

Nutrient utilization and cost benefits of crossbred heifers fed urea treated maize stover supplemented with varying levels of concentrate

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ABSTRACT

A study was conducted to evaluate the nutrient utilization and cost benefits of crossbred heifers fed urea treated maize stover supplemented with varying levels of concentrate. Sixteen crossbred heifers aged 8-10 months and weighing 90-120kg were divided into four groups and randomly allotted to four dietary treatments. In the control ration, chopped, untreated maize stover fed *ad libitum* was supplemented with concentrate mixture at 2.0% of body weight (T₁). For the other rations, urea treated maize stover was supplemented with concentrate mixture at 2.0, 1.5 and 1.0% body weight in groups T₂, T₃ and T₄ respectively. The results showed that total CP intake was similar between T₂ and T₃ treatments, and the values were significantly higher ($P>0.05$) than T₁ and T₄ treatments. Linear body measurements were not significantly affected ($P>0.05$) across treatments and chest girth was the best parameter for prediction of live body weight from body measurements. Cost of concentrate consumed was significantly higher ($P<0.05$) in heifers fed T₁ and T₂, than T₃ and T₄ rations. Cost of maize stover consumed was significantly higher ($P<0.05$) in heifers fed T₂, T₃ and T₄ than T₁ ration. Cost of feed consumed was significantly different ($P<0.05$) between treatment groups. Cost of feed consumed/Kg gain was lower in heifers on T₄, T₃ and T₂, than those in T₁. Feed conversion ratio was not significantly different ($P>0.05$) between dietary treatment groups. The results showed improved nutrient utilization and the economic feasibility to feed crossbred heifers urea treated maize stover with varying levels of concentrate supplementation.

Key words: Concentrate supplement, cost benefits, crossbred heifers, nutrient utilization, urea treatment.

INTRODUCTION

In sub-Saharan Africa, ruminant animals are reared mostly under traditional or pastoral production systems. The major feed resources available for animals managed under these systems are range forages, crop residues and agro-industrial by-products. In the tropics, crop residues are useful source of ruminant animal supplementary feed in the dry season (Oroka and Omoregie, 2015). These

residues are often the only livestock feed available especially in areas characterised by a defined dry season or with high land pressure resulting from a high human population.

During the dry season, available land for grazing by animals is liable to be abated entirely or in proportion due to continuous crop farming activities and land development. Therefore, efforts aimed at

development of an economic feeding system (Fall, 1990) by integrating pastoralists with the non-pastoralists (Yahaya and Kibon, 2013) are required. Also, the cost and availability of concentrate feeds constitutes an important factor in smallholder livestock production system. Hence, appropriate uses of available lower cost agricultural and agro-industrial by-products by smallholder farmers are important to profitable livestock production (Negesse *et al.*, 2007).

Maize stover is an important feed resource in Nigeria particularly during the dry season, but it is poorly utilized when the processing and supplementation is not properly planned, thus, leading to reduced animal performance. Also, cereal straws and stover are high in structural components and their associated fibre contents, their utilisation for animals is limited. These factors result in economic losses to the farmer. Urea treatment, being less hazardous, economical and safe, has been accepted more widely to improve utilization of cereal crop residues (Preston and Leng, 1984; Puri and Gupta, 2001). An increase in the nutritive value of maize stover after urea treatment has also been recorded (Iriso *et al.*, 2016). However, in order to maximize the utilization of urea treated stover by heifers, supplementation with concentrate leads to improved crossbred heifer performance (Iriso *et al.*, 2016; Iriso *et al.*, 2017).

Growth which is an increase in size or body weight at a given age, usually result from nutrient utilization and it is one of the important selection criteria for the improvement of heifers. In areas where weighing facilities are unavailable to farmers, linear body measurements can be taken to evaluate the live weight of animals (Ulutas *et al.*, 2002). Thus, body measurements could be used to predict live weight fairly well in such situations (Berge, 1977; Buvanendran *et al.*, 1980;

Goonerwardene and Sahaayuraban, 1983; Heinrichs *et al.*, 1992; Van Marle-Koster *et al.*, 2000) especially by smallholder farmers when taking management decisions involving marketing and growth evaluation. This study was conducted to determine the nutrients utilization and cost benefits of crossbred heifers fed urea treated maize stover supplemented with varying levels of concentrate.

