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Effect of unconventional sugarcane trash based complete diets on performance of NariSuwarna × Kenguri F1 sheep

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Abstract

Thirty NariSuwarna × Kenguri F1 adult sheep fed complete diets for six weeks. Animals were divided into six groups with five replications. The animal trail was conducted with ground sugarcane trash as roughage source in complete diets with six difference roughage concentrate ratio; (80:20) to (30:70). The ADG was 11.90, 12.62, 63.33, 72.38, 82.86 and 90.48 g/d in T-1, T -2, T-3, T-4, T-5 and T-6, respectively. As the proportion of CFM in diets increased ADG was also linearly increased due to additional digestible energy, protein and other essential nutrients. The mean total DMI was 715.1, 724.8, 961.0, 1084.9, 1086.3 and 1180.5 g/d in T-1, T -2, T-3, T-4, T-5 and T-6, respectively. DMI was linearly improved as the proportion of concentrates increased in the SCT based complete diets. Increase in the proportion of CFM in complete diets linearly improved digestibility of DM, OM, CP, EE and NFE. Whereas observed reduction in digestibility of fiber fractions. Sheep on all the diets were in positive N balance. It is concluded that unconventional SCT can be included upto 60% level in the total diet of sheep ration is beneficial and economical.

Keywords: sheep, sugarcane trash, complete diet, TMR nutritive value, digestibility

Introduction

Scarcity of green fodder and high cost of conventional feed ingredients have encouraged the researchers to improve the feeding value of poor quality crop residues. Efficient utilization of crop residues is one of the thrust area in ruminant nutrition to mitigate the shortage of feed resources to meet the maintenance requirements of livestock. Among several region specific crop residue resources available, only some parts of the crops are utilized as roughage source. Especially, in sugarcane crop, only sugarcane tops and sometime millable cane are used as animal feed where as the dry leaves around cane known as sugarcane trash left over on field after harvest of sugarcane was usually burnt on field or mulching of sugarcane trash was practiced by few farmers. However, the problems associated with the crop residues are low nutritive value, poorly available nitrogen, low digestibility and low voluntary intake (Saritha *et al*., 2012) [23] due to interlocking of cell wall polysaccharides with lignin and higher levels of silica (Mahesh and Mohini, 2013) [15]. Hence, the greatest challenge before the animal nutritionist is to improve the crop residues palatability in order to increase the intake. The concept of feeding complete rations or Total Mixed Ration (TMR) with use of locally available crop residues seems to be ideal and promising method of improving the utilization of poor quality fibrous crop residues (Aasha *et al*., 2006) [1]. Feed ingredients of low palatability may also be better utilized in this feeding system, because it prevents selection of ingredients during feed consumption. The advantages for sheep production efficiency of a TMR over feed ingredients provided separately are thought to exist because concentrates and forages are mixed and offered together and are therefore fermented in the rumen simultaneously. Hence, the present experiments have been designed to evaluate the effect of sugarcane trash as a source of roughage in complete diet of various levels on performance of adult NariSuwarna × Kenguri sheep.

2. Materials and Methods

2.1 Particulars of experimental animals

The experiment was approved by Institutional animal ethics committee. The present study was carried out at Department of Animal Nutrition, Veterinary College Nandinagar, KVAFSU, Bidar, Karnataka.

Thirty NariSuwarna × Kenguri F1 sheep of around 9-13 months age were selected and these were divided into six groups with five replications and randomly allotted to one of six dietary treatments in a completely randomized design. Uniform managemental care like deworming, vaccination etc., was under taken in stall fed condition.

2.2 Dietary treatments
The diet of the experimental sheep comprised of sugarcane trash as a sole roughage source used to formulate complete diets of various ratios. The complete diets with six different roughage concentrate ratio was formulated and the animal trial was conducted with following six Diets (D-1) 80:20, (D-2) 70:30, (D-3) 60:40, (D-4) 50:50, (D-5) 40:60 and (D-6) 30:70 roughage: concentrate ratios. The animals were fed as per ICAR (2013) requirements. The complete diets were offered ad libitum based on the intake and left over feed was recorded on the next day at 8.30 AM. Clean drinking water was provided to all the animals thrice a day at 9.00 AM. 1.00 PM. and 5.00 PM.

