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Full Length Research Paper

Optimum concentrate supplement to sorghum straw to reduce live weight loss in calves during summer season in Sudan

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A study was conducted in Rahad Agricultural Corporation with the objective to find the optimum level of concentrate that can offset live weight (lwt) loss during summer. Thirty Kenana x Friesian 1-1.5 year old calves were allocated to five levels of concentrate supplement (CS); 0, 0.5, 1.0, 1.5 % of animal body weight and CS 100%. In treatment groups, where CS was proportionate to body weight, *ad libitum* sorghum straw was offered as basal roughage. Feed DM, OM, CP and CF were evaluated. Rumen fluid was analyzed for pH, NH3 and protozoal count. In blood, haemoglobin (Hb) and heamatocrit (PCV%) was examined. The results showed that the digestibility of DM, OM, CP, CF and total dry matter intake (DMI) increased significantly with increasing level of CS in the ration. Rumen fluid pH was not affected by supplementation but was significantly decreased (P0<05) in exclusively concentrate fed calves (100% CS). Rumen NH3 was not affected by the level of supplement except in 100% CS feeding. Total protozoal count was unaffected by the different levels of CS. Both Hb and PCV% were significantly (p<0.01) increased with higher levels of CS. Optimum levels of CS was found at 0.34% of animal body weight. It could be concluded that CS of 0.5 % of body weight of calves improved feed digestibility, blood Hb and PCV% and prevented live weight loss. Increased CS levels of 1% and 1.5% increased significantly (P<0.1) MR compared to full concentrate feeding.

Key words: Supplementary feeding, calf, grain sorghum straw, weight gain, Sudan.

INTRODUCTION

Animal producers in Sudan are facing with chronic problem of feeding animals in terms of quantity and quality that further augmented due to shrinking land to produce animal feed and the simultaneous increase in the demand for human food. Further concentrate supplement CS consisted of sorghum grains as main energy source and oil seed cakes as a protein source became unaffordable especially for small producers. On the other hand, sugarcane molasses which was the only alternative energy source has become unavailable with introduction of an ethanol production industry for last two years. Therefore, agricultural by-products, especially sorghum straw and stover which represent the most important feed resources to fill the nutritional gap between animal requirements and pasture yield (National Strategy, 2002). Considerable percentage of feed inputs in the country and in summer season is the sole roughage source. Sorghum production in Sudan is 4,500.000 tonnes (U.S grains council, 2008). However, the quality of sorghum straw varies with the verity of sorghum cultivated in the country. Generally straw and stover are known to have high fiber content Romen and Jorge (2005), low in key nutrients such as nitrogen and minerals such as sulphur (Leng and preston, 1987), beside their low fat content (NRC, 2001). Also their feeding value differs among cereal species reflecting difference in the proportion of leaves and stem (Flashowsky et al., 1991). Both roughage level and source influence dry matter intake (DMI) and there by net energy for gain (NEg) intake (Defoor et al., 2002). Principle aim in feeding is to provide the animal with a bal-

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anced nutrient throughout the year. Galyean and Gleghorn (2001), stated that typical feedlot contain from 4.5 to 13.5% roughage in dietary dry matter. While Galyean and Abney (2006), concluded that NDF concentration of dairy and beef feedlot is closely related to dry matter and energy intakes. Livestock in Sudan which normally depend on sorghum straw during summer season tended to lose weight.

Application of both physical and chemical treatments of straw are not suitable for traditional animal producers due to lack of suitable infrastructure and high chemical cost. Supplementation is the only practiced method to improve the deficient nutrients in the straw and hence improving animal production.

To reduce live body weight loss and hence calf mortality during summer season in Sudan, this experiment was conducted with the objective to find an optimum of concentrate that supplementation to basal sorghum straw to maintain the animal live body weight and general condition during summer season. Another objective was to find the maximum concentrate level that give maximum marginal return.

MATERIALS AND METHODS

Animals and Feeds

An experiment involving 30 Kenana x Friesian male calves of 1-1.5 year old and about the similar body weight (BW: 117-121kg) was conducted in the Rahad Agricultural corporation. Animals were treated with Tetramizole (1.5g/kg BW) against internal parasites, sprayed with Cypermethrin against external parasites and were randomly allocated to five groups each consisted of 6 animals.

Animals in the control group (CG) received sorghum straw *ad libitum.* Animals in treatment group (TG) T1, T2 and T3 concentrate supplement (CS) at the rate of 0.5, 1 and 1.5% of the body weight respectively before offering the roughage. Animal in TG4 offered CS *ad libitum* without any roughage source. Water was available freely. Initial body weight of each animal measured at the beginning and subsequently at weekly intervals for six weeks. Straw substitution rate (SSR) in each TG was calculated as:

Straw intake in CG – (Straw intake – CS) in TG

CS intake in TG CS consisted of 30% sorghum grain, 20% ground nut cake, 15% cotton seed cakes, 19% wheat bran, 15%molasses and 1% NaCl salt.