MATERIALS AND METHOD

Experimental Site

The experiment was carried out at the Dairy Research Programme farm of the National Animal Production Research Institute (NAPRI), Shika-Zaria. Shika is located in the Northern Guinea Savannah Zone of Nigeria. Annual rainfall is 1100-1200mm, while mean temperatures is about 24.4⁰C (14.5-39.3⁰C), with the lowest temperature occurring during the early dry season (November-January), while, the highest temperatures are experienced during late dry season between February-April.

Feed Collection and Processing

Maize stover was collected after grain harvest, from farms within NAPRI, Shika-Zaria. The stover was chopped to 1-2cm long, using a forage chopper. The chopped maize stover was treated with urea (3.5% w/w) at 40 percent moisture. In a batch, 14kg urea was dissolved in 200 litres of water and sprinkled on 386kg maize stover (Bakshi *et al.*, 1987). The stover was mixed thoroughly on a concrete floor and covered with polythene sheet for 14-days fermentation. The treated maize stover was opened and aerated 24 hours before feeding to the animals.

Experimental Animals and Management

Sixteen crossbred (Friesian x Bunaji) heifers aged between 8-10 months and

weighing between 90-120kg were used for the growth trial. Prior to the commencement of the trial, the animals were dewormed with Albendazole[®]. They were treated against ectoparasites by weekly dipping with Acaricide[®]. The experimental animals were housed individually in well ventilated pens with concrete floor.

Experimental Treatments and Feeding of Animals

The experimental animals were randomly allotted to four dietary treatments with four animals per treatment, in a completely randomized design. The treatments were; untreated maize stover with concentrate mixture offered at 2.0 percent of body weight (T₁), urea treated maize stover with concentrate mixture offered at 2.0 percent of body weight (T₂), urea treated maize stover with concentrate mixture offered at 1.5 percent of body weight (T₃), urea treated maize stover with concentrate mixture offered at 1.0 percent of body weight (T₄). T₁ served as the control.

The concentrate mixture, consisting of crushed maize grain, cottonseed cake, wheat bran, rice bran, bone meal, common salt and vitamin premix, was formulated to contain approximately 14% crude protein. Untreated and urea treated maize stover was fed *ad libitum*. The daily allowance of the concentrate mixture was offered in the morning and consumed before the basal maize stover was offered. The animals had free access to fresh water. The animals were weighed fortnightly and the feeding allowances were adjusted accordingly. Daily record of feed offered andorts was maintained. The growth trial lasted for 90 days.

Linear Body Measurements

Experimental animals were taken from feeding pens at 8.00 a.m., confined to cattle crushes and body measurements obtained. Measurements were obtained at four weeks interval through the growth

trial (90 days) by two people, with each person taking a specific set of measurements on all the animals. Animals were weighed immediately afterwards before being returned to feeding pens. The following measurements were taken:

Wither height: The vertical distance from the floor to the point of wither (shoulders).

Body length: The distance between the points of shoulder to pin bone

Chest girth: The circumference of the body measured perpendicular to the median immediately posterior to the shoulder blade at the 6th-7th rib

Paunch girth: The circumference of the body midway between last rib and the hip bone.

A caliper was used for measuring wither height and body length, while chest girth and paunch girth was measured with a tape.

Cost-benefits Analysis

Market prices in Zaria and its environs were used to determine the cost of feeds. The costs of harvesting and transportation of maize stover was used as it is not sold in the markets. Feed consumption was used to multiply by the cost per kg of feed to obtain the cost of feed consumed.

Statistical Analysis

The data collected were subjected to analysis of variance (ANOVA) in a one-way classification for completely randomized design (Snedecor and Cochran, 1989). Means that were significant were separated using Duncan Multiple Range Test (Duncan, 1955). The interrelationship of body weights and linear body measurements were estimated by Pearson correlation analysis.