2.3 Digestion trial and chemical analysis
At the end of the experiment, 24 sheep (four sheep from each group) were subjected to metabolic trial for five days. Dung and urine voided by each sheep over 24 hours was weighed/measured every day at 9.00 AM. The dried pooled samples of feed, fodder and dung were analyzed for proximate constituents according to AOAC (2005) [4] except for crude fibre fractions. The crude fiber fractions, neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined according to Van Soest *et al*. (1994) [29]. The DOMD and ME were calculated as per methods described by Fuller (2004). The nitrogen content in the dung and urine sample was determined by macro Kjeldhal method as per the procedure of AOAC (2005) [4].

2.4 Statistical analysis
The data of BW, BW gain, DMI, various nutrient intake and digestibility of nutrients were analyzed statistically using analysis of variance technique in completely randomized design. The data on feeding trial and metabolism trial was subjected to statistical analysis using SAS programme (SAS, 2010) [24] and interpreted accordingly.

3. Results and Discussion
3.1 Chemical composition
The chemical composition (on % DMB) of complete diets of various roughage concentrate ratio is presented in Table 1. The chemical composition includes proximate analysis as well as forage fiber analyses. The inclusion of higher proportion of CFM in the diet lead to linear increase in OM, CP, EE and NFE content but decreased linearly in CF, TA, AIA, NDF, ADF, ADL, cellulose and hemicellulose content of the diet. This was due to the higher or lower content of respective nutrients in the concentrate supplements and the roughage sugarcane trash used for formulation of complete rations. Similar results in complete rations with various roughage source had reported by Reddy and Prasad (1983) [22] with cowpea hay, Cheeke, (1999) [8], Gomes *et al.*, (2004) [12] with wheat straw, Assefu gizachew (2012) [5] with sward hay, Venkateswarlu *et al.* (2014) [31] with sorghum stover and Nalini Kumari *et al.*, (2013) [18] with sweet sorghum bagasse as roughage source.

Table 1: Chemical composition (% on DMB) of complete diets

Parameter	D-1	D-2	D-3	D-4	D-5	D-6
DM	95.86	95.88	96.44	95.43	96.70	96.66
OM	87.10	87.86	87.48	88.97	88.64	88.13
CP	9.41	11.17	12.08	12.35	13.22	13.12
EE	0.939	1.041	1.152	1.633	1.706	1.966
CF	28.28	27.47	26.37	25.03	18.39	16.03
NFE	48.47	48.18	47.88	49.96	55.32	57.01
TA	12.90	12.14	12.52	11.03	11.36	11.87
AIA	7.91	6.84	6.51	5.64	4.34	4.07
NDF	76.85	72.04	68.30	60.45	54.58	50.37
ADF	48.88	44.63	42.78	35.08	31.26	28.07
ADL	21.17	19.80	18.64	17.95	16.00	14.29
Cellulose	28.11	27.24	26.29	25.56	23.80	22.65
Hemi-cellulose	27.97	27.41	25.52	25.37	23.33	22.29

3.2 Body weight and body weight gain
The mean body weights and body weight gain for six treatment groups during the feeding trial are summarized in Table 2. The treatment D-3, D-4, D-5 and D-6 had significantly (P<0.01) higher body weight gain when compared with T-1 and T-2. The gradual increase in proportion of CFM in diets of D-3 and D-6 increased ADG linearly which was due to the additional digestible energy and protein, and other essential nutrients supplied by the concentrate supplement. The poor quality roughage diets with high quality concentrates improve growth rate in lambs, as reported by Singh and Sankhyan (2003) [26]. Dhuria *et al.* (2007a) [10] reported that non-conventional roughage source like groundnut straw, cluster bean straw, bajra straw included up to 60 percent in the completed feeds of growing animals were not adversely affected to achieve higher growth rate and feed efficiency. Similarly increase in proportion of CFM in various roughage based complete diets improved gain linearly due to increase availability of nutrients as reported by Jabbar *et al.* (2008) [13] in berseem fodder, Nalini Kumari *et al.*, (2013) [18] in sweet sorghum bagasse, Venkateswarlu (2013) [30] in maize stover, sorghum straw and sweet sorghum straw and Pradeep (2015) [19] in Maize cob shank.

