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Evaluation of Spineless cactus (*Opuntia ficus indica*) as Energy Supplement in Diets Based on Finger millet straw and Maize grain by *in vitro* Technique

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ABSTRACT: A study was undertaken to evaluate the spineless cactus by chemical and *in vitro* methods. The chemical composition of Spineless cactus was found to be Moisture content, 91.39%; Crude protein, 4.92%; Ether extract, 2.04 %; Neutral detergent fibre, 27.0 %; Acid detergent fibre, 14.2 %; Ash, 18.5 % and Metabolizable energy, 8.82 MJ/kg DM. The rate of gas production of spineless cactus was 10.1%/ hour. CFM 1 was prepared by mixing 80% ground maize grain, 15% wheat bran, 2% urea, 2% mineral mixture and 1% salt. CFM 2, CFM 3 and CFM 4 were prepared by replacing CFM I at 30%, 40% and 50% levels, with cactus by part by part basis. The energy values derived from Rumen *in vitro* incubation and gas production for cactus incorporated diets did not vary. The similar *in vitro* organic matter digestibility of CFMs indicates that cactus can effectively replace CFM. It can be concluded that spineless cactus can be considered as a supplementary source of feed for ruminants to meet the nutrient requirement of maintenance and low productivity.

KEYWORDS: Spineless cactus, Chemical composition, rate of degradation, rumen *in vitro* incubation and gas production.

1. INTRODUCTION

Efficient ruminant production system depends on the availability of sufficient fodder. It has been estimated that there is a shortage of 665.80 million tonnes of green fodder and 138 million tonnes of dry fodder in the country [1]. The area under fodder cultivation is only about 4% of the cropping area, and it has remained static for long period of time while the area of permanent pasture and other grazing lands is 10.27 million hectares and this is gradually diminishing. Changes in the rainfall will also affect the crop yield and there was a decrease of 8.9 % of rain fall in India, during 2015 of which North West and central India was mostly affected with a decrease of 17 % and 16% rainfall respectively [2]. India also has an arid zone which covers about 31.70 m ha and spreads over seven states and constitutes 11.8 % of its geographical area. Reduced rain fall and drought is a major feature in these areas. Drought is considered as a major problem to livestock sustainability among all weather related crisis. So a failure of crops due to insufficient rainfall and

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non availability of fodder in drought like situation force many farmers to resort to livestock selling which results in economic crisis.

A challenge facing animal nutritionists is to introduce and promote alternative feed resources that have high nutritive value and are adapted to harsh environmental conditions. Thus, there is a need to identify such potential feed resources and use them for animal feeding [3]. All plants / plant parts cannot be used as source of fodder. The selection of plants / plant parts for to be used as fodder depends on the feeding value and nutritive value. *Opuntia ficus indica* or Spineless cactus has many of these characters and is a drought resistant plant convenient to cultivate and a potentially important feed for livestock particularly during low feed availability [4].

II. MATERIALS AND METHODS

A study was conducted to evaluate the nutritional value of Spineless cactus (*Opuntia ficus indica*) on the growth performance of lambs fed straw based diets. The study was carried out at Department of Animal Nutrition, Veterinary College, Bengaluru, Karnataka Veterinary, Animal and Fisheries Sciences University (KVAFSU). The spineless cactus and feed ingredients were analysed according to the procedure of AOAC. (2005)[5]. The NDF, ADF, ADL were determined according to the methods described by Van Soest *et al*, (1991)[6]. Based on the chemical analysis, five diets were formulated.

Table 1. Ingredient composition (per cent, as fed) of compounded feed mixture (CFM 1) fed to lambs

| Ingredients | Compounded feed mixture 1 |
|------------------|---------------------------|
| Maize | 80.00 |
| Wheat Bran | 15.00 |
| Cactus | 0.00 |
| Urea | 2.00 |
| Mineral Mixture* | 2.00 |
| Salt | 1.00 |
| Total | 100.00 |

*The mineral mixture used was MinIMix® containing Calcium - 22%, Phosphorous - 9%, Magnesium sulphate - 0.2%, Potassium iodide - 0.02%, Ferrous sulphate - 0.6%, Copper sulphate - 0.5%, Cobalt sulphate - 0.02%, Zinc sulphate - 0.2%, Selenium - 0.02mg Yeast - qs

CFM 1 - Control Diet (80 % Maize + 15% Wheat Bran)