RESULTS

Table 1 shows the nutrient intake of crossbred heifers fed urea treated maize stover supplemented with varying levels of concentrate. Organic Matter (OM) intake

through concentrate was significantly higher in T₁ and T₂ and the values were significantly higher ($P<0.05$) than in T₃, while T₄ was the least. Crude Protein (CP) intake, Neutral Detergent Fibre (NDF), Acid Detergent Lignin (ADL), cellulose and hemicellulose all followed the same pattern like the OM. OM intake through maize stover were not significantly different ($P>0.05$) between the treatments. The CP intake through maize stover was similar between T₂, T₃ and T₄ and the values were significantly higher ($P>0.05$) than T₁. NDF and Acid Detergent Fibre (ADF) intake through maize stover were not significantly different ($P>0.05$) between the dietary treatments. ADL intake was similar between T₂ and T₄ treatments, although, the values were significantly higher ($P>0.05$) in T₁ and T₃ treatments. The cellulose intake was not significantly different ($P>0.05$) across the dietary treatments, however, hemicellulose intake was similar between T₂, T₃ and T₄, but, significantly higher ($P>0.05$) in T₁. Total OM intake was significantly lower ($P<0.05$) in T₄ treatment than in treatments T₁, T₂ and T₃. Total CP intake was similar between T₂ and T₃ treatments, and the values were significantly higher ($P>0.05$) than T₁ and T₄ treatments. Total NDF intake was highest in T₁ although similar to T₂ and T₃, and least in T₄. Total ADF intake were not significantly different ($P>0.05$) across the dietary treatments. Total ADL intake was significantly higher ($P>0.05$) in T₁ followed by T₂ and T₃ and least in T₄. The total cellulose intake was not significantly different ($P>0.05$) across the dietary treatments, while, the total

hemicellulose intake was highest in T₁ followed by T₂ and T₃, and least in T₄ treatment.

Table 2 shows the linear body measurements of crossbred heifers fed urea treated maize stover supplemented with varying levels of concentrate. All linear body measurements recorded non-significant differences ($P>0.05$) across the treatment groups.

Table 3 shows the pooled correlation of crossbred heifers fed urea treated maize stover supplemented with varying levels of concentrate. Body weight was highly correlated with chest girth than other body measurements, as the association between body weight and chest girth accounted for about 84% of the variation in heifers fed different levels of concentrate supplementation. The best second correlation with body weight was paunch girth, which was 67% of the variation. Wither height showed the lowest correlation with body weight (-0.52) and was also relatively poorly correlated with body length (-0.25), chest girth (-0.44) and paunch girth (-0.13). The correlation of body length with paunch girth was significantly different ($P<0.05$), while, correlation of body length with chest girth and wither height were not significantly ($P>0.05$) different. The correlation between chest girth and paunch girth was significantly different ($P<0.05$).

Table 1: Nutrient intake of crossbred heifers fed urea treated maize stover supplemented with varying levels of concentrate

PARAMETERS (Kg/d)	T1	T2	T3	T4	SEM	LOS
Nutrient Intake through Concentrate:						
OM	112.92 ^a	115.97 ^a	83.55 ^b	54.39 ^c	3.66	*
CP	17.26 ^a	17.43 ^a	12.56 ^b	8.18 ^c	0.58	*
NDF	45.58 ^a	46.56 ^a	33.73 ^b	21.96 ^c	1.53	*
ADF	30.72 ^a	31.56 ^a	22.73 ^b	14.80 ^c	0.99	*
ADL	7.71 ^a	7.92 ^a	5.70 ^b	3.71 ^c	0.25	*
Cellulose	23.02 ^a	23.64 ^a	17.03 ^b	11.09 ^c	0.75	*
Hemicellulose	15.66 ^a	16.08 ^a	11.59 ^b	7.54 ^c	0.51	*
Nutrient Intake through Maize Stover:						
OM	151.16	128.36	144.90	136.84	9.31	NS
CP	7.48 ^b	14.56 ^a	16.44 ^a	15.52 ^a	0.96	*
NDF	127.60	106.81	120.57	113.87	7.78	NS
ADF	79.22	78.37	88.47	83.54	5.47	NS
ADL	10.98 ^a	8.03 ^b	9.06 ^{ab}	8.56 ^b	0.61	*
Cellulose	68.25	70.35	79.41	74.99	4.87	NS
Hemicellulose	48.21 ^a	28.44 ^b	32.11 ^b	30.32 ^b	2.41	*
Total Nutrient Intake:						
OM	264.08 ^a	244.33 ^{ab}	228.45 ^b	191.23 ^c	12.97	**
CP	24.74 ^b	31.99 ^a	29.00 ^a	23.7 ^b	1.54	*
NDF	173.18 ^a	153.37 ^{ab}	154.30 ^{ab}	135.83 ^b	9.31	*
ADF	109.94	109.93	111.20	98.34	6.46	NS
ADL	18.69 ^a	15.95 ^b	14.76 ^b	12.27 ^c	0.86	**
Cellulose	91.27	93.99	96.44	86.08	5.62	NS
Hemicellulose	63.87 ^a	44.52 ^b	43.7 ^b	37.86 ^c	2.92	**

