NIGER AGRIC J. 37 (2006) 35-43

EFFECT OF ADDITION OF SODIUM BICARBONATE TO MAIZE MILLING WASTE AS CONCENTRATE SUPPLEMENT ON FEED INTAKE AND LIVE WEIGHT RESPONSES OF SHEEP FED TWO ROUGHAGE TYPES.

BY

A. Fayomi

College of Agriculture and Animal Science, Division of Agricultural Colleges, PMB 2134, Ahmadu Bello University, Kaduna, Nigeria.

ABSTRACT

Twenty four Yankasa yearling rams were grouped into six of four rams per group and balanced for weight. The animals were randomly assigned to the following six experimental diets; T-1: Untreated maize husk (UMH) - control; T-2: UMH + maize milling waste (MMW)/sodium bicarbonate (SB); T-3: UMH + maize milling waste (MMW); T-4: untreated rice straw (URS) - control, T-5: URS + MMW/SB; and T-6: URS + MMW. Both UMH and URS were fed at the rate of 20g/kg body weight while SB and MMW were fed at the rate of 2g and 20g/kg body weight respectively. The objective of this study was to examine the effect of sodium bicarbonate (SB) on the intake and weight responses of sheep when roughages were fed as basal diet. Intake of UMH varied from 23.39g/KgW$^{0.75}$ to 29.03g/kgW$^{0.75}$ while that of URS varied from 26.35g/kgW$^{0.75}$ to 30.24g/KgW$^{0.75}$. The total feed intake (g/kg W$^{0.75}$) in T-1, T-2 and T-3 were 28.09, 40.46 and 71.91 respectively, while that of T-4, T-5 and T-6 were 26.35, 39.69 and 81.98 respectively. Total liveweight gain (kg) for treatments T-2 and T-5 for the $NaHCO_3$ supplemented diets were 0.40 and 0.50 respectively, while treatments T-3 and T-6 without $NaHCO_3$ supplementation gained 0.10 and 0.20 respectively. Results showed that the addition of $NaHCO_3$ to sheep diet improved liveweight gain and subsequently their market value.

Key Words: Yankasa, Untreated maize husk, Sodium bicarbonate, Untreated rice straw, Maize milling waste.

INTRODUCTION

Crop residues are a major basal roughage for livestock but their utilization is limited by low digestibility and nutrient content which inhibit intake and productivity. Appropriate supplementation is a means that has been used to enhance intake and utilization of crop residues and the consequent productivity of livestock(Greenhalgh, 1980).

The addition of bicarbonates such as sodium bicarbonate (SB) in the feed of ruminants has been known to enhance productivity (Salvay, 1983). Experiments have been conducted widely, especially in developed countries on the use of SB in ruminant diet (Orsbourn *et al.*, 1970; Emmanuel *et al.*, 1970). It is recognised that rumen fermentation is impaired and animal performance lowered when the nitrogen content of the diet is less than 1.2% (Conrad and Hibbs, 1968). The feeding of energy and protein supplements is known to enhance the utilisation of poor quality feeds like crop residues such as rice straw and maize husk by maximizing roughage degradation and optimizing rumen microbial protein synthesis (Anderson, 1978; O' Donovan, 1983). Because of high cost, scarcity and other logistic problems, the use of concentrates such as cotton seed

cake and soya bean meal cannot be justified especially in developing countries such as Nigeria, where these commodities are virtually out of the reach of peasant farmers. It has therefore become imperative to look inwards for some other substitutes that are relatively cheaper, easily available and within reach of the livestock producers. In Nigeria, maize milling waste (MMW) locally called 'Dusa' is widely used throughout the year, especially during the dry season, as supplement. Weight loss could be reduced during the dry season when used judiciously with available roughage types such as untreated maize husk (UMH) or untreated rice straw (URS). This could further be enhanced with the inclusion of sodium bicarbonate (SB) as an additive. In the Northern Guinea Savannah vegetational zone of Nigeria where this experiment was conducted, the inclusion of sodium bicarbonate in ruminant diet is yet to be exploited. In this zone, UMH and URS form a large percentage of ruminant basal diet.

The objective of this study was to investigate the effect of SB on the intake and weight responses of yearling rams fed a basal diet of UMH or URS and *Digitaria smutsii* using maize milling waste as a concentrate supplement.

