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COMPARATIVE EVALUATION OF ADDITION OF SODIUM BICARBONATE AND 'KANWA' TO MAIZE MILLING WASTE AND THE EFFECTS OF UTILIZATION OF TWO TREATED ROUGHAGE TYPES BY YANKASA YEARLING RAMS

FAYOMI, A.

College of Agriculture and Animal Science, Division of Agricultural Colleges,

Ahmadu Bello University, Kaduna, Nigeria.

SUMMARY

Twenty-four Yankasa yearling rams were grouped into six. Each group comprised of similar weights. The animals were randomly assigned to these six experimental feeds: Treated Maize Husk (TMH) +Maize Milling Waste (MMW) - control; TMH + Sodium Bicarbonate (SB) + MMW; TMH + MMW + 'kanwa' (KW); Treated Rice Straw (TRS) + MMW - control; TRS + SB +MMW; TRS + MMW + KW. Both TMH and TRS were fed at the rate of 20g/kg while SB or KW and MMW were fed at the rate of 2g and 20g/kg body weight respectively. The objective of this study was to compare the relative effects of SB and KW on sheep performance when roughages were enhanced by chemical treatment. Intake of TMH varied from 36.42g/KgW $^{0.75}$ to 43.43g/KgW $^{0.75}$, while that of TRS varied from 37.24g/KgW $^{0.75}$ to 44.66g/KgW $^{0.75}$. Intakes of supplements varied from 42.02g/KgW $^{0.75}$ to 51.68g/KgW $^{0.75}$. Addition of KW to the feed was superior to sodium bicarbonate in terms of feed intake and weight responses.

KEY WORDS: Yankasa, Rams, Rice straw, Maize, Sodium bicarbonate, 'Kanwa'

INTRODUCTION

Roughage supplementation especially with minerals is beneficial in ruminant digestion because of their positive effects on the rumen ecosystem. However, the efficiency of digestion can be enhanced when such roughages are treated and supplemented with minerals which serve as buffers. Buffers such as sodium bicarbonate and 'kanwa' (Natron or Potash) could be beneficial when diets produce unfavourably low pH in the digestive tract (Emerick, 1976). Responses to buffer are variable and seem to indicate a mode of action other than a change in pH of the digestive tract contents. Buffers in diets may increase the rate of disappearance of liquid material from the rumen as a result of osmotic action (Harrison et al; 1975). Kellaway et al; (1978) reported that the rate of liquid disappearance was increased when buffers such as sodium bicarbonate and potash were included in the diet. Addition of buffers has been known to positively affect the rate of passage and digestion in ruminant animals (Kovacik et al; 1986).

Since poor quality roughages contain suboptimal amounts of important nutrients needed for rumen microbes, they are not adequately degraded and subsequently, the animal does not derive the potential value of the feed. The addition of nitrogen supplements that are moderately degradable provides nitrogen through peptides and amino acids to NH_3. For such moderately degradable supplements, it is advisable to add a readily available or soluble source of energy so as to match rumen ammonia production with energy, thus ensuring maximum efficiency of microbial growth, multiplication and increased activity. Treatment of straw especially with urea has been known to enhance the N content of straws. But even after appropriate treatment, residues need to be supplemented to meet deficiencies of nitrogen and minerals (Pearce, 1982), hence the choice of a cheaper source of supplement such as maize milling waste. The efficiency of the rumen environment can also be enhanced by the addition of buffers such as $NaHCO_3$ and 'kanwa'. Reports on the efficacy of these additives and their comparative efficiency are scanty.

The objective of this work was, therefore, to examine the comparative effects of these additives on feed intake, and weight responses when maize milling waste was used as concentrate.

MATERIALS AND METHODS

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 through 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 yearling Yankasa rams were purchased from nearby markets of Shika and Giwa and 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. They were also vaccinated against Contagious Caprine Pleuropneumonia and Rinderpest. The animals were fed with *Digitaria* hay as basal diet supplemented with concentrate consisting of 25% Cotton Seed Cake (CSC) and 75% maize at the rate of 0.3kg/head/day during the period they were quarantined.