Note. abc= within the same row with different superscripts are significantly different ($P<0.05$), ADF=Acid Detergent Fibre, ADL=Acid Detergent Lignin, CP=Crude Protein, LOS=Level of Significance, NDF= Neutral Detergent Fibre, NS= Non Significant ($P>0.05$), OM=Organic Matter, SEM=Standard Error of Means.

Table 2: Linear body measurements of crossbred heifers fed urea treated maize stover supplemented with varying levels of concentrate

Parameter	T1	T2	T3	T4	SEM	LOS
Wither height (cm)	59.58	55.83	55.25	56.25	1.86	NS
Body length (cm)	79.67	82.17	81.08	80.59	2.30	NS
Chest girth (cm)	106.67	121.50	117.50	111.08	10.48	NS
Paunch girth (cm)	173.92	170.50	163.09	159.58	10.36	NS

Note. LOS= Level of significance, NS=Non Significant ($P>0.05$), SEM=Standard Error of Means.

Table 3: Pooled correlation between body weight and body measurements of crossbred heifers fed urea treated maize stover supplemented with varying levels of concentrate

Parameter (cm)	Body Weight	Body Length	Chest Girth	Wither Height	Paunch Girth
Body Length	0.40*	—			
Chest Girth	0.84**	0.11 ^{NS}	—		
Wither Height	-0.52 ^{NS}	-0.25 ^{NS}	-0.44 ^{NS}	—	
Paunch Girth	0.67*	0.31*	0.63*	-0.13 ^{NS}	—

NS= Non Significant ($P>0.05$), *= $P<0.05$, **= $P<0.01$

Table 4 shows the cost-benefits analysis of crossbred heifers fed urea treated maize stover supplemented with varying levels of concentrate. Concentrate intake was significantly ($P<0.05$) higher in heifers fed T₁ and T₂ than those fed T₃ and T₄ rations. Maize stover intake was not significantly different ($P>0.05$) between treatment groups. Total feed intake was significantly higher ($P<0.05$) in heifers on treatments T₁, T₂ and T₃ than those in T₄. The cost of concentrate consumed was significantly higher ($P<0.05$) in heifers fed T₁ and T₂, than those fed T₃ and T₄ rations. The cost

of maize stover consumed was significantly higher ($P<0.05$) in heifers fed T₂, T₃ and T₄ than those fed T₁ ration. The cost of feed consumed was significantly different ($P<0.05$) between treatment groups with the T₂ diet being significantly higher ($P<0.05$), although not different from T₁. The cost of feed consumed/Kg gain was lower in heifers on T₄, T₃ and T₂, than those in T₁. The feed conversion ratio was not significantly different ($P>0.05$) between dietary treatment groups.

Table 4: Cost benefits analysis of feeding crossbred heifers urea treated maize stover supplemented with varying levels of concentrate

Parameters	T1	T2	T3	T4	SEM	LOS
CI (kg)	136.98 ^a	141.15 ^a	101.38 ^b	66.25 ^c	7.39	*
MSI (kg)	172.73	162.35	182.83	172.95	11.47	NS
TFI (kg)	309.70 ^a	303.5 ^a	284.20 ^a	239.20 ^b	20.54	*
TWG (kg)	12.75	16.25	15.00	12.00	2.42	NS
COCC(₦)	6985.70 ^a	7198.70 ^a	5170.10 ^b	3378.80 ^c	376.52	*
COMSC(₦)	1381.80 ^b	2272.90 ^a	2559.60 ^a	2421.30 ^a	185.79	*
COFC(₦)	8367.50 ^{ab}	9471.60 ^a	7729.60 ^b	5800.10 ^c	519.49	*
COFC/kg gain (₦)	656.27	582.87	515.31	483.34	93.24	NS
FCR(Kg)	24.29	18.68	18.95	19.93	8.49	NS