MATERIALS AND MEHTODS

Background of research station

The study was conducted at the National Animal Production Research Institute of the Ahmadu Bello University, Shika, Zaria, Nigeria. Shika lies between latitudes 11 and 12°N, and between longitudes 7 and 8°E and has an altitude of 640m above sea level. Shika is situated within the Northern Guinea Savannah zone and has an average annual rainfall of about 1092mm. The rainfall is mainly between June and October while the dry season spans from November to May.

In addition, the mean maximum temperatures were between 27 and 35°C during the dry season when the experiment was conducted.

The experimental animals

Twenty four Yankasa yearling rams (16 from the station and 8 from the open market) were quarantined for 30 days prior to the commencement of the experiment. During this period, they were carefully examined, dewormed with Vermorid(R) and tick-bathed with Pfizona(R) at two weeks interval. The animals were fed Digitaria hay as basal diet supplemented with concentrate consisting of 25% cottonseed cake (CSC) and 75% maize at the rate of 0.3 Kg/head/day during the period they were quarantined.

The experimental feeds

The basal diets used were untreated maize husk (UMH) and untreated rice straw (URS). Both were post-harvest crop residues in and around the area of study. Harvest was done in October and these residues were gathered shortly after harvest. They were sun-dried for about a week and then stored for later use. The maize milling waste (MMW) used as supplement was the chaff from shelled maize procured in and around the study area. A pasture of predominantly *Digitaria smutsii* served as grazing reserve for the animals. The sodium bicarbonate used was purchased from Wilson Soda Co. Ltd., situated at kilometer 8 along Kaduna-Abuja Road, Kaduna, Nigeria.

Experimental design

Twenty-four Yankasa yearling rams were equally grouped in a Randomized Block Design into six treatments balanced for

weight to have a mean of 16.6Kg. They were individually fed. All animals were provided with drinking water *ad libitum* and allowed to graze on *Digitaria smutsii* pasture for at least 4 hours daily. Treatments T-1 & T-4 were controls which did not receive supplementation. The animals were weighed weekly and the residue of feed offered measured daily to determine the daily intake. The first 30 days were considered as adjustment period while sampling and readings were taken for 63 days. The body condition of the animals were scored at the beginning, mid and end of the 63 day experimental period by a set of 3 independent scorers using visual assessment (Lufadeju, 1988). The routine management of the animals included monthly deworming and dipping twice a month.

All feed samples were analysed at the National Animal Production Research Institute's Laboratory at Shika for proximate composition (A.O.A.C., 1985).

Statistical analysis

The data collected were analysed using the Statistical Analysis System Package (S.A.S,1988) to do the Analysis of Variance and the Duncan Multiple Range Test (Duncan, 1955) to test differences between treatment means.

RESULTS

Feeding regimen

The feeding regimen is shown in Table 1. where both roughages and MMW were fed at the rate of 20g/kg body weight while the additive was given at 2g/kg body weight.

Table 1: *Feeding Regimen*

g/Kg Liveweight

Treatment	UMH	DS	SB	URS
T-1	20	-	-	-
T-2	20	20	2	-
T-3	20	20	-	-
T-4	-	-	-	20
T-5	-	20	2	20
T-6	-	20	-	20

UMH = Untreated Maize Husk
MMW= Maize milling waste
SB = Sodium bicarbonate
URS = Untreated Rice Straw
T-1 = Untreated maize husk
T-2 = Untreated maize husk + SB/MMW mix.
T-3 = Untreated maize husk + MMW.
T-4 = Untreated rice straw
T-5 = Untreated rice straw + SB/MMW mix.
T-6 = Untreated rice straw + MMW mix.

Pasture Species grazed

The composition of the pasture species where the animals grazed is indicated in Table 2. The predominant forage that accounted for over 70% of the entire pasture was *Digitaria smutsii*. *Andropogon gayanus* and *Pennisetum pedicellatum* constituted about 15% while the rest of the forages were about 15% of the whole pasture. These forages in addition to the two roughage types (UMH and URS) used formed the basal diet for the animals.

