

Original Article

AN ORAL FEED STRATEGY IN SHEEP FOR IMPROVED DIGESTIBILITY, NUTRIENT UTILIZATION AND METHANE MITIGATION

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ABSTRACT

Objective: A trial was conducted to study the efficacy of herbal formulation Ruchamax (*M/S Ayurved Limited, India*) on digestibility and nutrient utilization in Deccani sheep.

Methods: 12 growing healthy Deccani sheep (5-6 months) were randomly divided into 2 groups. Control Group I (T_0) was not given any treatment. Group II (T_1) supplemented with Ruchamax (appetite stimulant and digestive tonic). The test herbal formulation was mixed in the concentrate feed as per the recommendations. Parameters like body weight, plasma cortisol level, blood enzyme estimation, feed analysis, nitrogen balance, methane estimation and carcass quality traits were studied.

Results: Statistically ($P < 0.05$) Ruchamax supplemented group had significantly superior average daily gain (g) than that of control. DMI, Dry matter digestibility and FCR of Ruchamax supplemented group were significantly ($P < 0.05$) improved. The maximum nitrogen balance was obtained in Ruchamax supplemented group T_1 . Significantly ($P < 0.05$) lower level of cortisol in Ruchamax supplemented animals confirmed the increased resilience of animal towards stress. The Ruchamax supplemented group T_1 emitted significantly less methane as compared to control group T_0 . Animals belonging to Ruchamax supplemented group T_1 had significantly higher dressing % as compared to control group T_0 . The enzymatic values in both groups were under normal physiological level.

Conclusion: The herbal appetite stimulant and digestive tonic Ruchamax was found to be safe for usage and efficient to improve digestibility, nutrient utility, performance traits in sheep alongwith added benefit of its methane mitigating potential.

Keywords: Plasma cortisol, Methane estimation, Carcass quality traits, Herbal formulation.

INTRODUCTION

Small ruminants occupy an important economic and ecological niche in agricultural systems throughout the developing countries [1]. Sheep provided milk, meat and clothing to mesopotamian and northern Indian civilizations and had a significant role in the economies of the cold north [2]. According to the 1972 census, the country had 40 m sheep, which contributed approximately \$175 m (Rs 1400 m) per year to the national economy, based on a rough estimate of production of 34.3 m kg of wool, 101 m kg of mutton, and 14.6 m skins [3]. The total sheep population in India was 65.06 million in 2012, declined by about 9.07% over census 2007 [4].

Health status of the animal is very important from the economics point of view. Inadequate nutrition in ruminant animals has often been associated with heavy economic losses because of animal weight and condition losses, reduced reproductive capacity and increased mortality rates [5]. The digestion process is carried out by fibrolytic bacteria such as *Ruminococcus albus*, *R. flavefaciens* and *Fibrobacter succinogenes*, fungi, some protozoa [6] and by enzymes [7]. During the dry season, the natural pastures and crop residues available for animals after crop harvest are usually fibrous and devoid of most essential nutrients including proteins, energy, minerals and vitamins which are required for increased microbial fermentation and improved performance of the host animal [8]. Enzymes and antibiotics in feed served as aids to nutrition and are widely used in intensive livestock production systems in developed societies to improve the digestibility of feeds and utilization of nutrients, are not available to many resource poor farmers in developing countries [9].

These synthetic supplements are often beyond the purchasing capacity of many resource-poor farmers. Polyherbal economic therapies are synergistic, potentiative and agonistic / antagonistic pharmacological agents within themselves that work together in a dynamic way to produce therapeutic efficacy with minimum side

effects [10]. They are naturally safe with pharmacologically active principles [11]. Current study was designed to evaluate the efficacy of herbal formulation Ruchamax (*m/s Ayurved Limited, Baddi, India*) on rumen ecology. Ruchamax is a unique blend of scientifically processed herbs for appetite stimulation and better utilization of feed through improved digestive functions.