Feed samples (sorghum straw and concentrate) and faeces were dried in a forced- air oven and analyzed for dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE) and Ash content according to AOAC (1990). Dry matter digestibility was determined from faeces selectively collected manually from each group.

Rumen Fluid Parameters (RF)

About 50 ml of Rumen fluid (RF) was collected at 4 hours of post prandial interval from each of the four used in digestibility trail of each group by stomach tubing.

Samples were collected weekly for four weeks. RF was strained through four layers of cheese –cloth. About 25 ml were stored at -20˚C for determination of NH3-N and total protozoa count.

Rumen Fluid pH

The strained RF samples were immediately used for determination of pH (Model:
Poitaltil 507, M/s). pH values were recorded for each RF samples for four weeks with16 reading for each treatment.

Rumen Fluid NH3-N

10 ml of stored RF were thawed, kept for sedimentation and 5ml of the upper clear layer was mixed with 10 ml of NaOH (40%) and steam distillated to determine NH3 concentration (mg/dl) according to AOAC (1990).

Rumen Total Protozoa Count (TPC)

TPC was carried with 1 ml of thawed RF by diluting with 9 ml of distilled water
(10-1) which further diluted with 9 ml of distilled water until attaining a dilution of 10-
8 and protozoa were counted in haemocytometer chamber using ocular lenses X10 under the microscope.

Blood Parameters

Blood parameters namely, haemoglobin (Hb) and packed cell volume (PCV%) analyzed by withdrawing 10 ml of blood sample weekly from the jugular vein of each selected animals in first 4 weeks in 20 ml tubes included EDTA as an anticoagulant. The samples were preserved at -20˚C for Hb and PCV determination by automatic machine type Kx 2IN.

Statistical Analysis

All data were subjected to analysis of variance in completely randomized design
(CRD) using the Statistical Analysis System computer package (SAS, 1997). For estimation of variance in initial, final and live BW changes, DMI and DMI as % of BW, 5 treatment groups with 6 replicates of animal units was applied in the design.

Straw intake and CS involved only the TGs (3 treatments) and CG and TGs and 100% CS respectively (4x6), While in the other parameters of feed (digestibility, OMD, CP and CF digestibility and N/OMD), rumen fluid para-

Table 1. Chemical composition of experimental diet (g/kg).

Parameter	Supplement concentrate	Sorghum straw
DM	880	910
CP	169	043
CF	088	421
EE	034	015
Ash	074	085
NFE	515	346

Table 2. Dry matter intakes and body weight changes in different treatments.

Treatment	CG	T1	T2	T3	T4	SEM
Initial BW kg	120.0	121.0	117.0	118.0	117.0	0.85
Final BW kg	110.0	123.5	125.0	133.0	145.7	3.67
BW change kg	- 10.0	2.5	8.0	15.0	28.7	0.79
Straw DMI kg /day	3.06	2.90	2.40	2.10	_	0.057
Concentrate DMI kg/day	_	0.60	1.20	1.80	3.50	0.11
Total DMI kg /day	3.06	3.50	3.60	3.90	3.50	0.07
% DMI from BWT	2.56	2.90	3.10	3.30	3.00	0.065
N/OMD (g/g)	0.015	0.017	0.026	0.029	0.045	0.003
Straw substitution rate (kg/kg)	_	0.27	0.55	0.53	_	0.013
% DM digestibility	54.6	59.5	62.2	67.3	73.8	1.10
% OM digestibility	59.3	62.7	64.6	69.7	75.3	0.52
%CP digestibility	41.9	50.1	56.1	60.3	70.5	1.10
%CF digestibility	34.5	38.7	43.2	45.6	42.2	0.77

meters (pH, NH3-N and TPC) and blood Hb and PCV% only four animals randomly selected from each group were used in each of the five treatments. In the three treatment groups (T1, T2, and T3) which included incremental levels of CS, differences in SSR were estimated as before. Differences between each two treatment means was compared using. Scheffe test at 5% level for estimation of optimum CS that offset BW loss, regression of BW change (Y) on CS (X) was calculated as $Y = a + bX$

Where:

a is constant and b is the regression coefficient .

Marginal return (MR) was calculated as the difference between live body weight changes over the difference of CS level in each successive treatments multiplied by unit price in Sudanese pound (SP).

RESULTS

Chemical Composition Intake and Digestibility of Feeds

Chemical composition of concentrate mixture and sorghum straw is shown in table 1.