Table 2: *Survey of Pasture Species in the Grazed Paddoc.k*

Grass Species	Occurrence
Andropogon gayanus	XXX
Cynodon dactylon	XX
Pennisetum pedicellatum	XXX
Sateria anceps	X
Sporobolus pyramindalis	XX
Digitaria smutsii	XXXX
Legumes & Herbs	
Angeratum conyzoides	X
Borreria radiata	X
B. verdicellata	X
Cassia acuta	X
C. occidentalis	X
C. tora	X
Indigofera herdellotii	XX
Lippia chevieliari	X
Sida acuta	X
Sundrella nodiflora	XX
Vernonia perrottetii	X
Shrub	
Isoberlina doka	XX

Key

X = Below 5%
XX = Below 10%
XXX = Below 15%
XXXX = Above 70%

Chemical composition

The chemical composition of the dietary constituents used in this experiment is shown in Table 3. URS was 1.09 percent higher than UMH in CP content. The highest CP content was in maize milling waste (MMW) (12.88%) and the lowest in UMH (3.06%). *Pennisetum pedicellatum* and UMH contained the most and least NDF (91.9% vs 47.31%), respectively. Maize milling waste and *Pennisetum pedicellatum* had the least and most ADF (15.58% vs 63.88), respectively. The value of hemicellulose was highest in MMW while it was lowest in UMH (70.06 vs 17.01). The highest lignin content was in *Pennisetum pedicellatum* while the least was in MMW (12.33 vs 3.65), respectively. Sodium bicarbonate / MMW mix had the highest ash content while the lowest was in MMW (60.28 vs 5.07), respectively.

Table 3: *Chemical Composition (%) of Dietary Constituents used in the experiment*

FEEDSTUFF	DM	CP	NDF	ADF	HEMICELLULOSE	IGNIN	ASH
Untreated rice straw	91.94	4.15	54.23	34.73	19.50	12.31	15.86
Untreated maize husk	91.53	3.06	47.31	30.2	7.10	8.23	18.34
Digitaria smutsii	95.40	7.88	77.59	51.23	26.36	7.13	7.34
Andropogon gayanus	6.30	6.72	84.38	4.67	29.71	9 .61	5.83
Pennisetum pedicellatum	95.69	6.38	91.96	63.88	28.08	12.33	8.68
Maize milling waste	92.39	12.88	85.64	15.58	70.06	3.65	5.07
Sodium bicarbonate /MMW mix	99.85	9.31	75.11	n.a	n.a	n.a	60.28

MMW = Maize Milling Waste n.a = Not Available NDF = Neutral detergent fibre
DM = Dry matter CP = Crude protein ADF = Acid detergent fibre

Daily and total feed intake

The average daily and total feed intakes are presented in Table 4. The intake of the controls (T-1 and T-4) differred significantly ($P < 0.01$) while there was no significant difference between T-2 and T-5. However, that of T-3 and T-6 differed significantly ($P < 0.01$). There was no significant difference between the intake of supplements (concentrate or additive). Intakes of T-1 and T-4 also differred significantly ($P < 0.01$), while that of T-2 and T-5 did not show any significant difference. On the other hand, T-3 and T-6 differred also significantly ($P < 0.01$).

Table 4: Mean *daily intake of sheep fed two roughage types with or without supplement*
supplement

	Treatments						
Feed Intake	*Untreated maize husk alone (T-1)*	*Untreated maize husk +MMW/NaHC0 ^{3} (T-2)*	*Untreated maize husk +MMW alone (T-3)*	*Untreated rice straw alone (T-4)*	*Untreated rice straw +MMW/ NaHC0^3 (T-5)*	*Untreated rice straw +MMW alone (T-6)*	*±SEM*
Daily roughage intake (g/kg $W^{0.75}$)	*28.09^{ab}*	*29.03^{ab}*	*23.39^{d}*	*26.35^{c}*	*28.51^{ab}*	*30.24^{a}*	*1.177*
Daily Supplement intake (g/kg $W^{0.75}$)	-	*12.57^{b}*	*50.54^{a}*	-	*12.56^{b}*	*51.98^{a}*	*2.379*
Total feed intake (g/kg $W^{0.75}$)	*28.09^{d}*	*40.47^{c}*	*71.91^{b}*	*26.35^{e}*	*39.69^{c}*	*81.98^{a}*	*2.434*

abdc = Means in the same row with different superscripts differed significantly (P<0.01)