The experimental feeds

The basal diets used were Treated Maize Husk (TMH) and Treated Rice Straw (TRS), both of which were post harvest crop residues that abound 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 treatment and use. The maize milling waste (Dusa) used as concentrate was the chaff from shelled maize grains procured in and around the study area. A pasture of predominantly *Digitaria smutsii* served as grazing reserve for the animals.

The sodium bicarbonate ($NaHCO_3$) used was manufactured by Wilson Soda Co. Ltd. situated at kilometer 8 along Kaduna - Abuja Road, Kaduna, Nigeria; while the 'kanwa' used was purchased at Shika market.

Treatment of roughage types

Unchopped maize husk and rice straw were treated with 4% urea solution (40g urea dissolved in 1 litre of water per kilogram of roughage) using a garden watering can, in batches of 10kg. Urea solution was sprinkled over the straw with simultaneous mixing to achieve uniform spread. The stack method of Lufadeju and Olorunju (1986) was adopted in the treatment of the two roughage types used in this experiment. A layer of polythene bag was put on a concrete floor and 10kg of roughage was weighed and put on the spread polythene sheet. Meanwhile, a watering-can was filled with about 10 litres of water and 400g of urea was measured and thoroughly mixed in the 10 L watering-can for about 10 minutes to allow the urea dissolve properly. The urea solution was then sprayed on the roughage. The roughage was sealed completely from all sides by rolling the top sheet with the bottom sheets and then left for 7 days inside a well ventilated room. The stack was then opened after 7 days for some hours to allow for aeration of excess NH_3. The roughage was stored, ready for use while the treatment of another stack commenced immediately going through the process all over again.

Experimental procedure

Twenty four Yankasa yearling rams were equally grouped in a Randomized Block Design into six treatments balanced for weight to have a mean of 15.7kg. They were allocated at random to the following six treatments in a Randomized Block Design: Treatment 1: TMH plus MMW which served as control for TMH roughage; Treatment 2: TMH plus $NaHCO_3$ - MMW mix; Treatment 3: TMH + Kanwa - MMW mix; Treatment 4: TRS plus MMW which served as control for TRS roughage; Treatment 5: TRS + $NaHCO_3$ - MMW mix; Treatment 6: TRS plus kanwa - MMW mix. The roughages and MMW were fed at 20g/kg live weight while sodium bicarbonate and kanwa were fed at 2g/kg live weight. All animals were allowed to graze for at least 4 hours daily on a predominantly *Digitaria smutsii* pasture. Water was made available *ad-libitum*.

Animals were housed in individual pens measuring 3.0x1.5sq m with concrete floors and half walls. The individual pens were washed and disinfected twice weekly. The animals were dewormed monthly while dipping with Pfizona(R) was done twice in a month.

There was an adjustment period of 30 days before measurements were taken on feed intakes and live weight responses. All animals were weighed once a week in the morning of the same day. The body conditions of the animals were scored at the beginning, mid and end of the 63 day experimental period by 3 independent scorers using visual assessments (Lufadeju and Olorunju, 1986).

All samples were analysed at the National Animal Production Research Institute's Laboratory, Shika, Nigeria. Samples for chemical analysis were ground through a 1.0mm sieve. Total N was determined by Kjeldahl method; ashing of samples was carried out in a mufffle furnace at 600°C for 5 hours and dry matter was also determined (A.O.A.C., 1985). Crude protein (CP) was calculated as N x 6.25. ADF and NDF determinations were carried out according to the methods of Goering and Van-Soest (Goering and Van - Soest, 1970). Lignin was determined according to the method suggested by Browning (1967). The method of Fonnesbeck and Harris (1971) was used in determining the hemi cellulose values of the samples.

