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Effect of feeding ensiled and fungal treated paddy straw based complete diet on performance of Corriedale female sheep

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Abstract
A growth trial of 90 days (March-April) was conducted on 18 female Corriedale sheep at Sheep Research Station, Shuhama, Srinagar (SKUAST-Kashmir), to study the effect of feeding fungal treated paddy straw based complete feed. The studies indicated no significant ($p\leq0.05$) differences between the experimental groups T_1, T_2 and T_3 in DMI and OMI, however numerically the values were highest in T_3, followed by T_2 and T_1. The digestibility coefficients of DM, OM, CP, EE and CF in T_3 were significantly ($p\leq0.05$) higher as compared to T_1 and T_2 whereas the digestibility coefficients of NDF, ADF, NFE, hemicellulose and cellulose in different experimental groups were statistically non-significant ($p\leq0.05$), however numerically the values were highest in T_3 group followed by T_2 and T_1. No significant ($p\leq0.05$) difference was observed in the overall average body weight of animals in different groups though the body weight of T_3 group was highest followed by T_2 and T_1. The periodical ADG and net weight gain in T_3 was significantly higher than T_1 whereas, periodical average ADG and net weight gain of T_2 was non-significantly ($p\leq0.05$) related to both T_1 and T_3. The average periodical FCR in T_1 was significantly ($p\leq0.05$) higher than that of T_2 and T_3 whereas the values in T_2 and T_3 could not reach statistical significance. Effect of treatments on rumen pH and NH_3-N were found non-significant while as TVFA, total nitrogen, TCA-ppt. N and NPN in groups T_2 and T_3 were found significantly ($p\leq0.05$) increased as compared to the control. Significant ($p\leq0.05$) effect of period irrespective of the treatment was observed on all the rumen parameters.

Keywords: fungal treated, paddy straw, Corriedale sheep

1. Introduction
The major constraint for the development of small ruminant production in Kashmir is shortage of feed/fodder particularly in the winter season. The conventional feed resources like pastures are no longer available due to competition of land usage and due to seasonal availability. Ruminant livestock raised in this region, therefore tend to reflect the cyclical variation in quantity and quality of these available forages. Paddy straw being the principal crop residues is available all the year around in large quantities in the region and can be used as the main bulky feed for ruminant animals. Rice straw is a main agricultural byproduct which farmers usually stored for use as ruminant feed in tropical area. Rice straws contain low nitrogen, vitamins and minerals, which hinder the availability of cellulose to be degraded by rumen microbes and eventually limit the necessary nutrient uptake for a satisfactory performance of animals, especially ruminants. The cellulose and hemi-cellulose content of paddy straw range between 25 - 45% and 18 - 30%, respectively, while the lignin content is between 10-15%. Although, ruminants are endowed with the ability to convert low quality feed into high quality protein and utilize feeds from land not suitable for cultivation of crops, however, the utilization of these low quality crop residues is hampered by its low protein content, fibre, digestibility, vitamin and minerals. Various treatment methods have been used to improve nutritive value of paddy straw including physical, biological and chemical treatment.
Hence, it is the need of the day to utilize these crop residues available in appreciable quantum locally in association with concept of complete feed technology and use of biological agents (lignolytic fungi) to maximize advantage from given feeds in animal system. Biological treatment of fortification of poor quality roughages is a favorable option and is believed to be more environmental friendly and safer with very low operating cost than the use of chemicals and physical treatment methods. Use of lignolytic fungi, cellulolytic enzymes and other beneficial microorganisms that are able to degrade the ligno-cellulosic components of paddy straw have been used to improve the availability of nutrients from paddy straw for the usage of rumen microorganisms (Euna *et al.*, 2006; Jahromi *et al.*, 2011) [8, 12].

But due to socio-economic and practical reasons, paddy straw is usually fed untreated and without supplements in spite of the fact that many methods for improved utilization of paddy straw have been developed and recommended (Devendra, 1997) [7].

2. Materials and Methods

A growth trial of 90 days was conducted on 18 male Corriedale sheep divided in three groups of six animals each, to study the effect of feeding of paddy straw based complete feed without (T1) or with ensiled paddy straw (T2) and with fungal treated paddy straw (T3) supplementation. A complete feed was prepared containing paddy straw 90 parts and concentrate mixture 40 parts on dry matter basis (ICAR 2013). The paddy straw was subjected to three treatments: untreated paddy straw, paddy straw treated with *Pleurotus florida* and paddy straw treated with *Trichoderma viride* @ 3.5% of the straw on fresh weight basis. Then the inoculated paddy straw was packed in perforated polythene bags (25 x 40cm and 100 gauge thickness). Each bag containing the inoculated straw was tightly closed with nylon thread and transferred to spawn running room of Mushroom laboratory, Division of Plant Pathology, SKUAST-Kashmir, Shalimar, at 25^{0}C and 70% humidity for incubation under dark conditions for 14, 21 and 28 days. After the completion of the incubation period, representative samples of the treated straw were brought to the laboratory for chemical analysis. The representative samples of feeds offered and residue collected were sampled, and analyzed daily for dry matter content to assess average DM consumption during the experimental period.