$NaHC0_3$ = Sodium bicarbonate (SB)

Liveweight changes and body condition scoring

The data on liveweight changes and body condition scoring are presented in Table 5. Animals in T-1 and T-4 consistently depreciated in body condition as against other treatment groups, which appreciated. However, T-5 was 21.4% superior to T-2 in body condition evaluation probably due to differences in CP content of roughage types (4.15%, URS vs 3.06%, UMH). There were significant differences ($P<0.01$) in liveweight changes in all the treatments except T-2 and T-5. The body condition scorings were vital in the evaluation of liveweight responses. The initial body condition scoring for T-1 which had no supplement was 2.68 while the final was 2.33, indicating depreciation in body condition. T-4 also followed the same trend (3.66 vs 3.34). Other treatments did not show a decline in body condition. T-5 was 21.4% higher than T-2 in body condition scoring. Also, T-6 was higher than T-3 by 49.7%.

Table 5: *Liveweight changes and body condition scoring*

	Treatments						
Variable Components	T - 1	T - 2	T - 3	T - 4	T - 5	T - 6	±SEM
No of Animals	4	4	4	4	4	4	
Mean initial Wt(kg)	16.84	16.66	16.38	16.23	16.65	16.53	0.112
Mean final Wt(kg)	15.64^{d}	17.06^{a}	16.48^{c}	15.23^{d}	17.15^{a}	16.73^{b}	1.137
Total gain/loss (kg)	-1.20^{d}	0.40^{a}	0.10^{c}	-1.00^{d}	0.50^{a}	0.20^{b}	0.964
Mean daily gain/loss (g)	-19.0^{d}	6.29^{a}	1.58^{c}	-15.86^{d}	8.00^{a}	3.14^{b}	2.011
Initial body condition*	2.68^{b}	2.22^{c}	2.33^{c}	3.66^{a}	2.62^{b}	3.45^{a}	1.291
Final body condition*	2.33^{d}	2.83^{c}	2.78^{c}	3.34^{b}	3.45^{a}	3.49^{a}	1.273
	(-ve)	(+ve)	(+ve)	(-ve)	(+ve)	(+ve)	

Abcd = Means in the same row with different superscripts differed significantly ($P < 0.01$)

* Subjective scoring on a scale of 1= poor; 2=moderate; 3=good; 4=very good; 5=excellent.

+ve = weight gain

-ve = weight loss

DISCUSSION

Taiwo *et al.*,(1992) reported the crude protein content of untreated maize husk to be 3.3% while Alawa and Umunna (1993) in their review of potential Agro-industrial by-products in Nigeria documented the CP content of untreated maize husk to be 2.6%. In this study, the CP content of UMH was found to be 3.06% which compared favourably with these values. The fact that the CP content of UMH is low and may not be able to support production is well documented. Alawa and Umunna (1993) found the CP content of untreated rice straw (URS) to be 4.5% while Kumwenda *et al.*, (1991) reported it to be 4.9%. In this study, the CP content of URS was 4.15%. Again, this result was at par with the values reported by these

authors. The CP content of a feed determines to a large extent its nutritive value.Consequently, animal performance has a strong bearing with the level of the CP content of the feed offered. In other words, feeds with high or moderate level of CP contents are likely to influence animal performance positively. The ash content (5.07%) of the maize milling waste used in this experiment was higher than the 3.69% reported by Adeloye (1994). The disparity may be due to the maize varieties used. This may further support the difference in CP content earlier mentioned since high ash content has been known to be correlated with low calorific value (Pathak *et al.*, 1986). The lignin content indicative of high crude fibre (CF) of MMW in this study (3.65%) was higher than 2.71% reported by Adeloye(1994). The varieties of maize used might also contribute to the difference. Although, the lignin content of UMH was lower than that of URS in this study (8.23 vs 12.31%), the value of hemicellulose of URS (19.50%) was higher than that of UMH (17.10%) which is an important factor in ruminant digestion and animal performance. There was not much difference between the lignin value (12.1%) of the URS reported by Pathak et al. (1986) and the value obtained in this study. However, the lignin content of the UMH in this study (8.23%) was slightly higher than the value (6.20%) reported by Taiwo *et al.*(1992). Again, maize varieties may likely account for this difference.