Statistical analysis

The data were analysed using ANOVA and SAS (1988) and the means compared by using Duncan Multiple Range Test (Duncan, 1955).

RESULTS

Feeding Regimen

The feeding regimen is shown in Table I, where both roughages and MMW were fed at the rate of 20g/Kg body weight, while the additives were fed at the rate of 2g/Kg body weight.

TABLE 1: Feeding Regimen

	G/Kg Live Weight			
Treatments	UMH	DS	SB	URS
T-1	20	-	-	-
T-2	20	-	20	-
T-3	20	20	-	-
T-4	-	-	-	20
T-5	-	20	20	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 Occurrence
The occurrence of pasture species in the paddock grazed is presented in Table II.

Chemical Composition
The chemical composition of the dietary constituents used in this experiment is shown in Table III. TRS was 2.93% higher than TMH in CP content. The highest CP content was in MMW (12.9%) and the lowest in *Pennisetum pedicellatum* (6.4%), respectively. The value of NDF was highest (92.0%) for *Pennisetum pedicellatum* and lowest (52.0%) for kanwa/MMW mix. The lowest ADF value (3.7%) was in 'kanwa' / MMW mix while the highest (63.9%) was in *Pennisetum pedicellatum*. The value of hemi cellulose was highest in MMW while it was lowest in *Digitaria smutsii* (70.1 vs. 26.4), respectively. The highest lignin content was in *Pennisetum pedicellatum* (12.3%), while the least (3.7%) was in MMW. 'Kanwa' / MMW mix had the highest ash content (77.8%) indicative of low calorific value while the lowest was in TMH (2.2%).

Daily and total average feed intake
The average daily and total feed intakes are portrayed in Table IV. The mean daily roughage intakes (g/kg $W^{0.75}$) were: T-1, 39.4; T-2, 36.4; T-3, 43.4; T-4, 37.2; T-5, 44.0 and T-6, 44.7. T-3, T-5 and T-6 did not differ but differed from the other treatments. There were significant differences between supplement intakes in all the treatment groups. The average total daily intake (g/kg $W^{0.75}$) for all the treatment groups was: T-1, 83.8; T-2, 76.4; T-3; 90.3; T-4, 78.7; T-5, 88.5; and T-6, 90.2. There was no significant difference ($P > 0.01$) in feed intakes of T-3, T-5 and T-6. However, while T-5 and T-6 did not show any difference statistically, T-2 and T-3 differed significantly ($P < 0.01$). There was also significant difference between the intakes of the control groups (T-1 and T-4). T-1 and T-2 differed significantly ($P < 0.01$).

Live weight changes and body condition scoring
The parameters for live weight changes and body condition scoring are shown in Table V. The total live weight changes in the 6 treatment groups were: T-1, 3.20kg; T-2, 5.30kg; T-3, 7.00kg; T-4, 3.30kg; T-5, 6.50kg and T-6, 8.10kg. The mean daily live weight changes over a period of 63 days were: T-1, 50.79g; T-2, 84.13g; T-3, 111.1g; T-4, 52.38g; T-5, 103.17g and T-6, 128.57g. While there were differences in live weight changes statistically ($P < 0.01$), T-1 and T-4 did not show significant difference in live weight changes. Diets with the inclusion of $NaHCO_3$/MMW mix or 'kanwa'/MMW mix had higher weight gains than the control but those with kanwa as additive appeared to be more efficient in animal performance. No treatment group lost weight.

There was no loss in body condition in all the 6 treatment groups as indicated by the condition scoring parameters in Table V. The initial body condition scorings for T-1 and T-4 which were the control groups were 2.78 and 3.00 respectively while the final scorings were 2.94 (T-1) and 3.25 (T-4) respectively indicating a lower positive live weight response when compared with other treatment groups with additives. All the treatment groups differed significantly ($P < 0.01$) except for T-2, T-3 and T-5 that did not differ from each other and T-1 and T-4 that also did not differ.

