

**EFFICIENCY OF PROTEIN UTILISATION OF FORAGE
LEGUMES FOR MILK PRODUCTION IN GOATS**

BY

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ABSTRACT

Protein is the one of the limiting nutrients in ruminants relying on natural rangelands due to seasonal fluctuation in quality in response to seasonality of rainfall. Understanding rumen degradability, digestion and utilisation for milk production of protein from forage legumes will aid in improving their use by smallholder farmers and decrease dependency on expensive, protein-rich supplements.

Six experiments were conducted to evaluate *Desmodium uncinatum* (Silverleaf desmodium), *Mucuna pruriens* (Velvet bean) and *Vigna unguiculata* (L.) Walp (Cowpea) forage legumes as protein supplements for goats. Rumen disappearance of amino acids, dry matter (DM), crude protein (CP), phosphorus (P) and calcium (Ca) were determined using the *in sacco* (Nylon-Bag technique) and *in vitro* (Daisy^{II} technique). Rumen degradability patterns were assessed using the Ankom^{RF} gas technique whilst feeding trials were carried out to determine apparent digestibility, milk production and utilisation of protein for milk production in goat.

Dry matter, CP and P effective disappearance of Cowpea were the highest and significantly ($P < 0.05$) different from Velvet bean and Silverleaf desmodium. Dry matter effective degradability of Velvet bean was higher than that of Silverleaf desmodium. However, the CP effective degradability of Silverleaf desmodium was significantly higher than Velvet bean ($P < 0.05$). Disappearance of Ca was significantly higher ($P < 0.05$) in Velvet bean forage followed by Cowpea. The volumes of gases produced ranged from 61.4 to 70.4 ml, with an average of 64.2 ml, whilst the fractional rate of gas production varied between 4.6 and 5.6 % h⁻¹ with a mean of 5 % h⁻¹. Effective gas production, (a), (b) and (c) were significantly ($P < 0.05$) different for the three legumes. Cowpea produced significantly ($P < 0.05$) the highest amount of gas followed by Velvet bean.

When both *in sacco* and *in vitro* techniques were correlated on dry matter degradability of the three forage legumes, a significant linear relationship was obtained at $P < 0.001$. When the values for the legume dry matter degradability were considered, there were significant ($P < 0.001$) correlations 0.93, 0.72 and 0.82 for Velvet bean, Silverleaf desmodium and Cowpeas respectively. The effective degradability values of both techniques were within the same ranges.

Total nitrogen intake was significantly ($P < 0.05$) highest in the commercial goat feed followed by hay supplemented with Cowpea, Silverleaf desmodium and Velvet bean respectively.

Microbial protein supply, calculated microbial true protein and digestible microbial true protein were affected ($P < 0.05$) by legume supplementation.

Total dry matter intake (DMI) and metabolisable energy (ME) intake were not significantly different among the different-diet fed animals ($P > 0.05$). Daily live weight loss was significantly highest ($P < 0.05$) in the treatment supplemented with Cowpea compared to the commercial goat feed, Silverleaf desmodium and Velvet bean.

Cowpea showed higher effective (58.6 %) rumen CP degradability value compared to Silverleaf (46.1 %) and Velvet bean (38 %) at 0.06/h outflow rate. Silverleaf produced (15.5 g/day) higher digestible microbial true protein compared to Cowpea (13.8 g/day) and Velvet bean (13.2 g/day). There was no significant difference in efficiency of microbial N synthesis 2.21, 2.01 and 2.06 for Velvet bean, Silverleaf and Cowpea respectively. The higher amount of digestible microbial true protein from the degradability of Silverleaf and lower values of degradability (higher undegradability) CP caused the legume to have higher efficiency of utilisation in comparison to Cowpea and Velvet bean. Higher DM intake values were observed in animals on Cowpea compared to animals on Silverleaf and Velvet bean. Nitrogen retention was higher on animals on Cowpea (0.84 g/day) compared to animals on Silverleaf (-0.46 g/day) and Velvet bean 9-1.29 g/day). Milk production was not significantly different amongst the treatments 405 g/day, 425 g/day and 447 g/day in Velvet bean, Silverleaf and Cowpea respectively. Fat, protein, lactose and ash in the milk were not different between the animals of the four treatments.

Among the legume forages Silverleaf desmodium had significantly ($P < 0.05$) the lowest efficiencies of utilisation of histidine, lysine and tyrosine, whereas, Velvet bean had significantly the highest efficiency of utilisation of phenylalanine ($P < 0.05$) compared to Silverleaf desmodium and Cowpea. Cowpea had the highest efficiency of utilisation of aspartic acid ($P < 0.05$) for milk production.

The efficiency of utilisation of nitrogen in the supplements could have been limited by metabolisable energy in the diets. Supplementation of poor quality veld hay with forage legumes could improve utilisation especially in the dry season. The levels of milk production attained in this study imply that some conventional commercial goat feeds can be substituted with forage legumes without significantly affecting milk yield and composition in goats.

Key words: legume forages, degradability, digestion, utilisation, milk production, goats