CFM 2 - 30% Replacement of CFM by spineless cactus

CFM 3 - 40% Replacement of CFM by spineless cactus

CFM 4 - 50% Replacement of CFM by spineless cactus

The CFM and feed ingredients were subjected to rumen *in vitro* incubation and gas production (RIVIGP) [7] for estimation of ME and rate of gas production. A lactating dairy cow producing 3 kg of milk per day, fitted with a flexible rumen canula of large diameter (Bar Diamond, Inc. USA), receiving a basal diet consisting of FMS and CFM (Maize 60% , WB 35% , Mineral mixture 2%, Urea 2%, Salt 1%) was used as the donor cow for rumen fluid. The FMS and CFM were fed separately. Six kg FMS was offered in small portions four times in a day, starting at 9.00 am. The CFM was offered 3.0 kg per day in two equal portions at 5.00 a.m. and 1.30 p.m. Rumen fluid was collected in the morning between 4:45 a.m. and 5.00 a.m. before offering CFM.

The ME in the FMS, CFM, feed ingredients and spineless cactus were determined by rumen *in vitro* incubation and gas production technique (RIVIGP) according to Menke and Steingass (1988)[7] using the equations:

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Concentrate ingredients, CFM and spineless cactus :

$$ME = 1.06 + 0.1570 GP + 0.0084 CP + 0.022 EE - 0.0081 TA$$

$$\text{Digestibility of organic matter} = 9 + 0.9991 GP + 0.0595 CP + 0.0181 TA$$

Finger millet straw:

$$ME = 2.2 + 0.1357 GP + 0.0057 CP + 0.0002859 EE^2$$

$$\text{Digestibility of organic matter} = 16.49 + 0.9042 GP + 0.0492 CP + 0.0387 TA$$

Where,

GP = Corrected Net Gas production, ml/200 mg. DM.

CP = Crude protein, g/kg. DM.

EE = Ether extract g/kg. DM.

TA = Total ash, g/kg. DM.

and ME = Metabolizable energy, MJ/kg DM.

Air equilibrated feed samples (200 ± 10 mg) of FMS, CFM and spineless cactus were incubated in 100 ml calibrated glass syringes in triplicate according to Menke and Steingass (1988)[7] with 30 ml mixed rumen suspension with three blank incubations and standards. Cumulative gas production was recorded at 2, 4, 6, 8, 12, 16, 24, 36, 48, 60, 72 and 96 hour of incubation. The rate and extent of gas production were calculated by nonlinear regression using the exponential model $Y = D(1 - e^{-kt})$ where, Y is gas volume (ml) at time t, D is potential gas production (ml) and k is rate (per hour) at which gas is produced [8].

III. RESULTS AND DISCUSSION

The Chemical composition and energy content of the ingredients of the diets namely spineless cactus, compounded feed mixture and finger millet straw are presented in Table 2.

Table 2. Chemical composition¹ (Per cent DM) and energy (MJ ME /Kg DM) of Spineless cactus, Compounded feed mixture and Finger millet straw

| | Spineless cactus | Compounded feed mixture | | | | Finger millet straw |
|----------------------------|------------------|-------------------------|-------|-------|-------|---------------------|
| | | CFM 1 | CFM 2 | CFM 3 | CFM 4 | |
| Dry matter | 92.3 | 93.1 | 90.6 | 91.3 | 90.6 | 93.9 |
| Organic matter | 79.5 | 95.7 | 90.3 | 89.4 | 88.6 | 94.1 |
| Crude protein | 4.91 | 16.0 | 14.2 | 14.5 | 12.8 | 2.69 |
| Ether extract | 2.58 | 3.52 | 2.85 | 2.72 | 2.12 | 0.70 |
| Total ash | 20.5 | 4.24 | 9.65 | 10.6 | 11.4 | 5.87 |
| Neutral detergent fiber | 27.0 | 22.6 | 29.6 | 31.2 | 34.2 | 76.8 |
| Acid detergent fiber | 18.2 | 8.09 | 7.65 | 7.02 | 6.45 | 49.2 |
| Acid detergent lignin | 0.51 | 1.98 | 1.46 | 1.26 | 1.04 | 2.48 |
| ME ² (MJ/Kg DM) | 8.81 | 13.1 | 12.2 | 11.8 | 11.2 | 7.46 |