3.3 Intake of dry matter and different nutrients
Intake of Dry matter and different nutrients were presented in Table 2. The mean total DMI (g/d) and DMI on % body weight in D-4, D-5 and D-6 were significantly (P<0.01) higher when compared to D-1 and D-2 group. Whereas DMI on metabolic BW (g/kg $BW^{0.75}$) was significantly (P<0.01) higher in D-4 and D-6 groups. When compared to D-1 and D-2. DMI was linearly increased as the proportion of CFM increased in the SCT based complete diets. Since feeding of complete diet increases the voluntary feed intake and ensures efficient utilization of the feed due to enhance palatability. Increased DMI in complete feed may be due to particle size reduction which avoids refusal of unpalatable portions of roughage, lesser retention time due to higher rate of passage of the smaller feed particles in the mash. According to Van Soest (1982) [28] dietary protein supplementation improves intake by increasing the supply of nitrogen to the rumen bacteria. This has a positive effect of increasing bacteria population and efficiency, thus enabling them to increase the rate of breakdown of the digesta. The improvement in total DM intake attributed to better supply of CP that promoted the proliferation of rumen microorganisms enabling more efficient digestion of the fiber components leading to higher feed intake as reported by Ranjhan (1997) [21]. Similar results

were observed by Venkateswarlu *et al.* (2014) [31] when sheep fed various levels of sorghum straw based complete ration. It is observed that the DMI is better in complete diets when compared to feeding sugarcane trash separately, Jaishankar (2017) [14].

Intake of OM, CP, EE and NFE increases linearly with gradual increase in the proportion of CFM in complete diets (Table 2). This increased intake is due to high levels of nutrients present in CFM. The dietary protein supplementation improve intake by increasing the supply of nitrogen to the rumen bacteria. This has a positive effect of increasing bacterial population and efficiency, thus enabling them to increase the rate of breakdown of the digesta and consequently higher feed intake as reported by Van Soest (1982) [28]. The results were well in agreement with the findings of Gomes *et al.* (2004) [12] wheat straw based diet, Senani *et al.* (2013) ragi straw and Dilipkumar *et al.* (2016) [11] wheat straw. Intake of CF, NDF, ADF, cellulose and hemicellulose decreased linearly with gradual increase in the proportion of CFM in complete diets (Table 2). This reduced intake was due to lower levels of these nutrients present in CFM. High NDF and ADF contents in the diet were expected to increase resistance to physical breakdown and contribute to more ruminal fill resulting in a lower voluntary intake (Adugna *et al.* 2002) [2]. The feed intake is negatively impacted by the quantity of indigestible fractions lignin or fractions with low digestibility like NDF and ADF content due to the need of more retention time in the rumen for further fermentation as reported by Bruinenberg *et al.* (2003) [7]. Similar results observed with sorghum straw roughage in complete diets by Venkateswarlu *et al.* (2014) [31].

3.4 Digestibility of nutrients

The mean digestibility of DM, OM, EE and NFE observed for treatment groups were presented in Table 3. D-6 had significantly (P<0.01) higher DMD, OMD, EED and NFED % when compared to other treatment groups. Increase in the proportion of concentrate in complete diets linearly increased digestibility of DM, OM, EE and NFE. Digestibility of CP was non significant and linearly increased 57.82, 60.08, 58.67, 58.95, 63.20, and 66.23% as the proportion of CFM increase in complete diets. The findings were in agreement with the findings of Van Soest (1994) [29]. In general digestibility of nutrients in concentrates is higher than roughages. Hence, increase in proportion of CFM in complete diets had shown better digestibility. Similar results were observed and reported by Ali *et al.* (1979) [3], Gomes *et al.*, (2004) [12] wheat straw and Dhuria *et al.* (2007a) [10] gram straw.

The mean digestibility of CF, NDF and hemicellulose observed for treatment groups were presented in Table 3. There is no significant difference observed between the treatment groups. There was a reduction in digestibility of fiber fractions as the proportion of CFM increased in the complete diets. The high ADF content of the trash could limit its digestibility, since feeds that contained high proportion of ADF had lower availability of nutrients due to the established negative correlation between ADF content and ADF digestibility of feeds (McDonald *et al.* 2002) [16]. Adugna *et al.* (2002) [2] reported that the higher NDF and ADF content in the diet were expected to increase resistance to physical breakdown and contribute to more ruminal fill resulting in a lower intake. Feed that was low in protein and high in fiber content resulted in low digestibility. Similarly Assefu gizachew (2012) [5] reported digestibility of fiber fraction decreased, Babu *et al.* (2014) [6] and Dilipkumar *et al,* (2016) [11] observed reduction in CF digestibility.