It is clear that sorghum straw has low level of CP and NFE,. while the CF is extremely high. Also the DM is very high as a result of keeping of this material under direct sun light. Contrary the concentrate mixture contains higher CP and NFE but lower CF.

Digestibility of DM, OM, CP and CF (Table 2) showed a significant ($p<0.05$) increase in treatment containing concentrate supplement at 0.5% BW (T1) compared to animals fed sole sorghum straw (CG). At higher levels of concentrate inclusion at 1 and 1.5% BW in treatments T3, T4 and that included sole concentrate (T5), digestibility of DM was also significantly ($P < 0.01$) increased compared to CG.

The same trend was observed in digestibility of DM, OM, CP and CF which were significantly ($P<0.01$) increased with increasing the level of CS. However higher digestibility of CF was obtained in T3 where 1.5% BW CS was added to the basal diet (sorghum straws) compared to other treatments.

Total DMI (%BW) increased with increasing level of CS (Table 2). However, increase in DMI was statistically significant in all treatments included CS and 100% concentrate of DMI.

The calculated N/OMD value of roughage used in this

Table 3. Rumen fermentation characteristics and some blood parameters.

Treatment	CG	T1	T2	T3	T4	SEM
pH	6.85	6.78	6.48	6.38	6.20	0.23
NH3-N mg/dl	8.6	10.9	10.7	11.4	15.9	0.22
TPC x10^{-5}	0.76	0.83	0.97	1.04	0.92	0.09
Hb (g)	8.45	8.90	10.20	12.00	13.25	0.89
PCV%	19.75	23.25	29.00	29.50	31.75	1.40

experiment was 0.015 and the calculated DOM to CP ratio in CG and T1 were 10.4 and 9.4 respectively.

As shown in the table roughage DMI decreased as N/OMD increased from 0.015 to 0.029. Optimum CS was calculated according to the following equation;

Y = -4.28 +x12.58.

Where R2 = 0.97 and α level was 0.0001. From the equation the calculated X (CS) when Y (BW change) was zero, corresponded to CS of 0.34% BW. This optimum level gave an optimum MR of 31.3 (table 4). Increased level of CS, increased the MR significantly (P<0.01). It is worth mentioning that, full concentrate feeding, significantly (P<0.01) lowered the MR compared to both CS levels of 1% and 1.5%.

Rumen Fermentation Characteristics

Mean values for rumen pH, NH3-N and TPC are presented in table 3. Rumen pH in treatment groups (TGs) was not significantly (P<0.05) affected by the incremental increase in CS.

While it was sharply decreased in T4 but was not significant at (p<0.05) compared to CG. While rumen ammonia concentration was significantly (P<0.01) affected by supplement itself but not its level (Table 3). In T4, compared to either CG or other TGs, ruminal NH3-N increased significantly (P < 0.01).

No significant difference at (p<0.05) in TPC between CG and TGs but increasing trend was observed with increasing level of supplement.

Hematological Parameters

The result obtained in this study for Hb (g/dl) (table3) showed that Hb was not significantly affected by CS at the rate of 0.5 and1% of BW. When CS was at the rate of 1.5% of BW or sole feed, Hb was significantly increased. However the PCV% in both CG and T1 was significantly (P<0.01) lower than that of the other treatments.

DISCUSSION

Chemical Composition Intake and Digestibility of Feeds

Sorghum straw which has low levels of CP (4.3%) was in agreement to the earlier reports (Sulieman and Mabrouck, 1999; Adam et al., 2010), but contrary was true with CF content (42.1%). Low levels of CP in sorghum straw however, may not able to meet minimum protein requirement of diet (7%) suggested by ARC (1980) when it was sole roughage.

Contrary to the observation of Blummel et al. (2003), who inferred that the OM digestibility of straws are mostly less than 50%, OM digestibility observed of sorghum straw was 59.3%.

Digestibility of DM, OM, CP and CF were significantly (P<0.01) increased with increasing the level of CS which coincides with the result of Teller et al. (2004), on diets consisted 70% barley straw and 30% CS. Also in agreement with Teller et al. (2004), who found that the apparent digestibility of DM, and CP were 5, and 33% higher (P0<05) respectively in diet containing 70% barley straw and 30% concentrate, digestibility found for DM and CP was 14 and 34% higher (p<0.01) in TG containing 67% sorghum and 33% CS (TG2). However, Ba et al. (2008), found that CP intake and digestibility both increased linearly as the amount of CS increased in the diet of fresh grass at 1.25% and rice straw *ad libitum.*

Total DMI (%BW) increased with increasing level of CS (Table 2) and such observations were reported by many workers (Ko et al., 2006; Ba et al., 2008; and Gaafar et al., 2009).