The chemical constitution of spineless cactus was found to be , Moisture content, 91.39%; Crude protein, 4.92%; Ether extract, 2.04 %; Neutral detergent fibre, 27.0 %; Acid detergent fibre, 14.2 %; Ash, 18.5 % and Metabolizable energy, 8.82 MJ/kg DM. (Table 2) The chemical composition depends on the location, soil and fertilization [9,10]. The CP value of this experiment was higher than those reported by Batisa, *et al.* (2009)[11] in Brazil, but lower than those reported by Ben Salem, *et al.* (2002)[12] in Tunisia, Tegegne *et al.* (2005)[13], Gebremariam *et al.* (2006)[14] from Ethiopia, and Tien and Beynan (2005)[15] from Vietnam, Sirohi, *et al.* (1997)[16] and Misra, *et al.* (2006)[17] from India. The NDF content were in the range of 21 to 28 % as reported by all authors except Sirohi, *et al.* (1997)[16] and Misra, *et al.* (2006)[17] from India who reported higher values. The ADF content was similar to those reported from

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different locations which were in the range of 14% to 20% except Sirohi, *et al.* (1997)[16] and Misra, *et al.* (2006)[17]. All authors reported higher values for Ash content which is in the order of 14% to 21% which agrees with the present result. The energy content is moderately high and the NDF content was 1/3rd of that of ragistraw which makes it to be used as a concentrate feed rather than roughage. The chemical, detergent fractions and metabolizable energy of finger millet straw and CFM 1 (control group) was similar to that reported by Vikram *et al.* (2014) [18]. The CP and ME content of the all the CFMs were adequate to provide the requirement of sheep at an intake level of 2.5 per cent of the body weight [19]. The Neutral detergent fibre level will be adequate for normal rumen function when fed to sheep along with FMS at roughage: concentrate ratio of 35: 65 [20].

Table 3. Rumen *in vitro* incubation and gas production values of ingredients, compounded feed mixture and total mixed rations

| Parameter | RIVIGP ¹ | ME ² | D (ml) ³ | k (h ⁻¹) ⁴ | t _{1/2} (h) |
|--------------------------------|---------------------|-----------------|---------------------|-----------------------------------|----------------------|
| Ingredients | | | | | |
| Finger millet straw | 36.4 | 7.46 | 49.9 | 0.06 | 11.6 |
| Spineless cactus | 52.8 | 8.82 | 55.1 | 0.16 | 4.36 |
| Compounded feed mixture | | | | | |
| CFM-1 | 65.3 | 13.1 | 81.3 | 0.12 | 5.96 |
| CFM-2 | 63.5 | 12.9 | 80.7 | 0.11 | 6.23 |
| CFM-3 | 63.0 | 12.8 | 79.6 | 0.11 | 6.17 |
| CFM-4 | 62.6 | 12.7 | 78.3 | 0.11 | 6.11 |

¹Rumen *in vitro* incubation and gas production (24 h, ml/200 mg DM)

² MJ/Kg DM)

³potential gas production (ml)

⁴Rate of gas production

All values were mean of six replicates

The rate of gas production of spineless cactus was higher than that reported by other authors. (Table 2) Abidi *et al.* (2009)[21] reported rate of gas production of *Opuntia ficus indica* as 3% and 4% in summer and winter, respectively. Batisa *et al.* (2003)[22] reported average rate of gas production of three varieties of opuntia as 6.7 % / hr. The variation in the rate of gas production from the previous studies may be due to the methodology, change in the diet offered to the fistulated animal or due to the variation in the species used. The value reported is higher than those reported for ten gramminaceous hays [23]. Tegegne *et al.* (2007)[24] reported that about 85% of the gas (54 ml/200 mg DM) was produced in 24 h where the total time of incubation was 72 hours. The gas volume recorded in the present study for 24 hrs was similar (53.7 ml) and about 90% of the gas volume produced in 24 hrs which indicates that spineless cactus is highly degradable in rumen.