MATERIALS AND METHODS

Present study was undertaken on Deccani sheep at Livestock Farm, Hayathnagar Research Farm (HRF), Central Research Institute for Dry land Agriculture (CRIDA), Hyderabad, India and was situated at 17°27'N latitude and 78°35'E longitude and about 515 m above sea level. The climate is semi-arid with hot summers and mild winters. The mean maximum air temperature during summer (March, April and May) ranges from 35.6 to 38.6°C, whereas, in winter (December, January and February) ranges from 13.5 to 16.8°C.

Experiment design

12 growing healthy Deccani sheep of nearly same age (5-6 months) and body weight 16.35 to 16.48 were selected for the study. These animals were randomly divided into two groups, so that each group was having similar and uniform age and body weight. The animals were kept in two pens to acclimatize to the conditions for a period of 7 days prior to commencement of animal experimentation. Group T_0 ($n=6$) was not given any treatment to serve as control. Group T_1 ($n=6$) was supplemented with Ruchamax, 500g/tonne of feed for 3 months along with concentrate mixture. Concentrate mixture was made from maize, groundnut cake, wheat bran, rice polish, mineral mixture and salt and offered to each animal 250 Gms daily. Green fodder of Hybrid Napier (Co-4 variety) was offered fresh in the pen after thorough chaff cutting 4 Kg per day. Hygiene conditions were maintained each day, the floor of the experimental shed was cleaned with potassium permanganate, a sanitizer. During the trial parameters like body weight gain/week, analysis of food/faeces samples,

plasma cortisol level, blood enzyme estimation, phenolic compound estimation, methane production estimation and carcass quality traits were studied.

Statistical analysis

Statistical analysis of the scientific data collected during the experiment was done with method described by Snedecor and Cochran [12]. Results obtained from the present investigation are presented herewith in the form of Mean \pm SE and significant level at 5%.

RESULTS

Average daily weight gain

The results of average daily weight gain (gms/d) are presented in table 1. Group T₁ animals supplemented with Ruchamax started showing significantly ($p < 0.05$) superiority weight gain over control at 15th day of the treatment. After three months of treatment the average daily weight gain (gms/d) in Ruchamax supplemented group T₁ (55.09 \pm 16.15^b) was significantly ($p < 0.05$) maximum in comparison to control group T₀ (42.07 \pm 5.69^a). The results are in accordance with the findings of Pradhan et al [13] and Hadiya et al [14].

DMI and FCR

Dry matter intake (g/d) (table 2) of Ruchamax supplemented group T₁ (765.63 \pm 19.12^b) was significantly ($p < 0.05$) more than that of in control

(698.71 \pm 12.12^a) which suggests that the product supplementation has improved the palatability of the feed. Similar findings of improvement in DMI by polyherbal supplementation were reported by Ramana et al [15]. Feed conversion ratio of Ruchamax supplemented T₁ group was significantly ($p < 0.05$) superior (13.89 \pm 1.19^b) than control T₀ group (16.64 \pm 1.21^a), which suggests supplementation of Ruchamax to be efficient in converting feed to meat. The results of FCR value are in accordance with Handekar et al [16].

Table 1: Effect of feed supplements in terms of body weight and Average Daily Gain (ADG) (Mean \pm SE) at fortnightly intervals in Deccani sheep

Particulars	T ₀	T ₁
0 Days	16.45 \pm 0.83	16.35 \pm 0.82
15 Days	16.63 \pm 0.76 ^a	17.89 \pm 1.05 ^b
30 Days	16.67 \pm 0.98 ^a	17.64 \pm 1.19 ^b
45 Days	17.36 \pm 0.82 ^a	18.31 \pm 1.39 ^b
60 Days	18.18 \pm 0.91 ^a	19.20 \pm 1.38 ^b
75 Days	19.21 \pm 0.82 ^a	19.70 \pm 1.56 ^b
90 Days	20.23 \pm 0.83 ^a	21.31 \pm 1.68 ^b
ADG (gms/d)	42.07 \pm 5.69 ^a	55.09 \pm 16.15 ^b

^{ab}Means with different superscripts in the same row differ at 5% level of significance