Note. abc =within the same row with different superscripts are significantly different ($P<0.05$), CI=Concentrate Intake, COCC =Cost of Concentrate Consumed, COFC = Cost of Feed Consumed, COMSC =Cost of Maize Stover Consumed, Naira (₦)= Nigerian currency, NS =Non Significant ($P>0.05$), MSI = Maize Stover Intake, TFI= Total Feed Intake, TWG=Total Weight Gain, FCR=Feed Conversion Ratio, SEM =Standard Error of Means,.

DISCUSSION

Supplementation of treated stover with varying levels of concentrate also improved nutrient availability and stimulated the total nutrient intake of the feed accompanied by an increment in CP intake. This may also be attributed to the availability of treated stover to supply nitrogen for cellulolytic ruminal microbial degradation. These results are in tandem with Kaitho (1997) who proposed that “a good supplement is one that either maintains the intake of the basal diet or enhances it”.

The non-significant differences in all linear body measurements agrees with previous findings of Egbu (2014) who studied calves fed urea treated and untreated maize stover diets with

Centrosema pubescens. Similar findings were also observed by Ferdous *et al.* (2010). This implies that tissue and skeletal development was relatively uniform between dietary treatment groups. Also, that smallholder farmers can make use of simple linear measuring devices in estimating feed requirements, access growth rates and monitor live weight changes of heifers.

From the pooled data, the chest girth was found to be the best in predicting body weight and in estimating live weight of heifers with higher precision than other measurement parameters (body length, wither height and paunch girth) in crossbred heifers fed urea treated maize stover supplemented with different levels of concentrate mixture. This observation is

in accordance with the results for some Nigerian breeds of cattle (Buvanendran *et al.*, 1980). Thus, in farm management decisions where the scale is not available, measurement of chest girth may be a better indicator of live weight than wither height as reported by Vargas *et al.* (2000). This demonstrates that chest girth could be the most important parameter in predicting the live weight of the animals without combinations with other body measurements. This also corroborates the reports of Msangi *et al.* (1999), Willeke and Dürsch (2002) and Bozkurt (2006) that body weight can be predicted more effectively by using chest girth as the most important prediction parameter.

The result in this study shows that concentrate intake, total feed intake, cost of concentrate consumed and cost of feed consumed differed, which may be due to differences in the levels of concentrate supplementation/intake. Cost of feed consumed per kg gain in Naira was higher in T₁ and lower in heifers fed urea treated stover and concentrate supplementation at 1% (T₄), 1.5% (T₃) and 2% body (T₂) weights respectively, indicating it was beneficial to supplement urea treated maize stover with different concentrate levels. Similar findings were also observed by Trishna *et al.* (2012) and Ali *et al.* (2002) in calves fed urea treated wheat straw. The non-significant differences in feed conversion ratio is in tandem with previous findings of Tesfaye *et al.* (2005) in crossbred calves fed urea treated maize stover and natural pasture hay. Similar findings were also observed by Zou *et al.* (1995). However, efficient feed conversion by animals, will be achieved only if an animal is able to obtain a substantial amount of nutrients from the feed above their maintenance requirements. In the tropics, supplementation to provide essential nutrients has been found to be the most feasible, economic and preferred method of improving the utilization of

poor quality forage materials by ruminant animals (Preston and Leng, 1987, Poppi and McLennan, 1995). This also corroborates the report of Ehoche (2002), who reported “urea treatment of crop residues is cheap and has practical use to smallholder farmers”.

CONCLUSION

Supplementation of treated stover with varying levels of concentrate enhanced nutrient intake and also, smallholder farmers can use linear body measurements (especially the chest girth) to predict live weight of heifers where weighing facilities are unavailable for various purposes such as marketing and growth evaluation and thus to make appropriate management decisions. The lower feed cost per kg live weight gain for heifers fed urea treated maize stover with varying levels of concentrate supplementation compared to those fed untreated stover with 2% concentrate supplementation indicates its economic feasibility and affordability for the production of good quality heifers.

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