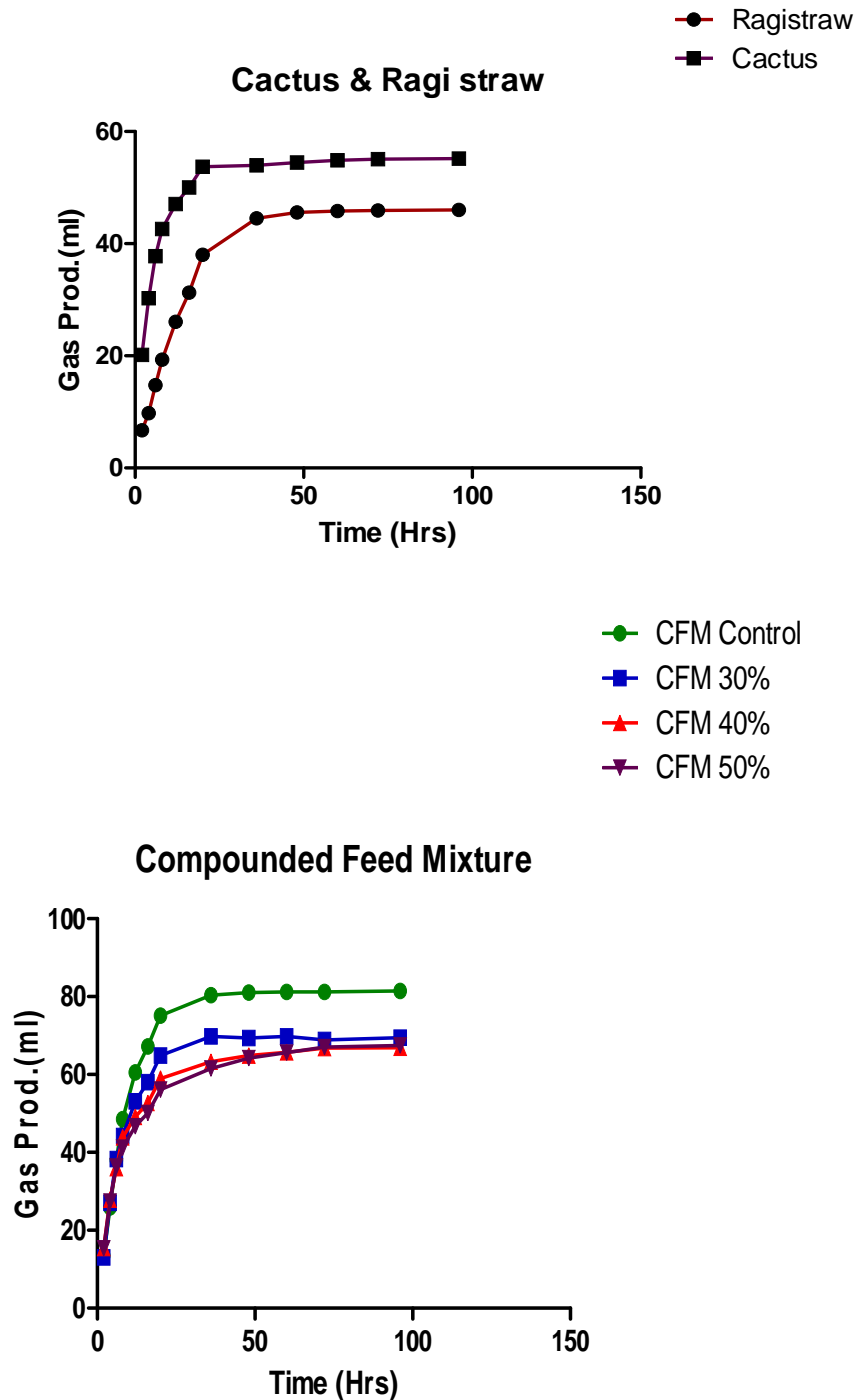
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Fig.1. *In vitro* cumulative gas production for Spineless cactus, finger millet straw and compounded feed mixtures (CFM) fitted with exponential model



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The predicted digestibility of organic matter of spineless cactus and straw as per the formula referred above were 69.4% and 23.5%. While that for CFM 1, CFM 2, CFM 3 and CFM 4 were 73.3 %, 73.5 %, 73.0 % and 72.5%, respectively. There was no difference in the predicted organic matter digestibility shows that the inclusion of spineless cactus will not affect the digestibility.

Perusing through the results, spineless cactus can be considered as a succulent, drought resistant plant which is having moderate level of energy. The rate of gas production and apparent organic matter digestibility is also high and hence can be successfully incorporated in compounded feed mixture replacing CFM.

IV. CONCLUSION

Based on the study it can be concluded that, spineless cactus could be considered as a supplementary source of feed for ruminants to meet the nutrient requirement for maintenance and low productivity.

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