At the end of experiment seven day metabolism trial was conducted to assess the digestibility of nutrients and balance of nitrogen and calcium and phosphorus by (Talpatra *et al.*, 1948) [23]. Samples of feed offered and their residues left, faeces and urine were analysed for proximate and cell wall constituents as per AOAC (2005) [5] and (Van Soest *et al.*, 1991) [24] method. Economics of feeding was determined on the basis of cost of experimental feed (per 100 kg feed prepared), average total feed consumed by the animals of each group and total body weight gain by the animal in the feeding trial. All animals were kept under uniform managemental conditions in individual housing pens within well-ventilated wooden floor sheds. The animals were treated for ecto and endo-parasites with proper doses of standard ant-helminthic before experimental feeding. Clean, wholesome drinking water was provided once daily on *ad libitum* basis.

3. Statistical analysis

The data obtained in the experiment were analyzed using statistical procedures given by Snedecor and Cochran (1994). Significance of mean difference was tested by Duncan's New Multiple Range Test (DNMRT) using the Statistical Package for the Social Sciences (SPSS), Base 20.0, SPSS Software products, Marketing Department, SPSS Inc. Chicago, USA.

4. Results and Discussion

Chemical composition of experimental diets

The proximate parameters were analyzed to determine the nutritive values of untreated paddy straw, ensiled paddy straw and fungal treated paddy straw (Table 1). It was found that the fungal treated straw had higher protein and ash content while CF, NDF, ADF, ADL, DM, cellulose and hemi-cellulose were decreased compared to the untreated counterpart and were similar to those reported by Khattab *et al*. (2009) [13], reported higher protein content for *Pleurotus ostreatus* treated wheat straw, Fazaeli *et al*. (2007) [9], reported that fungal inoculation of wheat straw increases CP while decreasing OM, NDF, ADF, CL and HCL and Azim *et al*. (2011) [6] reported that paddy straw and corn stalks treated with *Trichoderma viride* decreased OM and CF while the content of CP, EE and TA were increased in the treated straw when compared to the untreated straw. The results also corroborated with the findings of Akinfemi and Ogunwole (2012) [3], reported that *Pleurotus tuber-regium* treated paddy straw had higher CP in association with a decrease in CF. The higher ash content in the fungal treated paddy straw could be attributed to the residual calcium oxide that is applied to the paddy straw before the fungal treatment. Moreover, fungal growth on the straw also leads to the increased deposition of calcium and phosphorous in the treated straw. The results of the chemical composition of *Trichoderma viride* treated paddy straw in this investigation showed a significant decline in the lignin content along with decline in cellulose and hemicellulose of the straw. These results are in line with the findings of Sahni *et al.* (2013) [21] also reported lignin loss in paddy straw treated with *Coriolus versicolor*. Azim *et al*. (2011) [6] reported that bagasse treated with *Trichoderma viride* had increased CP and ash, while CL, HCL, NDF and ADF were reduced. Also reported that *Trichoderma viride* treated corn stover had significantly lower content of HCL.

Growth performance

Change in body weight gives reliable measure of performance of animals fed on different diets. Difference in the average periodical live weight of the animals in different treatment groups, although the average periodical live weight of animals in the treatment groups was numerically highest in the fungal treatment group (T_3) followed by the silage group (T) than the control. The ADG in the fungal treated paddy straw based complete diet fed group (T_3) was significantly higher as compared to control. Initially the average body weight of sheep in the silage treatment group and control group were more or less similar and with the advancement of age, the animals of these two experimental groups attained comparatively higher body weights showing statistically ($P \leq 0.05$) significant difference across the period particularly at 75 and 90 days of the experiment. However, the fungal treatment group recorded significant increase in the periodical live weight and ADG compared to the other two groups and the results fall in line with findings of Ramirez-Bribiesca *et al*.(2010) [20], Akinfemi and Ladipo (2011) [4]. The results of the current investigation also corroborate with Omer *et al*. (2012) [17]. Feed conversion ratio was lowest in T_3 group (6.84) i.e., animals which were fed on fungal treated paddy straw based complete diet followed by T_2 (8.24) and T_1 group (10.37). FCR was 20.54% and 34.04% lower in T_2 and T_3 groups respectively. Lower FCR in T_3 and T_2 group may be due to better utilization of nutrients from the treated paddy straw in comparison to untreated paddy straw. The cost of feeding/kg gain for the period of 90 days was reduced from rupees 169.01 in T_1 (control) to 167.10 and 166.48 in T_2 and T_3 group respectively, with a reduction in the feed cost of about 1.13% and 1.43% in T_2 and T_3 group respectively in comparison to control.

