surpassed vetiver grass at all minerals concentrations. For both plants, P and Ca values are within the recommended requirement for maintenance and non-lactating goat (Kearl, 1982). However, P and Ca content in vetiver grass were below the recommended requirements for lactating and growing goat (Kearl, 1982). The results of all nutrients components and TDN values were in agreement with Abdou *et al.* (2011) for clover hay and disagree with Falola *et al.* (2013) and Ahmadi Beni *et al.* (2014) for vetiver grass that could be attributed to different climatic, environmental and stage of growth factors.

Chemical composition and nutritive value of the experimental diets

Data in table 3. Showed that Chemical composition in the term of DM, CP, CF, NDF, ADF, EE and NFE were comparable for all experimental diets (D1, D2 and D3). Diet 3 (70% CM : 30% vetiver grass) had higher values of DM, CP and NFC (910.134 and 386 g /kg DM, respectively), than those in diet2 and diet1. On the other side, it is noticeable that increasing the level of CM in the diets reflected the decrease in CF, NDF, ADF and EE values. While TDV values was nearly similar for D1, D2 and D3 (582, 59.1 and 59.8, respectively). Similar trends were observed by Kim *et al.* (2018) when they study the effect of different concentrate diet levels on determination of in vitro rumen fermentation and methane production.

In vitro nutrients digestibility and gas production of the experimental diets

The effect of different levels of vetiver grass (30,50 and 70%) in the experimental diets are shown in table (4). Increasing the level of vetiver into diets had no effect ($P < 0.05$) on dry matter, organic matter and NDF digestibility. While high level of vetiver grass (70% of DM) in diet1 have negative effect on crude protein digestibility. The lower digestibility of protein in D1 could be attributed to the higher concentration of total tannins and saponin in vetiver grass (shown in table 1.) that could reduce the nutrients digestibility (Ghandour *et al.* 2014). In this respect, Mousa (2011) reported low digestibility of acacia and ascribed that to the inhibitory effect of tannin on ruminal microbial activity.

The results of DM, OM, NDF digestibility was in agreement with Chen *et al.* (2010) and Ghorbani *et al.* (2011) who suggested that the level of concentrates have no adverse effect on nutrient digestibility.

Total gas production significantly varied among the experimental diets, the highest value was recorded for D1 (30% CM + 70% vetiver grass) while the lowest values was recorded for D3 (70% CM + 30% vetiver grass). It is noticeable the positive effect on vetiver grass on total gas production. It mainly attributed to higher tannin and saponin contents for

vetiver grass that reflect in reduction of total gas production and total number of ruminal Bacteria as well (Makkar 2003). The present study suggest that

1- vetiver grass contained adequate amount of crude protein and metabolizable energy for livestock requirements

2- The anti-nutritional contents as total tannin and saponin were below the toxic level

3- Diet included vetiver grass up to 50% of dry matter had the best nutrient digestibility and reduces total gas emission.

Conclusion

From the previous results we could conclude that vetiver grass had a pronounced nutritive value as a fodder plants, had sufficient protein and metabolizable energy, could reduce emission of total gas production and could be used up to 50% in small ruminant diet. Further in vivo studies are needed to confirm in vitro results.

Table 1. Chemical composition, fiber fraction and nutritive values of clover hay vs vetiver grass

Items	Chemical composition (g/kg DM)		
	Clover	Vetiver	CM*
DM	890	875	925
CP	126	100	148
CF	296	246	86
NDF	560	520	330
ADF	425	341	278
Ash	124	66	64
EE	17	32	27
NFC	173	282	431
TDN	50.7	57.0	61.0
ME (M cal/ kg DM)	1.83	2.05	2.19
Total tannins	19	61	Nil
Saponin	44	63	Nil

*CM: concentrate mixture

DM = dry matter, CP = crud protein, CF = crud fiber, NDF = nutrient detergent fiber, ADF = acid detergent fiber, EE: ether extract, NFC: non-fiber carbohydrate and TDN: total digestible nutrient

Table 2. Some minerals contents of clover hay vs vetiver grass.

Items	Clover hay	Vetiver grass
Na (g/kg DM)	14.8	8.4
K (g/kg DM)	17.3	13.6
Ca (g/kg DM)	9.3	5.2
P (mg/kg)	6.6	2.6

Na: sodium ,K :potassium, Ca: calcium, P: phosphorus.

Table 3: Chemical composition and nutritive values of the experimental diets.

Items	Chemical composition (g/kg DM)		
	D1	D2	D3
DM	890	900	910
CP	114	124	134
CF	198	166	134
NDF	463	425	387
ADF	322	310	297

EE	30.5	29.5	28.5
NFC	327	357	386
TDN	58.2	59.1	59.8

D1: 30% CM + 70% vetiver grass,

D2: 50% CM : 50% vetiver grass

D3: 70% CM : 30% vetiver grass

DM = dry matter, CP = crud protein, CF = crud fiber, NDF = nutrient detergent fiber, ADF = acid detergent fiber, EE: ether extract, NFC: non-fiber carbohydrate and TDN: total digestible nutrient

Table 4. In vitro nutrients digestibility and cumulative gas production of the experimental diets.

	D1	D2	D3
IVDMD	49.8 ±1.8	53.2±2.7	54.1 ±2.4
IVOMD	56.8 ±3.9	52.3±4.8	55.5±1.2
IVNDFD	36.7 ±6.5	41.3 ±4.5	42.6 ±2.0
IVCPD	12.8 ^b ±5.6	14.2 ^a ±6.0	15.6 ^a ±8.5
TGP (ml /g DM)	154.8 ^b ± 12.5	167.3 ^{ab} ± 18.6	171.3 ^a ± 13.7

a,b Means having different superscripts within the same row differed significantly (P < 0.05), otherwise no significant differences were detected

D1: 30% CM + 70% vetiver grass

D2: 50% CM : 50% vetiver grass

D3: 70% CM : 30% vetiver grass

IVDMD = in vitro dry matter digestibility, IVOMD = in vitro organic matter digestibility, IVNDFD = in vitro nutrient detergent fiber digestibility, IVCPD = in vitro crud protein digestibility. TGP: total gas production.

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