Table 2: Dry matter intake and feed conversion efficiency in Deccani sheep

Groups	Initial B. wt. (kg)	Final B. wt. (kg)	DMI (g/day)	DMI (kg/100kg b. wt.)	FCR (kg/kg wt. gain)
T ₀	16.45 \pm 0.83	20.23 \pm 0.83 ^a	698.71 \pm 12.12 ^a	4.25 ^a	16.64 \pm 1.2 ^a
T ₁	16.35 \pm 0.82	21.31 \pm 1.68 ^b	765.63 \pm 19.12 ^b	4.68 ^b	13.89 \pm 1.19 ^b

^{ab}Means with different superscripts in a column differ at 5% level of significance

Table 3: Digestibility coefficients of nutrients in both groups of Deccani sheep

Groups	Dry matter	Organic matter	Crude fibre	Crude protein	Ether extract	NFE	NDF	ADF
T ₀	58.33 ^a	68.80 ^a	73.73 ^a	55.86 ^a	53.14 ^a	62.26 ^a	67.68 ^a	72.19 ^a
T ₁	60.86 ^b	71.66 ^b	75.95 ^b	57.51 ^b	56.08 ^b	65.08 ^b	70.42 ^b	74.77 ^b

^{ab}Values with different superscripts in a column differ at 5% level of significance

When energy and protein intake as per dry matter intake (DMI) was extrapolated, it was observed that in supplemented group consumed significantly ($p < 0.05$) more TDN, DCP, DE and ME which along with added advantage of superior digestibility resulted into attainment of better body weight as compared to control (Table 4). Group T₁ supplemented with Ruchamax consumed the significantly ($p < 0.05$) more TDN, DCP, DE and ME.

Table 4: Plane of nutrition of Deccani sheep as treated with both treatments

Particulars	T ₀	T ₁
TDN Intake (g/d)	422.51 ^a	480.44 ^b
DCP Intake (g/d)	56.55 ^a	67.06 ^b
DE Intake (MJ/d)	7.80 ^a	8.87 ^b
ME Intake (MJ/d)	6.39 ^a	7.27 ^b

^{ab}Values with different superscripts in a rows differ at 5% level of significance

Digestibility coefficients and plane of nutrition of Deccani sheep

One week of digestibility trial suggested that DM, OM, CF, CP, EE, NDF and ADF digestibility was significantly ($p < 0.05$) better in Ruchamax supplemented group T₁ as compared to control group T₀ (table 3). This improvement in nutrient digestibility leads to better availability of nutrients which explains the superior average daily gain and achieving greater body weight of Ruchamax supplemented group as compared to control.

This was because the polyherbal supplement Ruchamax feeding stimulate the appetite and digestive function with increased salivary

function, increased ruminal bacteria and protozoa [17] that help in better feed assimilation and metabolism.

Nitrogen balance

When nitrogen balance through the metabolic trial results were estimated, It was observed that significantly ($p < 0.05$) higher nitrogen was retained by Ruchamax supplemented group T₁ and which attained the maximum body weight during the experiment (table 5). The high level of nitrogen balance represents a great interest for decreasing the nitrogen secretions in the environment.

Table 5: Nitrogen balance of deccani sheep on the experimental diets

Particulars	T ₀	T ₁
Nitrogen intake (g/day)	9.05 \pm 0.76 ^a	10.73 \pm 0.89 ^b
Faecal nitrogen (g/day)	1.77 \pm 0.01	1.72 \pm 0.05
Digested nitrogen (g/day)	7.28 \pm 0.56 ^a	9.01 \pm 0.75 ^b
Urinary nitrogen (g/day)	3.95 \pm 0.02 ^a	3.30 \pm 0.06 ^b
Nitrogen balance (g/day)	3.33 \pm 0.12 ^a	5.71 \pm 0.23 ^b

^{ab}Values with different superscripts in a rows differ at 5% level of significance

Table 6: Blood cortisol (ng/mL) level in both groups of Deccani sheep at different time intervals

Days	T ₀	T ₁
0 day	40.01±1.69 ^a	43.23±1.43 ^b
45 day	37.08±3.20 ^a	27.31±1.58 ^b
90 day	22.56±1.43 ^a	8.94±1.9 ^b
Overall	33.12±2.02 ^a	26.49±1.79 ^b