TABLE II: Survey of Pasture Species in the Grazed Paddock Grasses

Specie	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%

TABLE III: Chemical Composition (%) of Dietary Constituents used in the experiment

FEEDSTUFF	DM	CP	NDF	ADF	HEMICELLULOSE	LIGNIN	ASH
Treated rice straw	95.74	12.31	80.09	49.75	**30.34**	**5.36**	9.65
Treated maize husk	95.20	9.38	89.32	49.95	**39.37**	**6.30**	2.22
Digitaria smutsii	95.40	7.88	77.59	51.23	**26.36**	**7.13**	7.34
Andropogon gayanus	96.30	6.72	84.38	54.67	**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 (MMW)	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
Kanwa/MMW mix	87.85	10.89	51.97	3.72	**48.25**	**1.77**	77.78

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

TABLE IV: Mean daily intake of yearling rams fed two roughage types with or without supplement

Feed Intake	Treatments					
	Treated maize husk MMW +MMW/Kanwa (T - 1)	Treated maize husk +MMW/$NaHCo_3$ mix (T-2)	Treated maize husk MMWKanwa (T - 3)	Treated rice straw MMW (T - 4)	Treated rice straw +MMW/$NaHCo_3$ mix (T-5)	Treated rice straw (T - 6)
Daily roughage intake (g/kg $W^{0.75}$)	39.36 ± 2.10^{b}	36.42 ± 1.82^{c}	43.43 ± 2.62^{a}	37.24 ± 1.93^{c}	43.99 ± 2.81^{a}	44.66 ± 2.89^{a}
Daily supplement intake (g/kg $W^{0.75}$)	47.85 ± 2.51^{d}	40.02 ± 2.11^{f}	51.68 ± 3.90^{b}	43.99 ± 2.81^{e}	49.11 ± 3.01^{c}	50.45 ± 3.80^{b}
Total feed intake (g/kg $W^{0.75}$)	83.82 ± 4.21^{b}	76.44 ± 3.91^{d}	90.34 ± 4.31^{a}	78.73 ± 4.01^{c}	88.50 ± 4.26^{a}	90.19 ± 4.28^{a}

abcdef = Means in the same row with different superscripts differed significantly ($P < 0.01$)
$NaHCo_3$ = Sodium bicarbonate (SB)

T-1 = Treatment 1
T-2 = Treatment 2
T-3 = Treatment 3

TABLE V: Live weight changes and body condition scoring of the yearling rams

Variable Components	Treatments					
	T - 1	T - 2	T - 3	T - 4	T - 5	T - 6
No of Animals	4	4	4	4	4	4
Mean initial Wt(kg)	15.56 ± 2.02^{a}	15.65 ± 2.22^{a}	15.82 ± 2.41^{a}	15.78 ± 2.31^{a}	15.65 ± 2.22^{a}	15.83 ± 2.42^{a}
Mean final Wt(kg)	18.76 ± 3.12^{b}	20.95 ± 3.41^{ab}	22.82 ± 3.60^{ab}	19.08 ± 3.20^{b}	22.15 ± 3.61^{ab}	23.93 ± 3.82^{a}
Total gain/loss (kg)	3.20 ± 0.21^{b}	5.30 ± 0.81^{ab}	7.00 ± 0.90^{ab}	3.30 ± 0.21^{b}	6.50 ± 0.85^{ab}	8.10 ± 1.01^{a}
Mean daily gain/loss (g)	50.79 ± 2.04^{b}	84.13 ± 3.92^{ab}	111.10 ± 4.84^{a}	52.38 ± 2.08^{b}	103.17 ± 4.10^{ab}	128.57 ± 4.93^{a}
Initial body condition*	2.78 ± 0.12^{b}	2.22 ± 0.08^{c}	2.50 ± 0.10^{b}	3.00 ± 0.20^{a}	2.63 ± 0.11^{b}	3.44 ± 0.22^{a}
Final body condition*	2.94 ± 0.10^{c} (+ve)	3.41 ± 0.20^{b} (+ve)	3.72 ± 0.41^{b} (+ve)	3.25 ± 0.09^{c} (+ve)	3.2 ± 0.05^{a} (+ve)	4.91 ± 0.81^{a} (+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**
T-1=Treatment 1
T-2=Treatment 2
T-3=Treatment 3
T-4=Treatment 4
T-5=Treatment 5
T-6=Treatment 6