DM intake and digestibility

Regarding the digestibility of dry matter and other nutrients in the treatment groups (Table 2), it was found that digestibility of CP, CF and NDF was significantly increased in the fungal treatment group. Digestibility of DM in the fungal treatment group was also significantly increased as compared to the other two treatment groups, and the experimental findings were similar to those reported by Marwaha *et al*. (2012) [15]. The digestibility of DM, CP, EE and OM in the treatment group that was fed on ensiled paddy straw based complete diet was non-significantly increased as compared to the control. However, digestibility of EE, CF and NDF was significantly increased as compared to the control and the results were similar to the findings of Abdollahzadeh *et al*. (2010) [1] and Ahn *et al*. (2002) [8]. The balances of nitrogen, calcium and phosphorus were estimated from the total intake, faecal output and urinary output in all the treatment groups. The statistical analysis of data revealed significant ($P<0.01$) difference between nitrogen intake in all the treatment groups. Comparison of means using DNMRT revealed significantly higher intake in T_3 (fungal treatment) group followed by T_2 (silage treatment) and T_1 (control) group. It was also observed that the urinary excretion of nitrogen was lowest in the control group as compared to the treatment groups and the results fall in line with the findings of Ganai and Teli (2010) [10].

Rumen fermentation parameters

The mean values of TVFA concentrations, total nitrogen and NH3-N recorded at different hours post feeding (Table 5). Different rumen parameters viz. pH, TVFA, total nitrogen, NH_3-N, TCA-ppt. N and NPN were studied at the end of 90 days experimental feeding at different time periods after feeding, in both control and treatment groups. In the fungal treatment significant increase was found in TVFA, Total nitrogen and TCA ppt-nitrogen as compared to the control. The results are in accordance with the results of Mahrous *et al*. (2011) [16] and Omer *et al*. (2012) [17]. There was no significant difference in the pH and NH_3-N of the fungal treatment group as compared to the control which is in line with the results of Kwak *et al*. (2010) [14].

Hemato-biochemical parameters

Regarding hemato-biochemical parameters as depicted in (Table 5). Blood profiling is considered to be one of the significant sources for judging the nutritional status and body condition of animals. All the blood parameters in the present study were found to be in the normal range which corroborates well with the findings of Radostits *et al.,* (2007) [18], reported that feeding fungal treated paddy straw had no adverse effects on the blood parameters of sheep. As far as the fungal treatment group is concerned, there was no significant increase in the blood parameters of the animals and the results are in line with the findings of Kwak *et al*. (2010) [14].

Table 1: Chemical composition of untreated and fungal treated paddy straw.

Parameters	Untreated paddy straw (Moist)	*Trichoderma viride* treated paddy straw			*Pleurotus florida* treated paddy straw		
		Days			Days		
		14	21	28	14	21	28
DM	21.03	20.23	19.42	17.56	19.13	17.42	16.50
DM (after sun drying)	-------	91.33	90.47	90.00	90.11	89.77	87.13
CP	3.29	2.89	4.66	7.21	3.33	5.44s	8.22
EE	1.68	1.91	2.40	2.80	1.70	1.91	2.28
CF	30.39	28.63	25.42	21.03	25.86	19.82	17.47
NDF	64.33	64.03	62.01	61.02	62.73	61.20	60.06
ADF	47.5	47.20	45.30	45.06	46.33	45.02	44.21
Hemicellulose	16.83	16.83	16.71	15.96	16.40	16.18	15.85
Cellulose	35.02	35.42	32.40	28.22	31.50	30.66	29.87
Total Ash	8.41	6.56	8.42	10.01	9.01	11.12	12.09
Lignin	8.15	8.05	7.09	5.83	8.01	6.90	6.55
Ca	0.91	2.02	2.33	2.77	2.71	4.74	5.31
P	0.39	0.13	0.11	0.14	0.33	0.13	0.15

Table 2: Dry matter intake, bodyweight, feed conversion and economics in different treatment groups

Particulars	Treatment groups		
	T1 Control	T2 Ensiled	T3 Fungal treated
Dry matter intake			
DMI (g/d)	661.06±41.12	692.74±41.13	739.46 ±48.11
Body weight			
Average Body weight (kg)	21.48±0.796	22.15±1.106	23.44±1.258
Average daily gain (g/d)	81.30±0.796	100.37±1.106	128.52±1.258
FCR	10.37±0.21	8.24±0.13	6.84±0.18
Reduction in feed cost/ animal (%)	------------	1.13	1.43