Table 2: Mean body weight, gain and intake of nutrients of adult sheep

Parameter	D-1	D-2	D-3	D-4	D-5	D-6	SE	P
Body weight (kg)	27.03	26.77	27.85	28.84	29.31	29.18	0.50	NS
Initial	26.70	26.68	26.68	27.84	27.78	27.78	0.44	NS
Final	27.20^{ab}	27.21^{a}	29.34^{abc}	30.88^{abc}	31.26^{bc}	31.58^{c}	0.63	<0.05
ADG (g)	11.90^{a}	12.62^{a}	63.33^{b}	72.38^{b}	82.86^{b}	90.48^{b}	7.29	<0.01
Total DMI (g/d)	715.1^{a}	724.8^{a}	961.0^{ab}	1084.9^{b}	1086.3^{b}	1180.5^{b}	46.46	<0.01
% BW	2.66^{a}	2.73^{a}	3.45^{ab}	3.75^{b}	3.70^{b}	4.00^{b}	0.13	<0.01
$W^{0.75}$	60.55^{a}	61.89^{ab}	79.29^{abc}	86.96^{bc}	86.05^{abc}	93.18^{c}	0.16	<0.01
OMI (g/d)	622.9^{a}	636.8^{a}	840.7^{ab}	965.2^{b}	962.9^{b}	1040.4^{b}	41.47	<0.01
% BW	2.32^{a}	2.40^{a}	3.02^{ab}	3.34^{b}	3.28^{b}	3.53^{b}	0.12	<0.01
CPI (g/d)	67.29^{a}	80.96^{ab}	116.08^{bc}	133.98^{c}	143.61^{c}	154.88^{c}	7.22	<0.01
% BW	0.25^{a}	0.31^{a}	0.42^{b}	0.46^{b}	0.49^{b}	0.53^{b}	0.02	<0.01
EEI (g/d)	6.72^{a}	7.55^{a}	11.07^{a}	17.72^{b}	18.53^{b}	23.21^{b}	1.26	<0.01
% BW	0.02^{a}	0.03^{ab}	0.04^{b}	0.06^{c}	0.06^{c}	0.08^{d}	0.004	<0.01
CFI (g/d)	202.2^{ab}	199.2^{a}	253.4^{ab}	271.5^{b}	199.8^{ab}	189.2^{a}	8.88	<0.05
% BW	0.75^{ab}	0.75^{ab}	0.91^{b}	0.94^{b}	0.68^{a}	0.64^{a}	0.03	<0.01
NFEI (g/d)	346.6^{a}	349.2^{a}	460.1^{ab}	542.0^{bc}	601.0^{bc}	673.0^{c}	28.53	<0.01
% BW	1.29^{a}	1.31^{a}	1.65^{ab}	1.87^{bc}	2.05^{bc}	2.28^{c}	0.08	<0.01
NDFI (g/d)	549.59	522.14	656.34	655.80	592.91	594.61	20.81	NS
%BW	2.05	1.97	2.36	2.27	2.02	2.02	0.06	NS
ADFI (g/d)	349.56	323.48	411.10	380.57	339.58	331.36	12.37	NS
% BW	1.30	1.22	1.48	1.32	1.16	1.12	0.04	NS
CI (g/d)	201.0^{a}	197.4^{a}	252.6^{ab}	277.3^{b}	258.54^{ab}	267.4^{b}	9.76	<0.05
% BW	0.75^{a}	0.74^{a}	0.91^{ab}	0.96^{b}	0.88^{ab}	0.91^{ab}	0.03	<0.05
HCI (g/d)	200.0^{a}	198.7^{a}	245.2^{ab}	275.2^{b}	253.4^{ab}	263.1^{b}	9.47	<0.05
% BW	0.74	0.75	0.88	0.95	0.86	0.89	0.03	NS

Note: P<0.01, Mean values bearing different superscript in a row differ significantly

3.5 Nitrogen balance

The mean nitrogen intake, nitrogen outgo and nitrogen balance by the experimental animals for the treatment groups were presented in Table 3. There was gradual increase in nitrogen intake and outgo was noticed as the proportion of CFM in complete ration was increased. Increased nitrogen intake and outgo were due to higher CP content of CFM. Treatment D-6 had significantly (*P*<0.01) higher positive nitrogen balance when compared to D-1, D-2, D-3 and D-4 groups. Nitrogen balance was linearly increased with higher levels of CFM in complete rations. Hence, sheep on all the diets were in positive N balance. Similar results were observed and reported by various authors Singh *et al*. (2006) [27] when Marwari rams fed cluster bean straw based diets, Dhuria *et al*. (2007a) [10] Marwari rams fed bajra straw based diets, Nalini kumari *et al.* (2012) [17] lambs fed sweet sorghum bagasse based diets and Venkateswarlu*et al.* (2014) [31] when Nellore ram lambs fed sorghum straw based complete diets showed positive nitrogen balance.