DISCUSSION

Urea - treated rice straw and maize husk have been found to be variable in CP contents depending on a number of factors (Kumwenda et al; 1991). These factors included amount of chemical used, method and duration of treatment. For TRS, a range of 7.2 to 16.9% CP has been reported when treated with urea - ammonia chemical. For instance, Kumarasuntharam et al., (1984) reported 7.2% as the CP content of urea - ammonia treated rice straw when a "9-day - open in heaps" system was used. However, Kumwenda et al., (1991) documented a CP content of TRS to be 16.9% when the treated heaps were left for 7 days. In this study, the CP content of TRS using identical method was 12.3%. This value is within the range documented by Adeloye (1994). Treatment has substantially improved the CP content of rice straw. Taiwo et al., (1992) found the CP content of TMH to be 13.9%. However, in this study, the CP content of TMH was found to be 9.4% which was lower than that reported by Taiwo et al., (1992).

There were significant differences in both the roughage and supplement intakes. However, roughage intakes of TRS with either $NaHCO_3$-MMW mix or 'kanwa'-MMW mix did not differ significantly ($P > 0.01$) but greater than the treatment without additive. On the other hand, TMH with either of the additives differed significantly ($P < 0.01$). The differences in intakes may not be unconnected with the difference in the CP content of the roughage types used (TRS, 12.3% vs. TMH 9.4%). Both Cooper (1987) and Parsons et al., (1994) have suggested that ruminants appear to select from feeds that differ in nutrient density or digestibility, a diet that enables their rumen to remain in a fit and adaptive state.

Addition of $NaHCO_3$ or 'kanwa' might have had a profound positive effect on the rumen environments since microbial activity within the rumen is greatly affected by changes in rumen environment (Russel and Strobel, 1993). This concept is of significance to the sheep as the supply of energy and protein to the small intestine depends principally upon the activity of these microorganisms. The total feed intakes for diets with 'kanwa' were relatively higher than those with $NaHCO_3$. This difference may be related to the difference in their CP and chemical composition contents. Moreover, addition of 'kanwa' may have influenced the efficiency of rumen digestion more than $NaHCO_3$ did.

The mean daily live weight gain was statistically ($P<0.01$) higher in TRS diet with 'kanwa' than that of TMH with 'kanwa'. The difference in CP contents of these diets may be responsible for their differences in weight gain. 'Kanwa' appeared to be more efficient than $NaHCO_3$ in ruminal digestion of feeds. The addition of MMW (CP, 12.9%) obviously potentiated the effects of treated roughages and additives on the live weight responses of the yearling rams. The trend in body condition scorings was essentially the same with that observed in live weight changes.

Both 'kanwa' and $NaHCO_3$ additives in the treatments proved their superiority over diets without additives. However, no treatment group lost condition, a factor that may be remotely associated with improved roughage diets. The N content of the roughages was substantially elevated by treatment with urea-ammoniation. It has been observed by Conrad and Hibbs (1968) that when the N content of a diet was less than 1.2%, then rumen fermentation would be impaired and animal performance lowered. Roughage treatment undoubtedly raised the N content of these roughages above this value.

CONCLUSION

It is concluded that addition of 'kanwa' to the feed of yearling rams increased the efficiency of its utilization more than that of sodium bicarbonate, and that treatment of roughage types improved their N content and thus enhanced their nutritive value.

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