It was observed from the study that increasing levels of CS improved the DMI as proposed by Pathirana, (1995).

The calculated N/OMD value of roughage used in this experiment was 0.015 which was lower than the value reported by Ketelaars et al. (1997), who stated that only when the critical value of N/OMD is less than 0.016, basal intakes may tended to improve.

This might explain the highly increased basal intake in CG where N/OMD was 0.015.

Roughage DMI decreased as N/OMD increased from 0.015 to 0.029 in the present study. It was concluded by Hogan (1982), that the microbial activity in ruminants consuming forage diet was only likely to be limited by ammonia when the digestible organic matter to crude protein ratio was 10.1 or more. It is clear in this study that the calculated DOM to CP ratio in CG and T1 were 10.4 and 9.4 respectively. This was well reflected on negative body weight change in the control and slightly positive body weight change in T1. Straw substitution rate (SSR) (g straw/ g concentrate) observed in this study was 0.27, 0.55 and 0.53 respectively in T1, T2

Table 4. Marginal return from increasing level of concentrate.

Treatment	Optimum	T1	T2	T3	T4	SEM
% level of CS	0.34	0.50	1.00	Full concentrate	1.50	0.06
MR (SP)	31.3	44.1	110.3	144.8	87.1	4.46

and T3 respectively. This lower SSR might be attributed to the habituatation of the animals in the area to straw feeding. However, this SSR is almost moderate when compared to substitution range of 0 – 1 kg DM forage/ kg DM concentrate reported by (Stockdale, 2000; Heard et al., 2004).

Optimum CS calculated in this study, corresponded to 0.34% BW. This optimum level gave an optimum marginal return (MR) of 31.3 (table 4). Increased level of CS, increased the MR significantly (P<0.01). It is worth mentioning that, full concentrate feeding, significantly (P<0.01) lowered the MR compared to both CS levels of 1% and 1.5%.

Rumen Fermentation Characteristics

It seems that the trend of rumen pH is consistent with the literature Russell et al. (1998); Krause et al. *(*2002); and Clover and de Vetch (2002). However, it was decreased with increasing level of CS. The result obtained in T4 is similar to that reported by Russell (1998), who found that, cows fed 90% CS had lower ruminal pH values (6.22 *Vs* 6.86) than cows fed forage only .Only CG and T2 fell within the pH range of 6.5 – 7 reported by (Hungate, 1966) for maximum microbial growth .

The values reported for rumen NH3-N in this experiment for CG, T1 and T2 are nearly similar to 10.3 mg NH3-N/100ml ruminal fluid reported by Rotger *et al* (2005) when heifers fed diet containing 30: 70 and 12: 88 roughage to concentrate ratio and 5.1% CP. In T4, compared to either CG or other TGs, ruminal NH3-N increased significantly (P < 0.01) this may be according to (Stritzer et al., 1988) was due to more intake of starch without cell wall fiber . NH3-N observed in CG and TGs was lower than the optimal of 15-30 mg/100ml for improving rumen ecology, microbial protein synthesis and voluntary feed intake (Perdok and Leng, 1990).

No significant difference at (p<0.05) in TPC between CG and TGs but increasing trend was observed with increasing level of supplement.

This result may be consistent with that, the increased level of supplement may increase level of starch and soluble sugar based on the result of Jounney and Ushida (1999), who found that numbers of protozoa per ml rumen fluid depend on the rate of soluble sugar and starch in the ration and also pH.

Hematological Parameters

Haemoglobin (Hb) was not significantly affected by CS at the rate of 0.5 and1% of BW. When CS was at the rate of 1.5% of BW or sole feed, Hb was significantly increased and similar values were reported by Prasad et al. (2009), for buffalo calves fed on conventional feed consisted of paddy straw plus concentrate mixture. Also these results of CG, TG 1 and, 2 are near to that quoted from Bhatti et al. (2009), who substituted saltbush fodder for Mott grass and Berseem fodder in feeding Nili buffalo heifers.

Packed cell volume (PCV %) in T2, T3 and T4 (29 , 29.50 and 31.75%) respectively was about similar to that reported by Bahtti et al., (2009). While the trend of PCV% in all of the treatments except the CG is consistent with that reported by Parasad et al., (2009).

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CONCLUSION

It could be concluded that concentrate supplement at about 0.34% BW can maintain calves without loss or gain during summer feed shortage. This level of CS may be recommended for producers who wish to store their animals when feed resources are limited or meat prices are low. However incremental increase in CS levels significantly (P0<01) increased the MR. Supplementation of sorghum straw at 1 and 1.5 concentrates as percent of BW significantly increased MR compared to full concentrate feeding.

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