^{ab}Values with different superscripts in a rows differ at 5% level of significance

Blood cortisol level

Cortisol is released in response to stress. Anxiety-related behavior of cattle can be correlated with cortisol levels [18]. Blood cortisol level was estimated in the both groups at different time intervals. Initially cortisol level was significantly less ($p < 0.05$) in control group T₀ animals than supplemented animals (Table 6). But the trend was totally reversed after supplementation where Ruchamax supplemented group T₁ animals had less cortisol value (26.49±1.79^b) than control (33.12±2.02^a), which suggests that herbal formulation used in the experiment has increased the tolerance capacity of animals against heat stress.

Blood enzymes levels

The overall alkaline phosphatase levels (U/L) in control group T₀ (176 U/L) and in ruchamax supplemented group T₁ (186 U/L) were found to be in normal range. The reason for high numerical value of ALP (U/L) in ruchamax supplemented group may be that one of the biological roles of ALP is detoxification of endotoxin, so high level within physiological limit is making animals more endurable against toxins and a sign of superior physiological adaptation. The serum SGOT level was found to be 92 U/L in Ruchamax supplemented group T₁, the values were significantly less than 124 U/L i. e of control group T₀. The plasma SGPT level was significantly less in Ruchamax supplemented group T₁ i. e 20 U/L in comparison to untreated control group T₀, 27 U/L. The low level of SGOT and SGPT within physiological limits is a favourable adaptive status against stress.

Methane emission estimation

Enteric emissions from the animals were measured using closed respiratory chamber method. Air samples from the chamber were collected from various heights at regular interval of 60 min in 24h duration. After sampling, gas samples were analyzed on same day for methane concentration using a gas chromatograph (450-GC, BRUKER Daltonics, Bremen, Germany) with three detectors Thermal Conductivity Detector (TCD), Electron Capture Detector (ECD) and Flame Ionization Detector (FID) with a 1041 PWOC Packed/Wide bore On-Column [19]. In the present investigation, Ruchamax supplemented T₁ group was found to be significant ($p < 0.05$) efficient in reducing methane emission from the Deccani sheep. Further, Ruchamax supplemented T₁ group emitted significantly less ($p < 0.05$) methane (Methane weight emitted gms/kg of DDMI, 39.112^b) as compared to control T₀ group (47.322^a) (table 7).

Table 7: Methane emission in different groups of Deccani sheep

Particulars	T ₀	T ₁
Recovered CH ₄ volume (L)	46.290 ^a	41.923 ^b
Recovered CH ₄ weight (g)	33.064 ^a	29.945 ^b
Methane emission (L)/kg of DDMI	66.251 ^a	54.756 ^b
Methane weight emitted (gms)/kg of DDMI	47.322 ^a	39.112 ^b
Methane emission (L)/kg of DMI	113.579 ^a	89.971 ^b
Methane weight emitted (gms)/kg of DMI	81.128 ^a	64.265 ^b

^{ab}Values with different superscripts in a rows differ at 5% level of significance

Methane (CH₄) promotes stratospheric ozone depletion [20]. Methane is the second major contributor to global warming with a

100-year global warming potential (GWP), 23 times that of CO₂ [21]. Low emission of CH₄ in the rumen with Ruchamax supplementation has implications not only for global environmental protection but also for efficient animal production.

Plant secondary metabolites such as saponins and tannins have a role in reducing CH₄ emissions [22]. Saponins have been shown to possess strong defaunating properties both in vitro [23] and in vivo, which could reduce CH₄ emissions. Recently, a number of studies have reported that feeding tannin-containing forages to ruminants may reduce methane emissions [24, 25, 26]. In the present experiment also, significantly ($p < 0.05$) maximum pure tannin and CT content was found Ruchamax supplemented T₁ group (Table 8) which explains the maximum reduction in methane emission by this group of animals.