There were significant differences in voluntary roughage intake of DM from UMH, URS, supplement and total diet.The variation in voluntary intake may not be unconnected with roughage types used in the experiment. The difference in voluntary intake may also be associated with feed composition and palatability of the diet offered. Naturally, $NaHCO_3$ is pungent in taste and sheep are not too comfortable with this taste hence their inability to consume large quantity of it even when combined with a 'carrier.' Voluntary intake might be improved perhaps if the method of $NaHCO_3$ incorporation into the 'carrier' is improved by pelleting. The inclusion of $NaHCO_3$ in T-2 and T-5 greatly stimulated roughage intake .The stimulatory effect of $NaHCO_3$ on feed intake and performance has been well documented (Kellaway *et al.*, 1978). It was suggested that this stimulatory effect might be attributable to an increase in rumen buffering capacity and some indication of an increase in the fractional outflow rate of water and possibly particulate matter from the rumen. The supply of ?-linked glucose polymer to the small intestine has also been associated with the inclusion of buffer agent (NaCl or $NaHCO_3$) in ruminant feed. Earlier, Kellaway *et al.* (1978) and Kellaway *et al.* (1977) had shown that voluntary feed intake of cereal-based diets or roughages by calves was greatly stimulated by the addition of mixed buffer salts or $NaHC0_3$ to the diet. Harrison *et al.* (1975) reported that buffer salts had an osmotic action in the rumen which could increase rumen dilution rate and improve the efficiency of ruminal digestion. It was also observed that $NaHCO_3$ inclusion influenced rumen conditions such that an increase in food intake was probably due to greater ability of the rumen micro-flora to digest the extra dietary nutrients presented to them. Carter and Grovum (1990) reported that the intake of a single feed was affected by both rumen pH and osmolarity. Sodium bicarbonate ($NaHCO_3$) has a tremendous positive effect on both. Several researchers have also reported that supplemental $NaHCO_3$

increased ruminal pH (Rogers *et al.*, 1982; Okeke *et al.*, 1982). Increased ruminal pH, in turn has been shown to increase ruminal digestion of protein (Okeke *et al.*, 1983) and fibre (Rogers *et al.*, 1982). Addition of $NaHCO_3$ influenced rumen digestion positively in this study. The explanation advanced for the difference in weight changes between the animals in T-2 and T-5 treatment groups is that the CP content of URS is 30.3% higher than that of UMH, a factor which cannot be overlooked in the evaluation of the nutritive values of roughages. The value of CP content is very important in a diet offered to animals because it has been documented that when the nitrogen content of a diet is less than 1.2% (Nx6.25=CP), then rumen fermentation would be impaired and animal performance lowered (Conrad and Hibbs,1968). Although both the values for UMH and URS were lower than the figure given above, the nitrogen values of MMW and $NaHCO_3$ mix were slightly higher than 1.2%. This might be responsible in part for the positive response in liveweight of the animals in groups which had additional supplement. The feeding of energy and protein supplements has been known to enhance the utilization of poor quality feeds by maximizing roughage degradation and optimizing rumen microbial protein synthesis (O' Donovan, 1983). The supplements added in this experiment demonstrated this phenomenon as evidenced in the positive weight responses.

It is concluded that addition of sodium bicarbonate to animal feed substantially enhanced the efficiency of rumen digestion and subsequently, liveweight performance. Also, the inclusion of MMW as concentrate improved liveweight responses.

REFERENCES

Adeloye, A. A. (1994). The influence of varying ratio of cowpea husk and maize milling waste on the intake of protein and energy utilization by goat. Nig. J. Anim. Prod. 21: 108-112.

Alawa, J.P. and Umunna, N. N. (1993). Alternative feed formulation in the developing countries: Prospects for utilization of agro-industrial by-products. J Anim. Prod. Res. 13 (2): 63-98.

Anderson, D.C. (1978). Use of cereal residues in beef cattle production systems. J. Anim. Sci., 46:849-861.

A.O.A.C. (1985). Association of Official Analytical Chemists. Official methods of Analysis, 13th Edn. Washington, D.C.