Note: Means superscripted with different letters in a row (ab) or column AB) for a particular data differ significantly ($P\leq 0.05$)

Table 3: Mineral balance in different treatment groups

	T1 Control	T2 Ensiled	T3 Fungal treated
Nitrogen balance			
g/day	12.44^{a}±0.72	13.38^{b} ±1.02	18.59^{c} ±0.97
% retention	41.03^{a} ±2.33	43.24^{b} ±1.78	51.48^{c}±2.67
% absorbed	65.69^{a} ±3.12	69.90^{b} ±1.44	78.91^{c} ±2.22
Calcium balance			
g/day	5.79^{a} ±0.34	10.74^{b} ±0.80	16.49^{c} ±1.66
% retention	50.93^{a} ±3.13	63.31^{b} ±3.11	70.85^{c} ±1.17

% absorbed	77.18 ^{a} ±1.77	84.03 ^{b} ±1.09	87.00 ^{c} ±0.44
Phosphorous balance			
g/day	3.78 ^{b} ±0.29	2.93 ^{a} ±0.28	6.30 ^{c} ±0.33
% retention	50.41 ^{a} ±3.47	65.88 ^{b} ±3.22	66.07 ^{c} ±2.87
% absorbed	69.20 ^{a} ±1.89	82.31 ^{b} ±2.91	88.66 ^{c} ±2.88

Note: Means superscripted with different letters in a row differ significantly (P≤0.05)

Table 4: Average digestibility coefficients of DM and other nutrients in different treatments

Attributes	Treatments		
DM	57.97^{a}±0.19	60.72^{a}±0.27	65.48^{b}±0.26
OM	61.78^{a}±0.29	64.23^{a}±1.11	68.40^{b}±1.01
CP	61.04^{a}±0.54	64.13^{ab}±0.77	67.66^{b}±0.81
EE	64.00^{a}±0.99	69.78^{ab}±0.87	73.13^{b}±1.04
CF	64.98^{a}±0.32	66.83^{a}±0.31	71.85^{b}±0.37
NFE	70.17±0.79	70.92±0.71	72.70±0.83
NDF	55.77±0.43	57.74±0.55	61.65±0.52
ADF	64.92±0.51	68.54±0.52	69.93±0.68
Hemicellulose	69.55±0.76	72.37±0.78	74.99±0.82
Cellulose	64.17 ^{a} ±0.76	62.23 ^{a} ±0.78	68.68 ^{b}±0.82

Note: Means superscripted with different letters in a row differ significantly (P≤0.05)

Table 5: Haemato-biochemical and rumen fermentation parameters of animals in different treatment groups

Period (DYS)	Treatment groups		
	T_1 Control	T_2 Ensiled	T_3 Fungal treated
Haemoglobin (g%)	11.30^{a}±0.09	11.81^{b}±0.15	11.49^{ab}±0.12
Packed cell volume (%)	33.90^{a}±0.29	35.72^{b}±0.38	34.82^{ab}±0.47
Blood glucose (mg/dl)	65.25±1.07	63.25±1.66	64.50±1.02
Total protein (mg/dl)	7.27	7.58	7.32
Blood urea nitrogen (mg/dl)	4.20	4.35	4.10
Serum creatinine (mg/dl)	2.76	2.93	2.91
Rumen fermentation parameters			
pH	6.71±0.01	6.49±0.04	6.66±0.03
TVFA(mEq/l)	78.29^{a}±1.01	81.49^{b}±0.94	83.04^{b}±1.02
Total Nitrogen(mg/l)	85.97^{a}±3.54	89.01^{b}±3.44	89.69^{b}±3.52
NH3-N (mg/d)	20.13±0.57	22.69±0.35	21.29±0.65
TCA ppt. Nitrogen (mg/dl)	45.11^{a}±1.64	47.68^{b}±1.92	48.95^{b}±1.83
NPN (mg/dl)	40.15^{ab}±1.66	39.43^{b}±1.68	37.37^{a}±1.75

Means superscripted with different letters in a row (AB) for a particular data differ significantly (P<0.05)

5. Conclusion

Based on the results of study regarding nutrient improvement, body weight gain, feed intake, nutrient digestibility, heamato biochemical and rumen fermentation parameters, it was concluded that both ensiling of paddy straw with the fungal treatment of paddy straw has a potential to increase the nutritive value of paddy straw as well as the animal performance and can be used as a potential means to fortify poor quality crop residues especially paddy straw.

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