Table 8: Phenolic content of the supplemented concentrate ration

Particulars	T ₀	T ₁
Total phenolics (%)	5.23 ^a	6.58 ^b
Non-tannin phenolics (%)	2.23 ^a	1.96 ^b
Pure tannin phenolics (%)	3.00 ^a	4.62 ^b
Condensed tannins (CT) (%)	5.34 ^a	7.26 ^b

^{ab}Values with different superscripts in a rows differ at 5% level of significance

Carcass quality traits

At the end of the 90-day feeding trial, all animals were slaughtered for carcass characteristics evaluation. When animals were slaughtered for carcass characteristics, it was found that animals belonging to Ruchamax supplemented T₁ group (52±3.34^b) had significantly ($p < 0.05$) higher dressing % (Table 9) as compared to control group T₀ (44.1±1.02^a), which suggests superior utilization of feed resources for production of edible parts in supplemented groups with Ruchamax.

Table 9: Carcass quality traits (Mean±SE) of Deccani sheep

Body parts	T ₀	T ₁
All 4 feet (kg)	0.50±0.04 ^a	0.54±0.06 ^b
Head weight (kg)	1.46±0.24 ^a	1.53±0.21 ^b
Intestine with content (kg)	1.30±0.36 ^a	1.03±0.23 ^b
Stomach with content (kg)	3.44±0.86 ^a	3.45±0.85 ^b
Pluck (kg)	0.71±0.04 ^a	0.59±0.01 ^b
Separable fat weight (kg)	0.11±0.01 ^a	0.15±0.02 ^b
Skin (kg)	2.70±0.78 ^a	2.31±0.19 ^b
Blood weight (kg)	0.57±0.05 ^a	0.64±0.04 ^b
Live weight (Kg)	19.10±3.90 ^a	20.44±2.64 ^b
Dressed carcass weight (kg)	8.46±1.96 ^a	10.50±0.66 ^b
Dressing (%)	44.1±1.02 ^a	52±3.34 ^b

^{ab}Values with different superscripts in a rows differ at 5% level of significance

DISCUSSION

Herbal remedies have been used for the treatment of live stock ailments [27]. Therefore the pharmacological activity in improving digestibility and improved nutrient utilization of Ruchamax, an herbal formulation was estimated. All the study parameters were compared with the unsupplemented control group. In previous experiments with different herbal dietary supplementation an average daily weight gain was reported in chickens [28], in cattle [29] and in pigs [30]. In the current study with supplementation of herbal formulations ruchamax a significant gain in body weight was observed in sheep. DMI, FCR, Digestibility coefficients were improved in ruchamax supplemented groups. This was because Ruchamax is a blend of 21 herbs and minerals, was highly effective in correcting and optimizing the digestion as an appetite stimulant and digestive tonic contains in bovines [31]. Approximately, 70-75% of the N consumed by animals is lost or excreted due to the

inefficiencies associated with protein digestion and or absorption [32, 33]. Nitrous oxide is a potent greenhouse gas. Per gram, its atmospheric warming effect is approximately 296 times as strong as carbon dioxide. On Ruchamax supplementation the atmospheric emission of nitrogen due to enteric fermentation was significantly reduced and nitrogen absorption increased. Similarly the emission of methane from the sheep in Ruchamax supplemented group was significantly reduced. Stress in animals leads to low productivity and health. Annual economic losses due to heat stress alone for the US dairy industry have been estimated at \$900 million [34]. On Ruchamax supplementation stress hormone cortisol level was significantly reduced. Blood enzymes levels were in normal range after Ruchamax supplementation, suggesting its safety as an appetite stimulant and digestive tonic. Carcass quality has a great economic importance. After supplementation with Ruchamax the significantly higher dressing % was recorded. This adds further economic benefit to the sheep rearers.

CONCLUSION

From the results of the present investigation it can be concluded that the herbal formulation Ruchamax feeding not only improved the digestibility, weight gain, health, carcass traits of the sheep but also maintained the nitrogen balance and reduced the emission of methane. It can be concluded that herbal formulation Ruchamax has both implications for efficient animal production and on global environmental protection.

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CONFLICT OF INTERESTS

Declared None

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