Table 3: Nutrient digestibility, Nitrogen balance and nutritive value of diets

Digestibility (%)	D-1	D-2	D-3	D-4	D-5	D-6	SE
DM	47.51^{a}	47.55^{a}	49.65^{a}	48.16^{a}	52.89^{a}	65.15^{b}	2.87
OM	52.58^{a}	53.30^{a}	55.86^{a}	53.52^{a}	57.71^{a}	68.49^{b}	2.69
CP	57.82	60.08	58.67	58.95	63.20	66.23	2.38
EE	33.92^{a}	36.70^{a}	49.31^{ab}	57.24^{b}	63.58^{bc}	78.33^{c}	4.14
CF	62.80	55.79	51.95	54.37	46.49	57.02	2.88
NFE	45.97^{a}	50.66^{ab}	57.47^{b}	51.64^{ab}	59.95^{b}	71.89^{c}	3.11
NDF	50.35	46.80	46.00	41.52	41.30	55.16	2.76
ADF	43.88^{b}	38.37^{ab}	41.19^{ab}	30.08^{a}	29.39^{a}	48.45^{b}	3.18
Cellulose	67.19^{b}	63.87^{ab}	62.02^{ab}	61.94^{ab}	58.45^{a}	61.44^{ab}	2.10
Hemicellulose	61.66	60.52	54.05	57.34	57.29	63.59	2.30
N Intake	10.76^{a}	12.77^{a}	20.13^{b}	21.42^{b}	24.14^{b}	26.47^{b}	2.58
N Outgo	9.53^{a}	9.23^{a}	12.96^{ab}	14.99^{b}	15.35^{b}	13.48^{ab}	1.89
N Balance	1.23^{a}	3.54^{ab}	7.17^{bc}	6.43^{bc}	8.79^{cd}	12.99^{d}	2.10
DCP %	5.44^{a}	6.71^{ab}	7.09^{bc}	7.28^{bc}	8.35^{cd}	8.69^{d}	1.11
DOMD %	45.80^{a}	46.83^{a}	48.87^{a}	47.62^{a}	51.16^{ab}	60.36^{b}	2.54
TDN %	46.20^{a}	47.30^{a}	49.58^{a}	48.79^{a}	52.51^{a}	62.28^{b}	2.62
ME* (MJ/kg)	6.99^{a}	7.15^{a}	7.50^{a}	7.38^{a}	7.94^{a}	9.42^{b}	1.02
DCP intake (g/d)	18.13^{a}	23.13^{a}	36.50^{ab}	40.54^{ab}	50.07^{bc}	69.49^{c}	4.57
ME intake (MJ/d)	5.01^{a}	5.13^{a}	7.78^{a}	8.16^{ab}	9.06^{ab}	12.00^{b}	1.73

* ME calculated as 1kg TDN = 15.12 MJ of ME

Note: *P*<0.01, Mean values bearing different superscript in a row differ

3.6 Nutritive value of the diet

The mean DCP, DOMD, TDN and ME observed for treatment groups were presented in Table 3. The nutritive value of the diet increased when the proportion of CFM increased to roughage source. Since, digestibilities of nutrients were high in CFM than roughage source. Similar results were observed and reported by several authors Pratap Reddy *et al.* (1989) [20], Dhuria *et al.* (2004b) [9], Nalini kumara *et al.* (2012) [17] and Babu *et al*. (2014) [6]. The mean digestible crude protein intake (g/d) and ME intake (MJ/d) recorded for treatment groups were 18.13, 23.13, 36.50, 40.54, 50.07 and 69.49%; 5.01, 5.13, 7.78, 8.16, 9.06 and 12.00 MJ/d respectively, in D-1, D -2, D-3, D-4, D-5 and D-6 groups. The DCP and ME intake was gradually increased when proportion of CFM in complete diet increased. This was due to better palatability of CFM than roughage and higher DCP and ME content of diet.

4. Conclusion

Sugarcane trash was equal to any of the crop residues in nutritional composition. As the proportion of CFM increased in complete diet, the ADG and DMI were improved in adult NariSuwarna × Kenguri sheep. However, SCT can be included less than 60% level in the total diet of sheep ration is economical, digestibility of nutrients and nutritive value of the diet increased as the proportion of the CFM increased in the diet.

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