Carter, R.R. and Grovum, W.L. (1990). A review of the physiological significance of Hypertonic body fluids on feed intake and rumen function: salivation, mobility and microbes. J. Anim Sci., 68:2811-2832

Conrad, H.R. and Hibbs, J.W. (1968). Nitrogen utilization by the ruminant. Appreciation of its nutritive value. J. Dairy Sci.., 51:276-284.

Duncan, D.D. (1998). Multiple range and Multiple F Tests. Biometrics, 11:1-42.

Emmanuel, B., Lawlor, M.J. and Mc Aleese, D. (1970). The effect of phosphate and

Carbonate-bicarbonate supplements on the rumen buffering systems of sheep *Brit. J. Nutr. 24: 653-660.*

Greenhalgh, J.F.D. (1980). Use of straw and cellulosic wastes and methods of improving their value. By-products and Wastes in Animal Feeding. Occasional Publ. No. 3 Brit. Soc. of Anim. Prod. Pp. 25-31.

Harrison, D.G., Beever, D.E., Thomson, D.J. and Osbourn, D.F. (1975). Manipulation of rumen fermentation in sheep by increasing the rate of flow of water from the rumen. J. *Agric. Sci., Camb. 85*: 93-101.

Kellaway, R.C., Thomson, D.J., Beever, D.E and Osbourn, D.F. (1977). Effects of Na Cl And $NaHCO_3$ on food intake, growth rate, acid base balance in calves. *J. Agric. Sci. (Camb.) 88:1-9.*

Kellaway, R.C., Thomson, D.J., Beever, D.E Thomson, D.J., Austin, A.R., Cammell, S.B. and Elderfileds, M.L. (1978). The effect of NaHCO3 on digestion in the stomach of weaned calves. J. *Agric Sci., 91*: 497-503.

Kumwenda, M.S.L., Jayasuriya, M.C.N., Wanters, G and Bhattacharya, A.N. (1991). Rice straw as a day season feed. Use of chemical treatment and by-product supplements on growth and milk production in cattle. A technical report FAAO, 120

Lufadeju, E.A. (1988). Evaluation of improving utilization of mature *Andropogon gayanus* (Gamba hay) by Freisian-Bunaji heifers. Ph.D Thesis Ahamdu Bello University, Zaria, Nigeria, 207p.

O'Donovan, P.B. (1983). Untreated straw as a livestock feed. A review nutr. Abstr., Revs. Series 53: (7) 444-455.

Okeke, G.C., Buchanan-Smith, J.G. and Grieve, D.G. (1982). Effect of sodium Bicarbonate on rate of passage and degradation of soyabean meal in post partum diary cows. J. *Dairy Sci. 66*: 1023 (Abstr)

Okeke, G.C., Buchanan-Smith, J.G. and Grieve, W.L. (1983). Effect of buffers of Ruminal rate of passage and degradation of soyabean meal in steers. Dairy cows *J Anim. Sci. 56*Orsbourn, D.F., Terry, R.A., Camwell, S.B. and Onten, G.E. (1970). Some effects of feeding supplements of maize meal and sodium bicarbonate upon the digestion of forage cellulose by sheep. Proc. Nutr. Sci. 29:12-13.

Pathak, B.S., Jain, A.K. and Singh, A. (1986). Characteristics of crop residues. *Agric. Waste.* 16: 27-35.

Rogers, J.A., Davis, C.L. and Clark, J.H. (1982). Alteration of rumen fermentation, Milk fat Synthesis, and nutrient utilization with mineral salts in diary cows. J. Dairy Sci., 65:577 (Abstr).

SAS (1988). Statistical Analysis Systems Inst. Ins., Users' Guide version 6 edn., Cary North Carolina, USA pp. 283-773.

Salvay, S.A. (1983). Sodium bicarbonate in animal nutrition. Rue du prince Albert, 33, 1050 Brussels Belgium. Pp. 1-4.

Taiwo, A.A., Adebowale, E.A. Greenhalgh, J.F.D. and Akinsoyinu, A.O (1992). Effects of Urea treatment in the chemical composition and degradation characteristics of some crop residues. Nig. J. Anim. Prod. 19 (1 2): 25-36.